WELDER

TRADE PRACTICAL

NSQF LEVEL - 4

HANDBOOK FOR CRAFTS INSTRUCTOR TRAINING SCHEME

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

Published by

National Instructional Media Institute
Post.Box.No. 3142,
Guindy, Chennai - 600032
Email : chennai-nimi@nic.in
Website: www.nimi.gov.in

First Edition, 2024

Rs. 375/-

Printed in India at
National Instructional Media Institute
Post. Box. No. 3142,
Guindy,
Chennai - 600032

Disclaimer

The information contained herein has been obtained from sources reliable to Directorate General of Training, New Delhi. NIMI disclaims all warranties to the accuracy, completeness or adequacy of such information. NIMI shall have no liability for errors, omissions, or inadequacies in the information contained herein, or for interpretations thereof. Every effort has been made to trace the owners of the copyright material included in the book. The publishers would be greatfull for any omissions brought to their notice for acknowledgements in future editions of the book. No entity in NIMI shall be responsible for any loss whatsoever, sustained by any person who relies on this material. The material in this publication is copyrighted. No parts of this publication may be reproduced, stored or distributed in any form or by any means either on paper or electronic media, unless authorized by NIMI.

A Comprehensive Training Program
under Crafts Instructor Training Scheme (CITS)
for Instructors

HANDBOOK ON TECHNICAL INSTRUCTOR TRAINING MODULES

अतुल कुमार तिवारी, I.A.S.
सचिव

ATUL KUMAR TIWARI, I.A.S.
Secretary

भारत सरकार
कौशल विकास एवं उद्यमिता मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT AND ENTREPRENEURSHIP

सत्यमेव जयते

Foreword

In today's rapidly evolving world, the role of skilled craftsmen and women is more crucial than ever. The Craft Instructor Training Scheme (CITS) stands at the forefront of this transformation, shaping the educators who will train the next generation of artisans and technicians. This book aims to provide an in-depth understanding of the subject, exploring its significance, methodologies, and impact on vocational training.

The Craft Instructor Training Scheme was established with the objective of enhancing the quality of instruction in industrial training institutes and other vocational training institutions. By equipping instructors with advanced skills and knowledge, the scheme ensures that they are well-prepared to impart high-quality training to their students. This, in turn, contributes to the creation of a highly skilled workforce capable of meeting the demands of modern industry.

The initial chapters provide the importance of specialized instructor training. Following this, detailed chapters delve into the curriculum covering advanced techniques, safety protocols, and instructional strategies. Each section is designed to offer both theoretical insights and practical applications, ensuring a well-rounded understanding of the subject.

The book offers recommendations for overcoming obstacles and enhancing the effectiveness of the program, with the ultimate goal of producing highly skilled instructors capable of shaping the future workforce.

This book is intended for a diverse audience, including current and aspiring instructors, vocational training administrators, policymakers, and industry stakeholders. It serves as a valuable resource for understanding the intricacies of the subject and its pivotal role in vocational education.

I extend my heartfelt gratitude to all contributors who have shared their experiences and expertise, enriching this book with their valuable insights. Special thanks to the contribution of the development team, reviewers and NIMI that have supported this endeavor, providing essential data and resources.

It is my sincere hope that this book will inspire and guide readers in their efforts to enhance vocational training, ultimately contributing to the development of a skilled and competent workforce.

ATUL KUMAR TIWARI, I.A.S.
Secretary, MSDE

त्रिशलजीत सेठी
महानिदेशक
Trishaljit Sethi, IPoS
Director General

सत्यमेव जयते

भारत सरकार
कौशल विकास एवं उद्यमशीलता मंत्रालय
प्रशिक्षण महानिदेशालय
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
DIRECTORATE GENERAL OF TRAINING

FOREWORD

The Craftsmen Training Scheme (CTS) implemented by the Directorate General of Training (DGT) provides skill training to the youth and ensures a steady flow of skilled manpower for the industry. It aims to raise quantitatively and qualitatively the industrial production by systematic training, and to reduce unemployment among the youth by providing them with employable skills.

The Craft Instructor Training Scheme (CITS) is an indispensable part of the Craftsmen Training Scheme (CTS). It offers comprehensive training both in 'skills' and in 'training methodology' to the instructor trainees to make them conversant with techniques of transferring hands-on skills.

I congratulate NIMI for taking the initiative of preparation of the course content for CITS. This will help institutionalize the mechanism for imparting training to the trainers all across the ecosystem. I also extend my gratitude to the Instructors and Officials of National Skill Training Institutes (NSTIs) and the DGT for their invaluable contribution in preparation of the CITS course content.

As we navigate the complexities of a rapidly changing world and the technological disruptions, the significance of CTS and CITS has increased manifold. It not only empowers individuals with practical skills but also lays the foundation for a prosperous future. I am confident that this book will serve as a guiding light to all instructor trainees for skill development and nation-building.

(Trishaljit Sethi)

PREFACE

The Craft Instructor Training Scheme is an indispensable module of the Craftsmen Training Scheme, which has been an integral part of the Indian skill development industry since its inception. This program aims to equip instructors with the necessary skills and teaching methodology to effectively transfer hands-on skills to trainees and promote a holistic learning experience. The first Craft Instructor Training Institute was established in 1948, followed by six more institutes across India in 1960. Today, these institutes, including the National Skill Training Institute (formerly Central Training Institute for Instructors), offer the CITS course, which is mandated by the Directorate General of Training (DGT).

The Craft Instructor training program is designed to develop skilled manpower for industries. The course aims to offer instructors an opportunity to improve their instructional skills, engage learners effectively, offer impactful mentoring, and make efficient use of resources, leading to a more skilled workforce in various industries. The program emphasizes collaborative and innovative approaches to teaching, resulting in high-quality course delivery. Overall, the Craft Instructor Training Scheme is a pivotal program that helps instructors grow in their careers and make a significant contribution to society. This program is essential for developing skilled manpower and promoting a robust learning environment that benefits both trainees and instructors alike.

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following experts to bring out this Instructional material **(Trade Practical)** for **CITS Welder (NSQF Level - 4)** under the **Capital Goods & Manufacturing** Sector for **Instructors**.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

Shri. Subhankar Rana	-	Training Officer, NSTI, Howrah.
Shri. Narasimha Prasad	-	Training Officer, NSTI, Hyderabad.

COORDINATORS

Shri. G.C. Ramamurthy	-	Joint Director, CD - Section, DGT.
Shri. T.V. Rajasekar	-	Joint Director, NIMI, Chennai.
Shri. Snehasish Bandyopadhyay	-	Assistant Director, CD - Section, DGT.

NIMI records its appreciation of 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 staff who have contributed for the development of this Instructional Material.

NIMI is grateful to all others who have directly or indirectly helped in developing this IMP.

ABOUT THE TEXT BOOK

The Vocational Instructor Training Program is a comprehensive initiative designed to equip aspiring students with the necessary skills and knowledge to effectively teach in vocational education settings. This program encompasses a range of pedagogical strategies, instructional techniques, and subject-specific content tailored to the diverse vocational fields. Participants engage in coursework that covers curriculum development, assessment methods, classroom management, and the integration of industry-relevant technologies. Practical experience and hands-on training are emphasized, allowing participants to apply theoretical concepts in real-world teaching environments. Through collaborative learning experiences and mentorship opportunities, aspiring vocational instructors develop the confidence and competence to facilitate engaging and impactful learning experiences for their students. This training program aims to cultivate a new generation of educators who are not only proficient in their respective vocational fields but also adept at fostering the success and employability of their students in today's competitive workforce.

This text book covers communication, self-management, information and communication technology, entrepreneurial and green skills. It has been developed as per the learning outcome-based curriculum.

G C Rama Murthy,
Joint Director,
Curriculum Development, DGT,
MSDE, New Delhi.

CONTENT

CONTENT

CONTENT

CONTENT

◆ MODULE 1 : Induction Training & Welding Process ◆

EXERCISE 01: Familiarize with the institute

Objectives

At the end of this exercise you shall be able to

- identify the staff structure of the institute
- identify the general discipline, laid down by the institute
- record the general discipline, laid down by the institute.

TASK 1: **Visit to various sections in your ITI**

Note: The Instructor will read the new students to various sections in the ITI

1 During the visit note down and collect all information of staff, designation, their name.

2 Identify and note down the various sections (trades) in which training is given.

3 Locate your ITI, showing nearest land marks like post office, Railway stations, Bus stop, and their approximate distance from the ITI.

4 Collect the telphone numbers of the ITI office, nearest Hospital, Police station, nearest firstation and display it.

— — — — —

TASK 2 : **Familiarisation**

1 Identify the head of the institution and his deputy.

2 Classify the majot divisions of the Institute such as group Instructor, office Hostel, Stores, Medical.

3 list out the trades and the trad Instructor for each trade

4 list out the staff working under office Administration

5 list out the staff under hostel division

6 Medical division with a M.O. compounder and dresser

7 List out the general discipline to be followed with in the Institute

8 Learn and follow the rules and regulation of the Institute.

Based on the organisation structure, identify the major function of the staff listed in Table.

Designation	**Function**	**Name**
Principal		
Vice- Principal		
Medical Officer		
Accountant		
Trg & Placement officer		
Group Instructor		
Voc Instructor		
Office Supdt		
Hostel Warden		
Stores Officer		
Phy. Training Instructor		

— — — — —

TASK 3 : Listing Rules & Regulations

The Moral image of the Institute depends on the discipline followed list out the major rules and discipline followed in the institute.

S.No	Rules & Regulation	S.No.	Discipline in the Institute

— — — — —

EXERCISE 02: Demonstration of machinery used in welding trades

Objectives

At the end of this exercise you shall be able to

- name the machinery used in welding shop
- record the name and its uses of each machine in given table.

Job Sequence

- Identify the machinery in your work shop.
- Name the machine and explain their uses.
- Record it in table 1.

Table 1

S. No.	Name of the Machine	Uses
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

- **Get it checked by your instructor.**

Table 1: Referring the machine and use the machine name with help of instructor.

EXERCISE 03: Identification of safety equipment and their uses

Objectives

At the end of this exercise you shall be able to

- identity the safety equipment listed in the drawing
- record the uses of respective safety equipment in the table.

Note: The instructor may provide or arrange the different types of personal protection equipment or chart and explain how to identify and select the PPE devices suitable for the work and ask the trainees to write names and its uses in the given table.

Job Sequence

- Read and interpret the personal protection equipment by visually on real devices or from the charts.
- Identify and select the personal protection equipment used for suitable type of protection.
- Write the name of the PPE to the corresponding type of protection in table 1.

Table 1

S. No.	Name of the PPE	Hazards	Type of protection
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

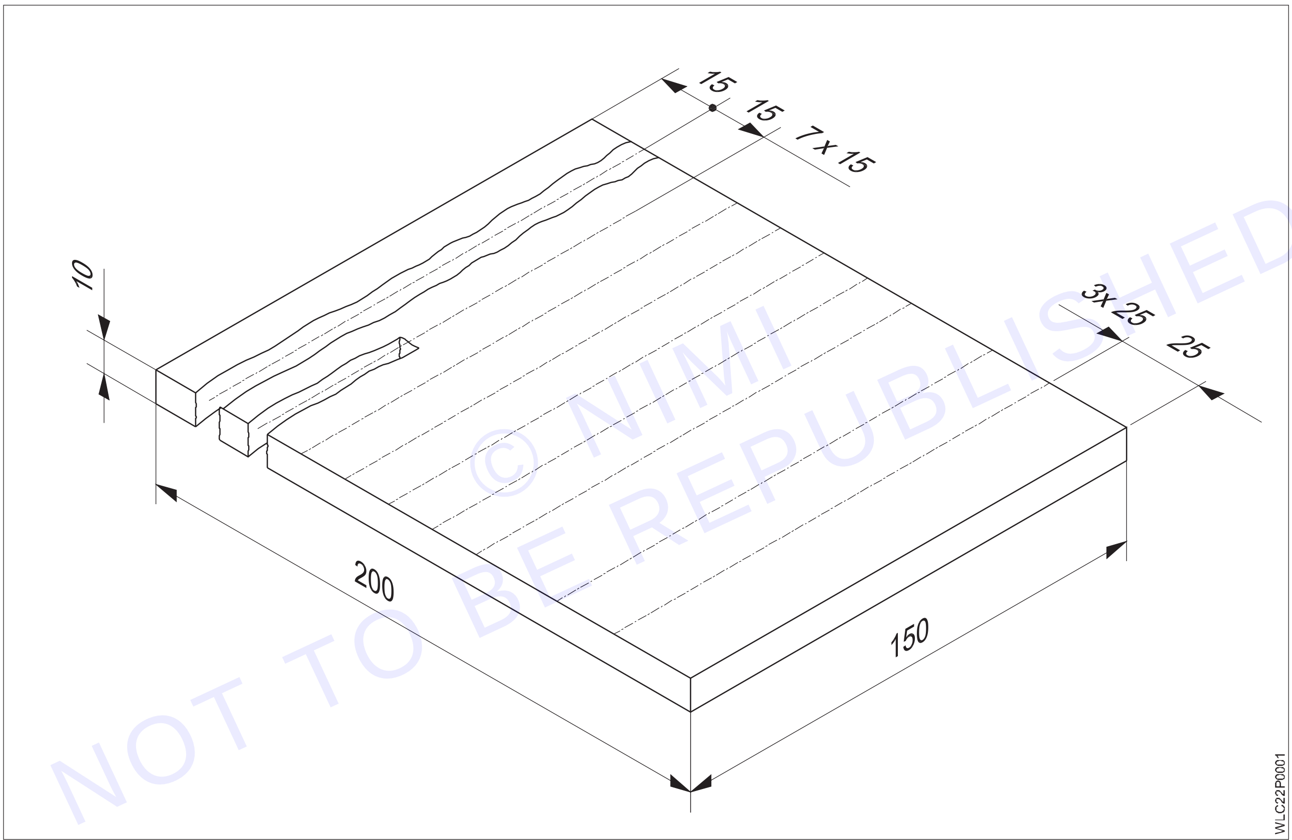
- **Get it checked by your instructor.**

EXERCISE 04: Setting of Oxy - Acetylene and make straight cuts (free hand)

Objectives

At the end of this exercise you shall be able to

- set the work piece for a straight cutting
- adjust the gas cutting flame
- gas cut along a straight line by hand
- observe safety while cutting with gas
- clean and inspect the gas cut surface.



Job Sequence

- Wear complete safety apparel.
- Set the gas welding plant with a cutting blowpipe.
- Attach the correct nozzle according to the thickness of the metal.
- Adjust the gas pressure of acetylene and cutting oxygen according to the thickness of the metal and the cutting nozzle.
- Clean the surface to be cut.
- Punch a straight line.
- Adjust proper cutting flame.
- Hold the cutting blowpipe at 900 to the cut line and plate surface.
- Hold at one end of the plate on the punch line up to cherry red hot.

Note: Keep a distance of about 5mm between the work piece and the nozzle.

- Release the cutting oxygen and observe the cutting action.
- Move the cutting blowpipe towards the other end, following the procedure line.

Note: Maintain a correct speed and distance of the nozzle.

- Close the cutting oxygen and shut off the flame on the completion of the cut.
- Clean the cut and inspect for its accuracy.
- Repeat the exercise till a good and smooth cut is achieved.

Skill Sequence

Straight cutting along by hand

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

- set an oxy-acetylene plant for gas cutting
- gas cut in a straight line by hand
- inspect the faults in a gas cut.

Setting the gas cutting plant: Set the oxy-acetylene plant and connect the cutting blowpipe.

Setting the job for cutting (Fig 1)

Set the job for cutting on a rigid surface.

Provide overhang so that the parting piece is free to fall.

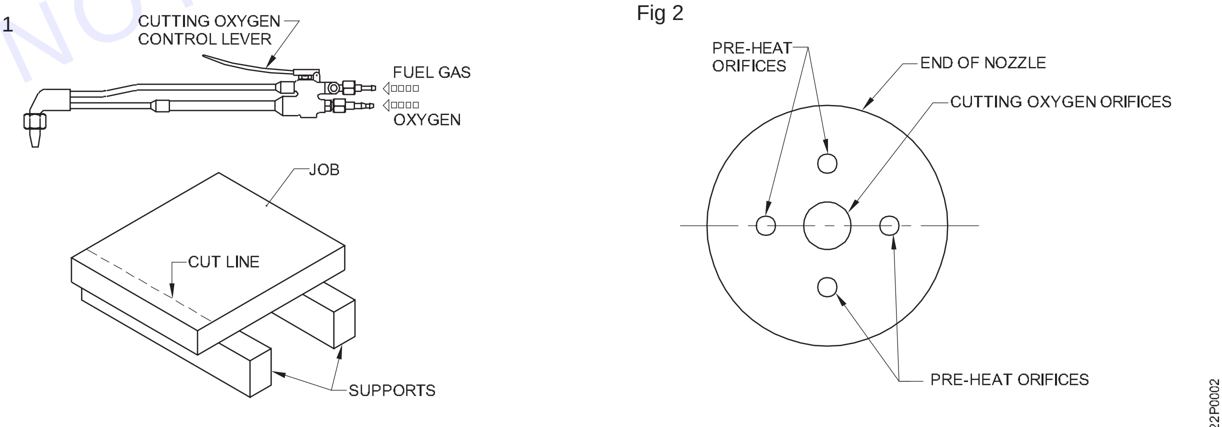
Ensure the underside of the cut line is free from any obstruction.

Wear safety apparel while gas cutting.

Adjusting the cutting flame Select the cutting nozzle and set the gas pressure as per the cutting job thicknesses. (Table 1)

Fig 1

Fig 2



CUTTING JOB SET ON SUPPORTS

HOLES ON THE CUTTING BLOWPIPE NOZZLE

Table 1

Data for cutting

Diameter of cutting oxygen orifice nozzle	Thickness of steel plate	Cutting oxygen Pressure
(1) mm	(2) mm	(3) kg/cm2
0.8 1.2 1.6 2.0 2.4 2.8 3.2	3-6 6-19 19-100 100-150 150-200 200-250 250-300	1.0-1.4 1.4-2.1 2.1-4.2 4.2-4.6 4.6-4.9 4.9-5.5 5.5-5.6

Set the cutting nozzle in the blowpipe correctly. (Fig 2)

Adjust the neutral flame for preheating. (Fig 3)

Note: Ensure that the flame adjustment is not disturbed while operating the control lever for cutting oxygen.

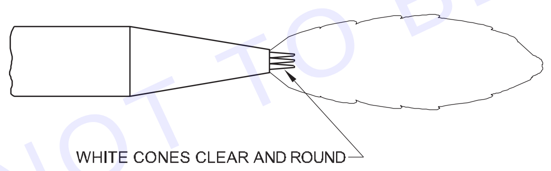
Straight cutting

Hold the cutting blowpipe at 900 with the plate surface, and cut along the line (Fig 4)

Preheat the starting point to red heat. (Fig 4)

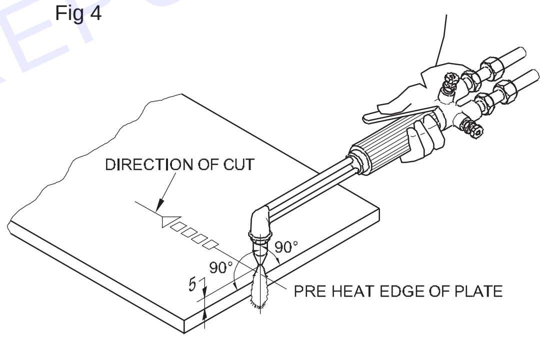
Note: Keep the distance between the work piece and the nozzle about 5mm to avoid backfire. (Fig 4)

Fig 3



CORRECT FLAME ADJUSTMENT FOR CUTTING

Fig 4



STARTING OF CUT

WLC22P0003

Release the extra oxygen, observe the cutting action and start travelling along the punched line at a uniform speed. (Fig 5)

While gas cutting ensures

Note: Straight travel of the cutting blowpipe without side-to-side movement and correct nozzle position with the plate surface till the cutting oxygen valve is fully open.

If possible, fix the straight edge to the plate, and also the spade support to ensure a straight cut (Fig 6) and to maintain correct nozzle distance.

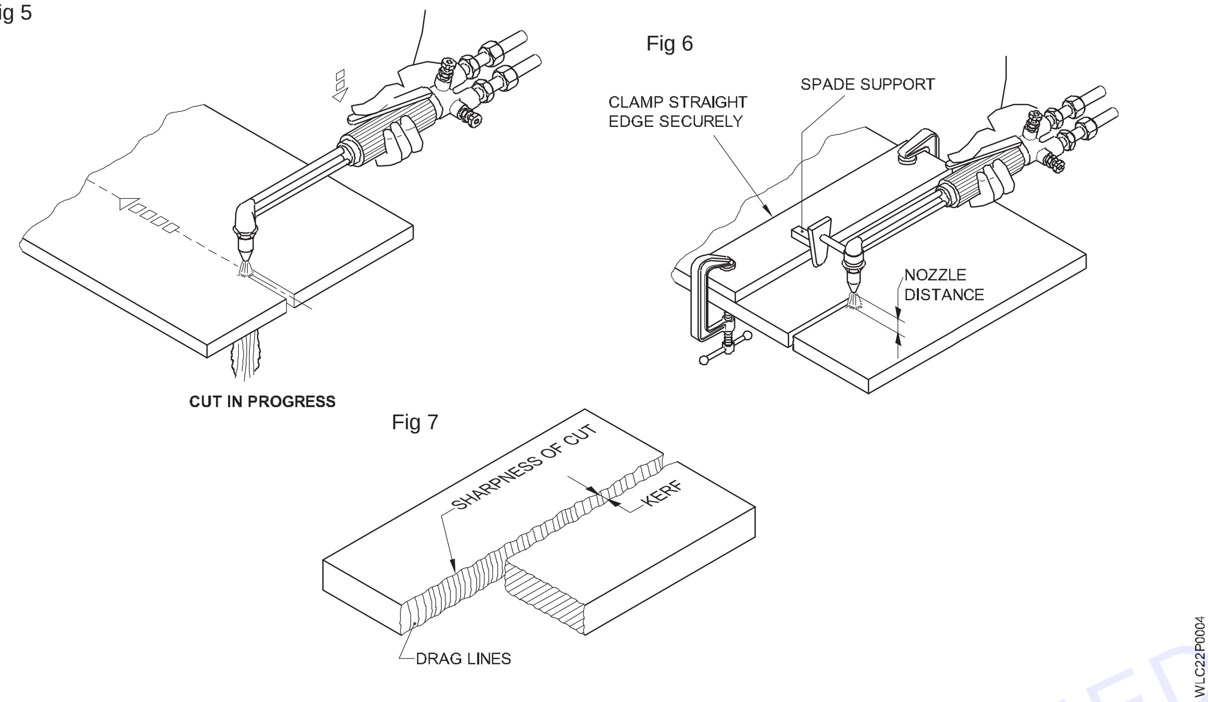
Inspection of gas cut (Fig 7)

Clean the gas cut with a chipping hammer, chisel and wire bunch.

Fig 5

Fig 6

Fig 7



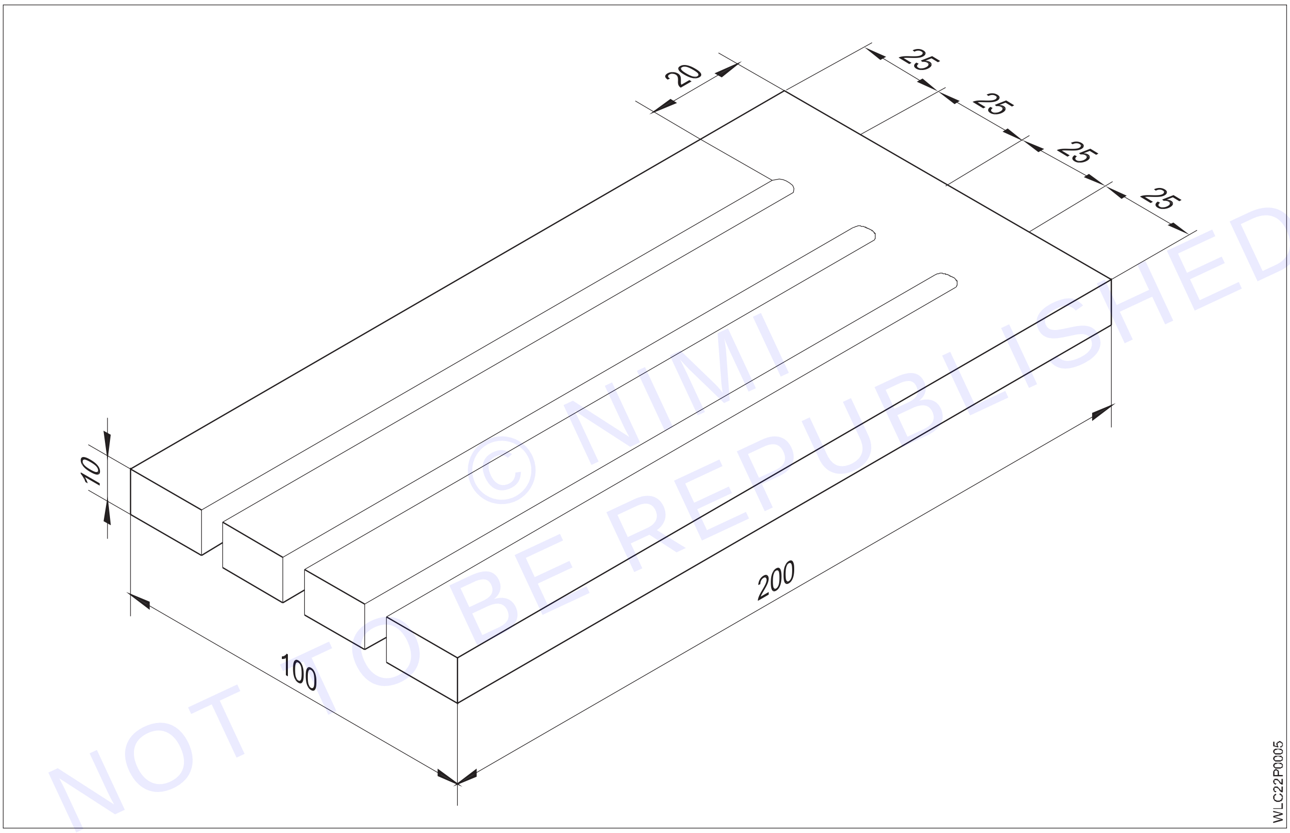
Inspect for uniform

- Smooth cut or drag lines
- Straightness of cut
- Sharpness of cut
- Width of cut.

Perform making straight line cutting of MS plate 10mm thick by gas accuracy within +/-2mm

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

- set the work pieces for a straight cutting
- adjust the gas cutting flame
- gas cut along a straight line by hand
- observe safety while cutting with gas
- clean and inspect the gas cut surfaces.



Job Sequence

Making straight cuts

- Wear all safety clothing.
- Set the gas welding plant with a cutting blowpipe, and cutting oxygen regulator.
- Fit the correct cutting nozzle according to the thickness of the metal to be cut (for M.S. plate 10mm thickness use 1.2mm dia. orifice cutting nozzle)
- Adjust both oxygen and acetylene gas pressure according to the cutting nozzle size. (Oxygen 1.6 kg/sq.cm and acetylene 0.15 kg/sq.cm)

Note: While adjusting the pressure, keep the cutting blowpipe valves open.

- Take 200×150×10 thick plate, clean, mark and punch the straight lines on the plate 25mm apart.
- Set the neutral flame.
- Wear the gas welding goggles.
- Hold the blowpipe at an angle of 90° between the line of cut and the cutting nozzle axis and between the nozzle and the surface of the plate.
- Heat one end of the punched line up to cherry red-hot condition.
- Keep the distance between the work piece and the tip of the nozzle about 5mm.
- Place the preheat cone approximate 1.6mm above the plate.
- Move the flame in circle a little larger than the tip size. When metal is heated to Cherry red, move the tip to the edge of the plate.
- Operate the cutting oxygen lever immediately and move the torch slowly along cutting direction.
- Maintain correct torch speed and distance between the plate surface and the nozzle up to the end of the cut.
- If long plates are to be cut, to get a good straight gas cut surface, clamp a straight edged flat parallel to the line of cut and use a spade guide attached to the cutting torch. Move the torch uniformly along the clamped flat and pressing the spade guide against the flat.
- On completion of the cut release the cutting oxygen lever and shut off the flame.
- Clean the cut surface by wire brush after chipping off any slag sticking to the cut edge

Skill Sequence

Gas cutting

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

- set the gas cutting plant
- cut the material to the required size.

Setting the gas cutting plant: Set the oxy-acetylene gas cutting plant in the same way as was done for welding and connect the cutting blowpipe in the place of the welding blowpipe. (Fig 1) Also change the oxygen welding regulator with oxygen cutting regulator.

Setting the job for straight line cutting (Fig 2): Mark and punch 7 straight lines on the plate 15 mm apart for a straight line cut and 3 lines 25mm apart for bevel cutting on other edge.

Set the job on the cutting table so that the parting piece is free to fall.

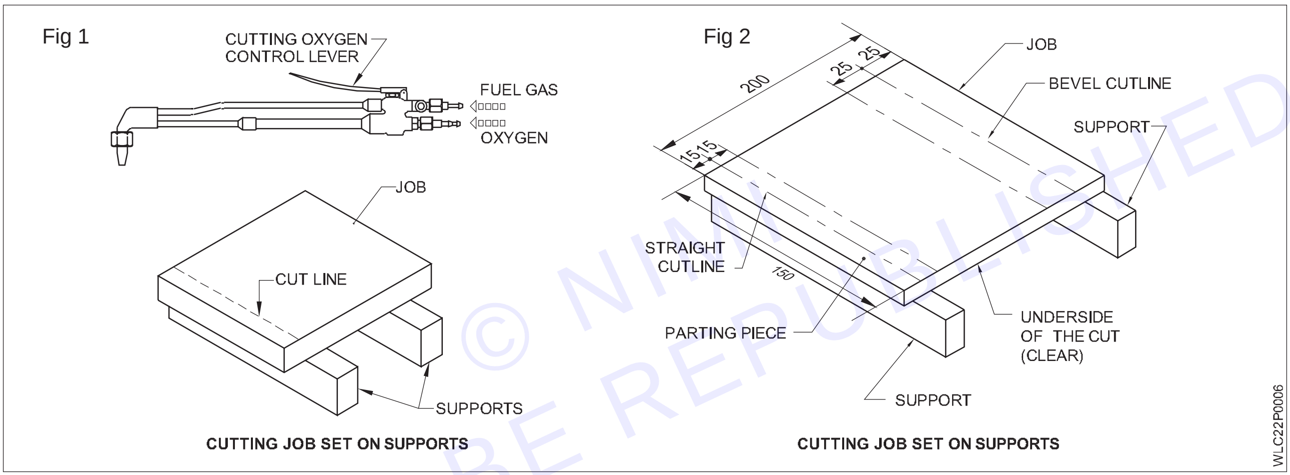
Ensure that the underside of the cutting line is clear and no combustible materials are lying nearby.

Adjusting cutting flame: Select the cutting nozzle and set the gas pressure as per the cutting job thickness. (Table1)

TABLE 1

Data for cutting

Diameter of cutting oxygen orifice nozzle	Thickness of steel plate	Cutting oxygen Pressure
(1) mm	(2) mm	(3) kg/cm2
0.8	3-6	1.0-1.4
1.2	6-19	1.4-2.1
1.6	19-100	2.1-4.2
2.0	100-150	4.2-4.6
2.4	150-200	4.6-4.9
2.8	200-250	4.9-5.5
3.2	250-300	5.5-5.6



The bevel thickness will be more for bevel cut, when compared with a square cut for same thickness.

Acetylene pressure should be 0.15 kg/cm2 for all thickness of plates.

Select ø 1.2 mm (orifice) cutting nozzle for cutting a 10mm thick plate.

Set 1.6 kg/sq.cm pressure for the cutting oxygen and 0.15 kg/sq.cm pressure for the acetylene gas.

Ensure safety apparel is worn.

Fix the cutting nozzle into the cutting blowpipe correctly. (Fig 3)

Check for leakage in the blowpipe connections of oxygen and acetylene gas lines.

Adjust the neutral flame for preheating. (Fig 4)

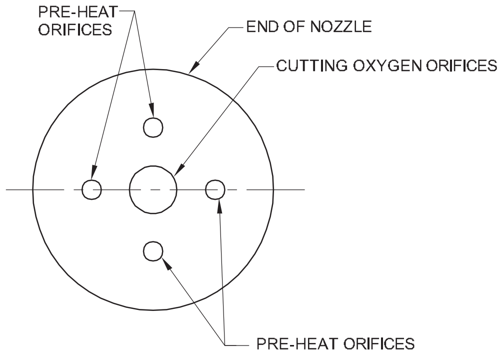
Ensure that the flame adjustment is not disturbed while operating the cutting oxygen lever.

Straight line cutting: Keep the hand cutting blowpipe at 90° angle with the plate surface and start cutting a straight line. (Fig 5)

Preheat the starting point to red heat before pressing the cutting oxygen lever. (Fig 5)

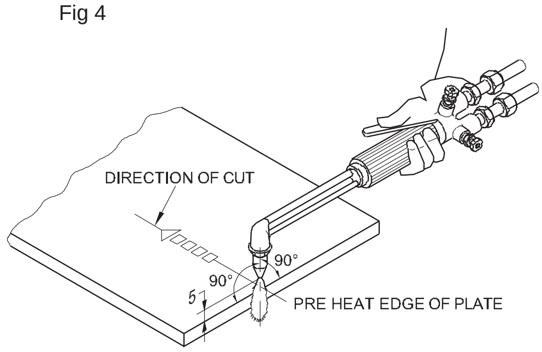
Keep the distance between the work piece and the nozzle about 5 mm to avoid backfire. (Fig 5)

Fig 3



HOLES ON THE CUTTING BLOWPIPE NOZZLE

Fig 4



STARTING OF CUT

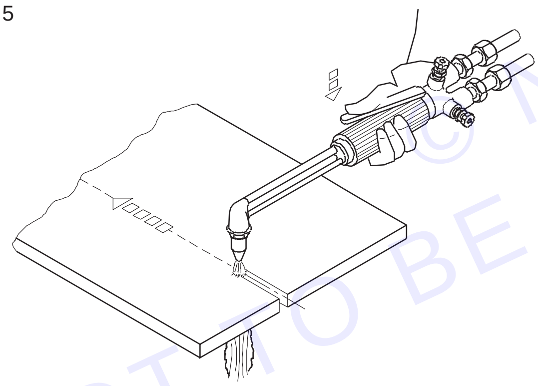
Release the cutting oxygen by pressing the cutting oxygen control lever and start the cutting action and move the blowpipe along the punched line with uniform speed. (Fig 6)

Ensure straight travel without any side-to-side movement.

The nozzle angle is 90° with the plate surface till the completion of cut.

Open the cutting oxygen valve fully. If possible, fix a straight edge or template to the plate and fix a support to the cutting nozzle so as to ensure constant distance between the tip of the nozzle and the plate surface and maintain a uniform straight cut. (Fig 7)

Fig 5



CUT IN PROGRESS

Fig 6

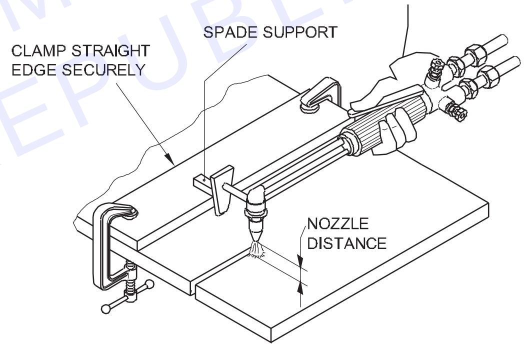
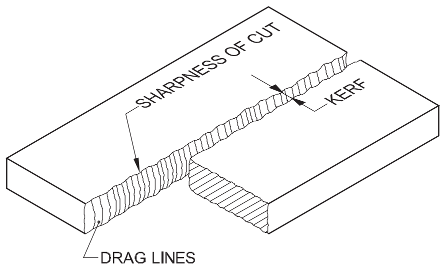


Fig 7



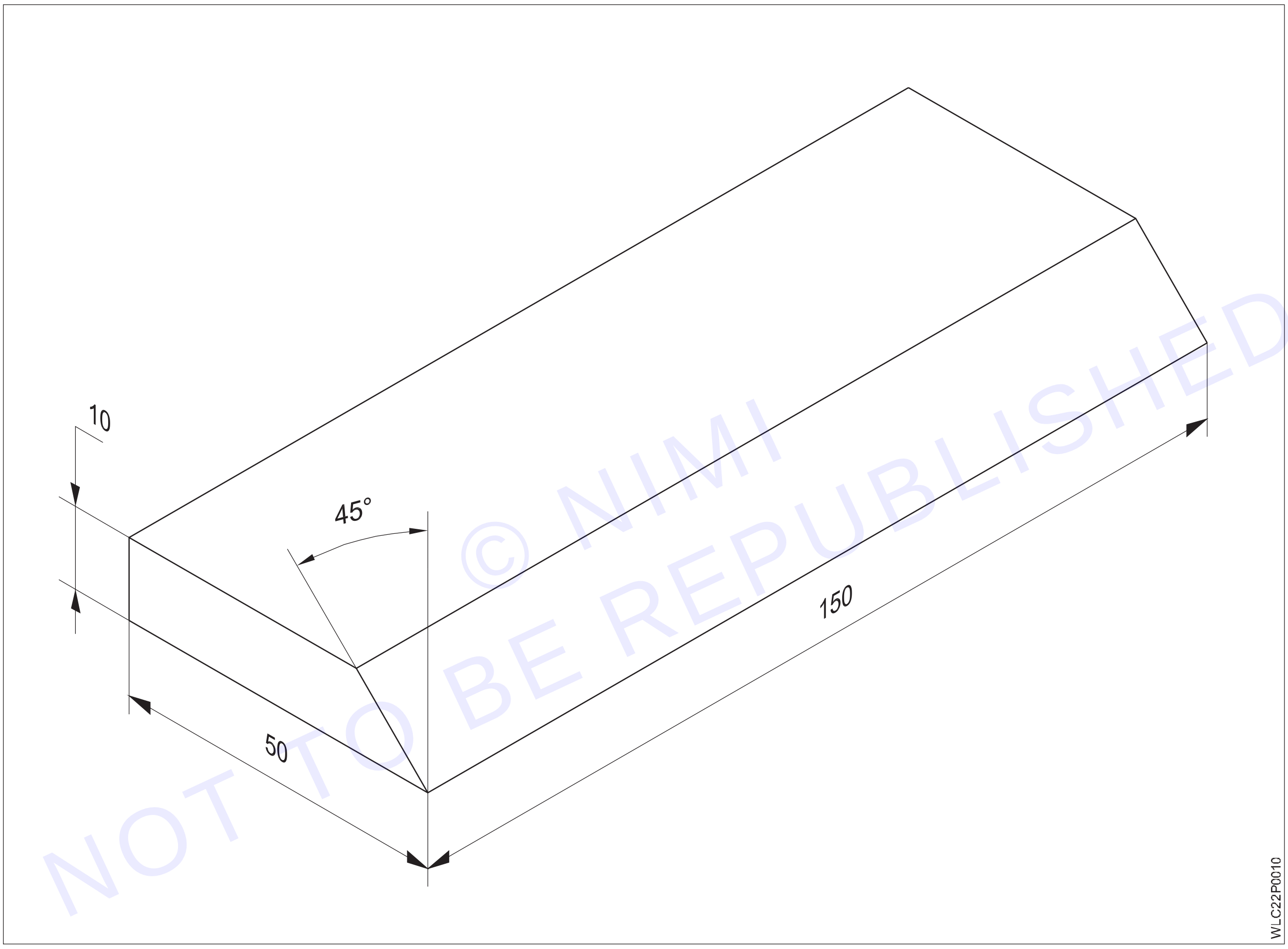
Inspect the cutting for

- uniform and smooth cut or drag line
- straightness, sharpness
- width of the cut (Kerf)

Bevelling of MS plates 10mm thick cutting regular geometrical shapes and irregular shapes cutting chamfers by gas cutting

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

- set the work piece for bevel cutting
- cut bevel by hand using gas cutter
- clean and visually inspect the gas cut.



Job Sequence

- Wear safety apparel.
- Clean the surface to be cut.
- Set the gas welding plant and fix the cutting blowpipe.

Note: Ensure the cutting nozzle is according to the thickness of the metal.

- Adjust the gas pressure of acetylene and the cutting oxygen.

Note: Ensure the pressure setting as per the metal thickness and size of the cutting nozzle.

- Mark and punch the plate at the required bevel angle.
- Adjust a proper cutting flame.
- Hold the cutting blowpipe at the proper bevel angle to be cut.
- Heat at one end of the plate on the punch line up to cherry red hot.
- Release the cutting oxygen, and observe the cutting action.
- Move the cutting blowpipe towards the other end, following the punched line slowly and steadily at the required angle.

Note: Maintain a correct speed and distance of the nozzle.

- Close the cutting oxygen and extinguish the flame on the completion of the cut.
- Clean the cut, and inspect for its accuracy.
- Repeat the exercise till you achieve a good and smooth cut.

Skill Sequence

Bevel cutting by hand (Oxy-acetylene)

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

- set the work piece for bevel cutting
- gas cut bevel surfaces by hand
- inspect the bevel cut.

Setting the job (Fig 1)

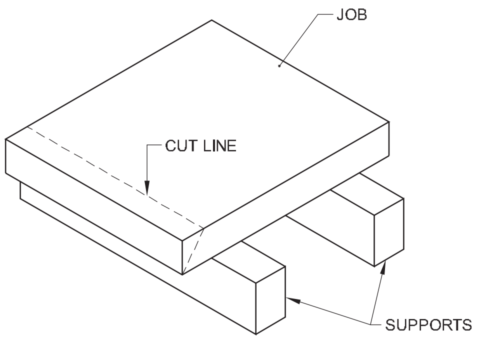
Set the job on a rigid table.

Note: Ensure the underside of the cut line is clear.

Adjustment of the cutting flame.

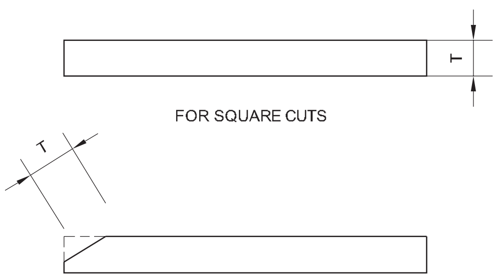
Select a cutting nozzle as per the length of the bevel. (Fig 2)

Fig 1



SETTING JOB ON SUPPORTS

Fig 2



FOR BEVEL CUTS

WLC22P0011

Set the cutting nozzle in the blowpipe and adjust the neutral flame for pre-heating.

Note: Ensure that the flame adjustment is not disturbed while operating the cutting oxygen lever.

Bevel cutting

Hold the cutting blowpipe (nozzle) at the required bevel angle. (Fig 3)

Preheat the starting point to a cherry red colour.

Note: Distance between the work piece and the nozzle tip should be about 5mm to avoid backfire. (Fig 3)

Release extra oxygen, observe the cutting action and start travelling along the punched line with a uniform speed (Fig 4) and steady hand.

Fig 3

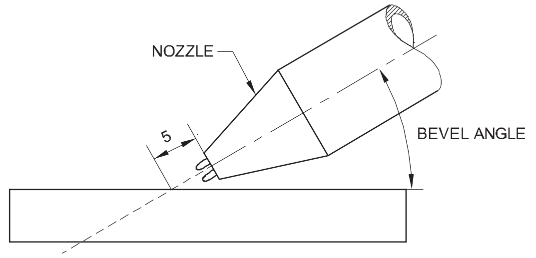
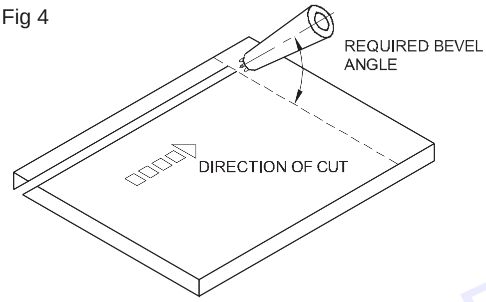


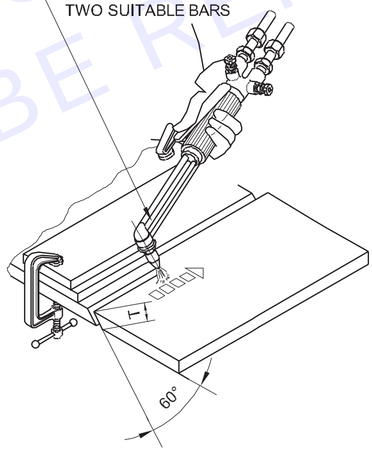
Fig 4



Note: The cutting speed should be less than required for the straight cut for the same thickness.

If possible, fix suitable straight bars to the cutting job to ensure a straight cut and angle maintenance. (Fig 5)

Fig 5



Inspection of bevel cut

Clean the cut and inspect the cutting quality

A good quality cut is indicated by a straight top edge and extremely smooth-cut face. (Fig 6a) Poor quality gouging is a common defect in gas cutting. (Fig 6b) This is caused by excess speed or too mild a heating flame.

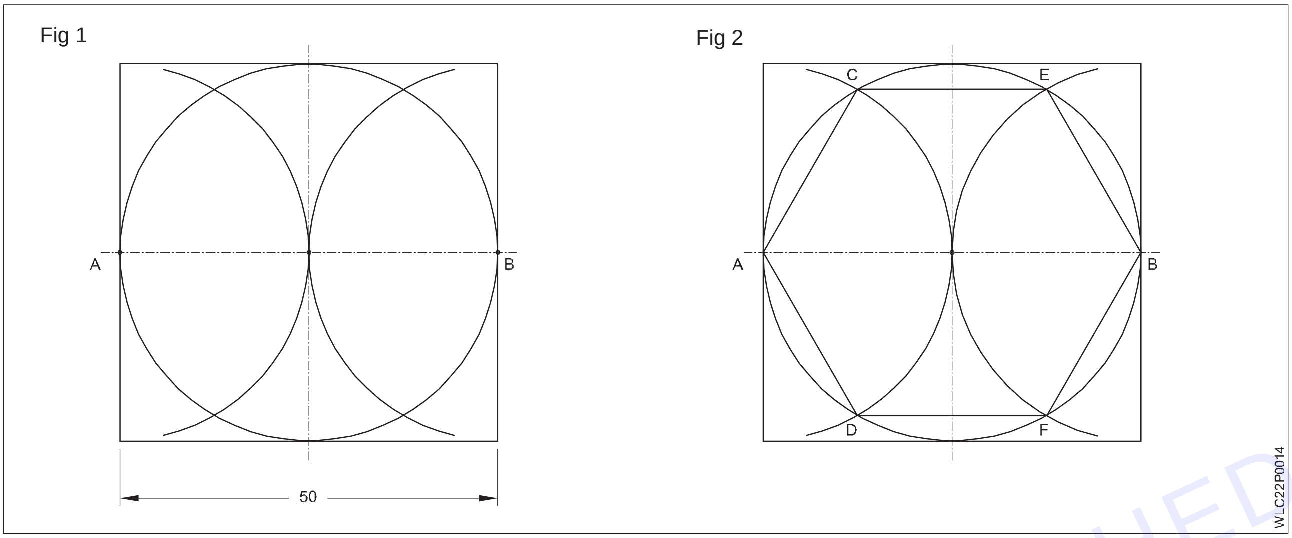
— — — — —

TASK 2

Job Sequence

- Clean the surface of raw material 100 15F6 50 mm long.
- Mark the centre line of the job, and punch the intervention.

- Scribe the circle of diameter 100 mm, using divider (Fig 1).
- Scribe the arc with centre A of radius 50 mm (Fig 1) cutting the circle, repeat with centre B to scribe the arc as shown in Fig 1.
- Scribe the lines to join AC, CE, EB, BF, DF and DA as in Fig 2, using straight edge and scribes to farm hexagon.



- Punch witness marks to complete the hexagon shape.
- Mark the triangle with in the hexagon as per the dimension shown in the drawing, and punch witness marks to complete the triangle.
- Drill a hole of ø6mm on centre mark.
- Set the oxy-acetylene plant and cutting blowpipe for gas welting the geometrical profiles.
- Attach suitable nozzle for gas cutting, according to thickness metal to be cut.
- Adjust the gas measure of acetylene and cutting oxygen, according to the thickness of metal to be cut.
- Adjust proper cutting flame, and hold the cutting blowpipe at 90° (Refer skill sequence on 1.1.15).
- Start the gas welting from drilled hole to triangle line marked.
- Cut the profile on marked line to complete the triangle.
- Start the cutting from the edge of plate to the marked line of hexagon as required.

Note: Maintain correct speed and distance of nozzle while cutting.

- Close cutting oxygen and extinguish the flame on completion of cut.
- Clean the cut, after one job is cooled.
- Inspect the surface cut for uniformity.

— — — — —

TASK 3

- Clean the surface of metal to be cut.
- Mark and punch as per the profile shown in the drawing.
- Set the gas cutting plant with a cutting blow pipe.
- Attach the correct cutting nozzle according to thickness of the metal.
- Adjust the gas measure for the cutting.
- Adjust a proper cutting flame and has the blowpipe in proper position.
- Heat the metal surface at the starting point to bright red hot.
- Move the cutting blow pipe towards the other end following the punched line slowly and steadily.
- Maintain a correct speed and distance of the nozzle while cutting.
- Close the cutting oxygen and extinguish the flame a completion of the cut.

Skill Sequence

Setting the gas cutting plant

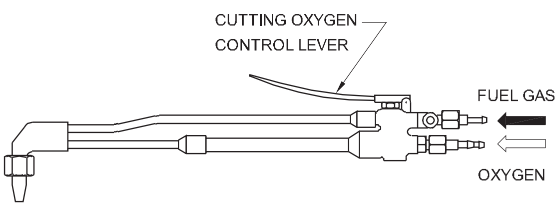
Objectives: At the end of this exercise, you shall be able to

- set the work pieces for bevel cutting
- gas cut bevel surfaces by hand
- inspect the bevel cut.

Set the oxy-acetylene gas cutting plant in the same way as was done for welding and connect the cutting blowpipe in the place of the welding blowpipe. (Fig 1) Also change the oxygen welding regulator with oxygen cutting regulator.

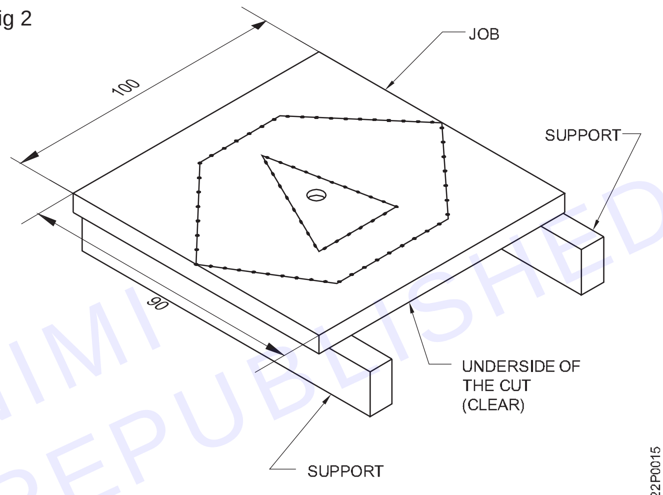
Setting the job for straight line cutting of Triangular shape (Fig 2): Mark and punch straight lines on the plate.

Fig 1



CUTTING BLOW PIPE

Fig 2



CUTTING JOB SET ON SUPPORTS

Set the job on the cutting table so that the parting piece is free to fall.

Note: Ensure that the underside of the cutting line is clear and no combustible materials are lying nearby.

Adjusting cutting flame: Select the cutting nozzle and set the gas pressure as per the cutting job thickness. (Table1)

TABLE 1

Diameter of cutting oxygen orifice nozzle	**Thickness of steel plate**	**Cutting oxygen Pressure**
(1) mm	(2) mm	(3) kg/cm2
0.8 1.2 1.6 2.0 2.4 2.8 3.2	3-6 6-19 19-100 100-150 150-200 200-250 250-300	1.0-1.4 1.4-2.1 2.1-4.2 4.2-4.6 4.6-4.9 4.9-5.5 5.5-5.6

Data for cutting

Acetylene pressure should be 0.15 kgf/cm2 for all thickness of plates.

Select 0.8 mm ø cutting oxygen (orifice) nozzle for cutting a 6 mm thick plate.

Set 1.4 kg/sq.cm pressure for the cutting oxygen and 0.13 kg/sq.cm pressure for the acetylene gas.

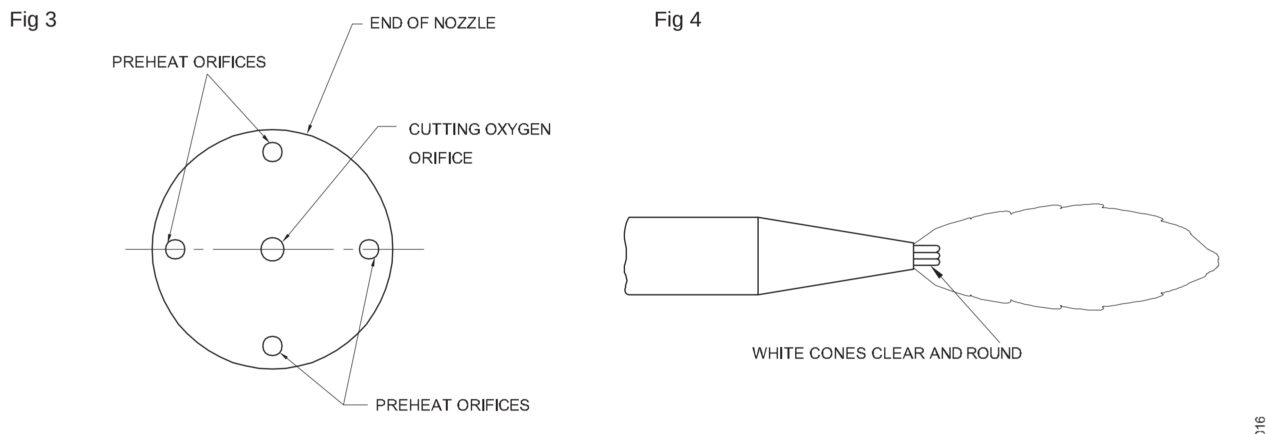
Ensure safety apparel is worn.

Fix the cutting nozzle into the cutting blowpipe correctly. (Fig 3)

Check for leakage in the blowpipe connections of oxygen and acetylene gas lines.

Fig 3

Fig 4



PREHEATING ORIFICES (HOLES) ON CUT LINE

SETTING OF CUTTING NOZZLE

Adjust the neutral flame for preheating. (Fig 4)

Ensure that the flame adjustment is not disturbed while operating the cutting oxygen lever.

Straight line cutting: Keep the hand cutting blowpipe at 90° angle with the plate surface and start cutting a straight line. (Fig 5)

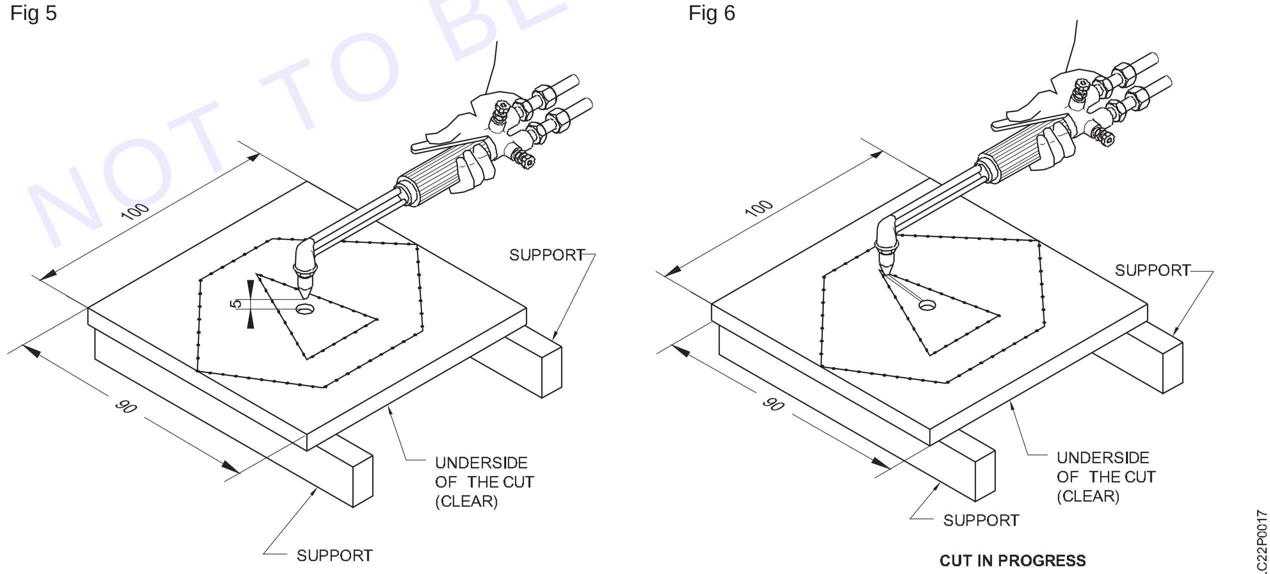
Preheat the starting point to red heat before pressing the cutting oxygen lever. (Fig 5)

Keep the distance between the work piece and the nozzle about 5 mm to avoid backfire. (Fig 5)

Release the cutting oxygen by pressing the cutting oxygen control lever and start the cutting action and move the blowpipe along the punched line with uniform speed. (Fig 6)

Fig 5

Fig 6



CUT IN PROGRESS

Ensure straight travel without any side-to-side movement.

The nozzle angle is 90° with the plate surface till the completion of cut.

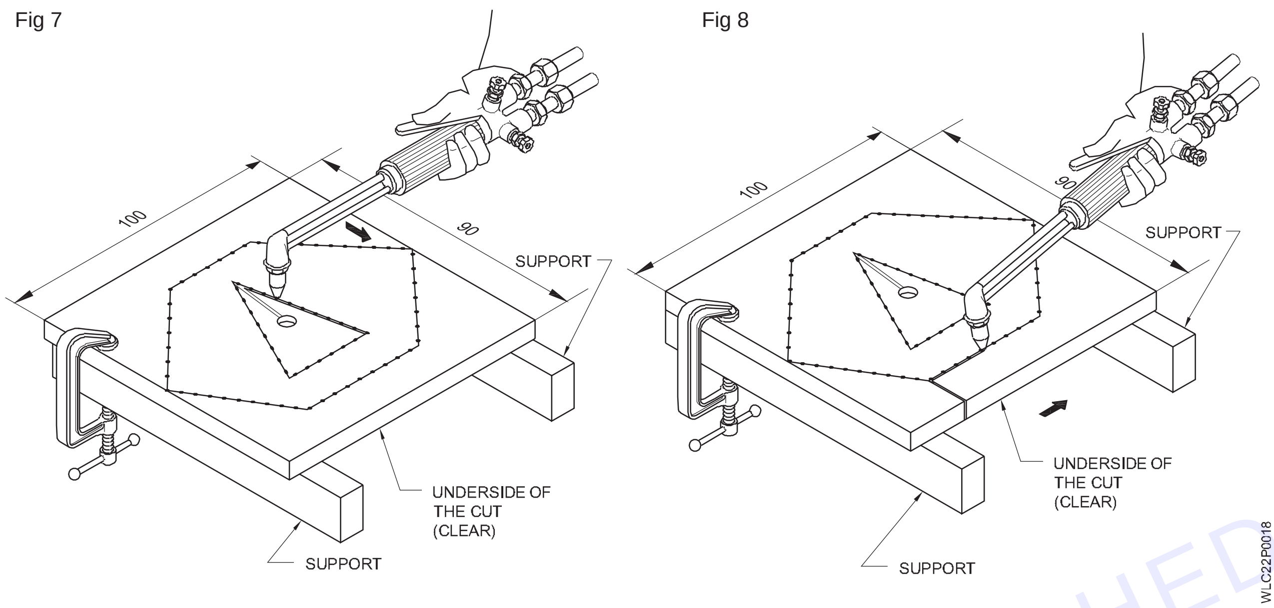
Open the cutting oxygen valve fully.

If possible, fix a straight edge or template to the plate and fix a support to the cutting nozzle so as to ensure constant distance between the tip of the nozzle and the plate surface and maintain a uniform straight cut. (Fig 7)

- Complete to cut the shown in of interned for angle along the punched times.

Fig 7

Fig 8



Hexagon cutting

- Set the job as shown in Fig 8.
- Hold the cutting flow pipe (nozzle) at required angle is 90°.
- Cut the hexagon along the punched lines.

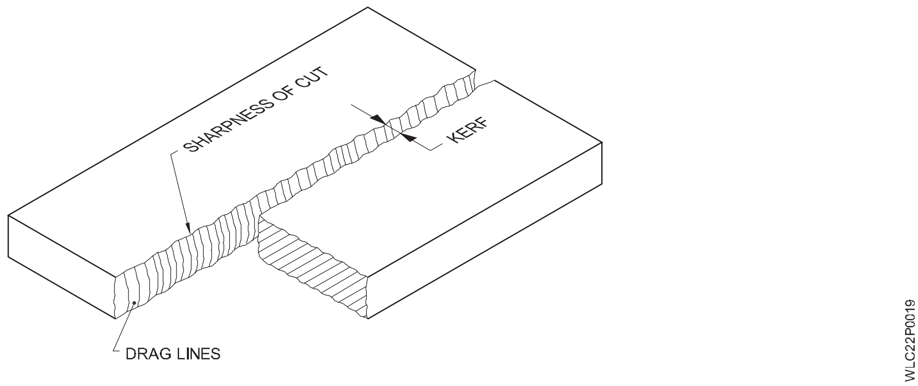
Inspect the cutting for

– uniform and smooth cut or drag line

– straightness, sharpness

– width of the cut (Kerf) (Fig 9)

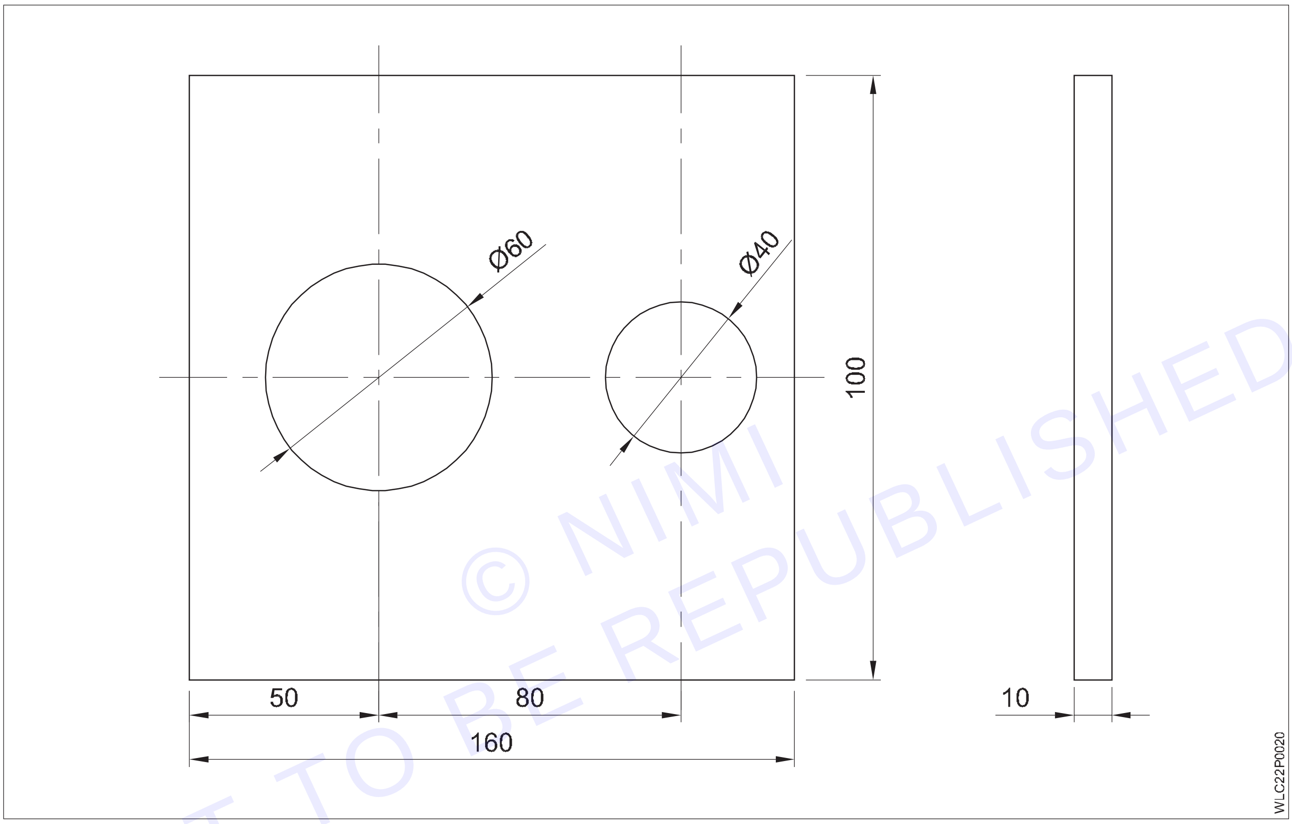
Fig 9



Circular gas cutting on MS plate 10mm thick by profile cutting machine(OAGC)

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

- set the profile cutting machine
- set the cutting parameter for cutting
- cut the circle as per dimensions.



Job Sequence

- Set the cutting machine and connect the oxygen and acetylene cylinders, regulators to the hoses of the machine and fix a suitable cutting nozzle.
- Fit the circular and profile template on the cutting machine table.
- Clean the surface of the metal plate to be cut.
- Select and fix the nozzle as per the thickness of the plate to be cut.
- Clean the track on which the cutting torch assembly unit is mounted and the circular and profile templates and make sure that there is no dirt on them.
- Check the starting lever and ensure that it is in neutral position.
- Set the required pressure of oxygen and acetylene according to the size of the nozzle.
- Set the required speed in the speed control dial according to the thickness of the metal to be cut.
- Adjust the nozzle to a height such that the inner cone of the preheating flame is 3 mm from the surface of the metal to be cut.
- Place the cutting machine at the starting point.

- Ignite and set the neutral flame.
- Allow for sufficient preheating, and then switch ‘on’ the jet of oxygen.
- Simultaneously switch ‘on’ the machine to move the cutting unit forward with the correct speed on the rails to make a straight line cut.
- Stop the machine and turn the switch to neutral position at the end of the cut.
- Set the cutting nozzle to 30° angle and cut the bevel similar to the straight line cut.
- Turn the job plate by 180° and cut the 60° bevel angle by setting the cutting nozzle to 60°.
- Arrest the linear movement of the cutting unit of the machine with the rails using a clamp and attach it to the pivot block used for cutting circle and profiles.
- Set the pivot block to get the required diameter and fix it on the machine table.
- Set the cutting nozzle perpendicular to the job plate and ignite it and set the preheating flame.
- When the plate becomes red hot, open the stream of cutting oxygen and cut the circle.
- For profile cutting attach the template of the profile to the machine table and make the cutting head unit to follow the profile.
- After the cut is over stop all machine movements and remove the slag from all the gas cut surfaces.
- Use tongs while handling the gas cut job.
- Ensure that the molten slag diving cutting and solidified hot slag chipped after cutting fall into a collecting through kept below the table.
- Clean the cutting edges from slag and inspect the cut for gas cutting defects.

Skill Sequence

Assembly of the portable cutting machine

Objectives: At the end of this exercise, you shall be able to
- assemble the cutting machine
- set the templates system for reproduction
- set the correct gas pressure.

The assembly of the machine, the use of templates or systems of reproduction, the position of the work, the speed range and cutting nozzles vary according to the type of the machines.

Assemble the accessories like cutting head for straight and bevel cutting with the cutting machine. (Fig 1)

Select the 1.2mm size of the cutting nozzle for 10mm thick plate.

Set the correct gas pressure of 0.15 kg/cm2 for acetylene and 1.4 to 2 kg/cm2 for oxygen for 1.2mm size nozzle.

Set the machine to run freely as per the regulated speed i.e. 50cm/min for 10mm thick plate.

Ignite the flame and adjust the neutral flame.

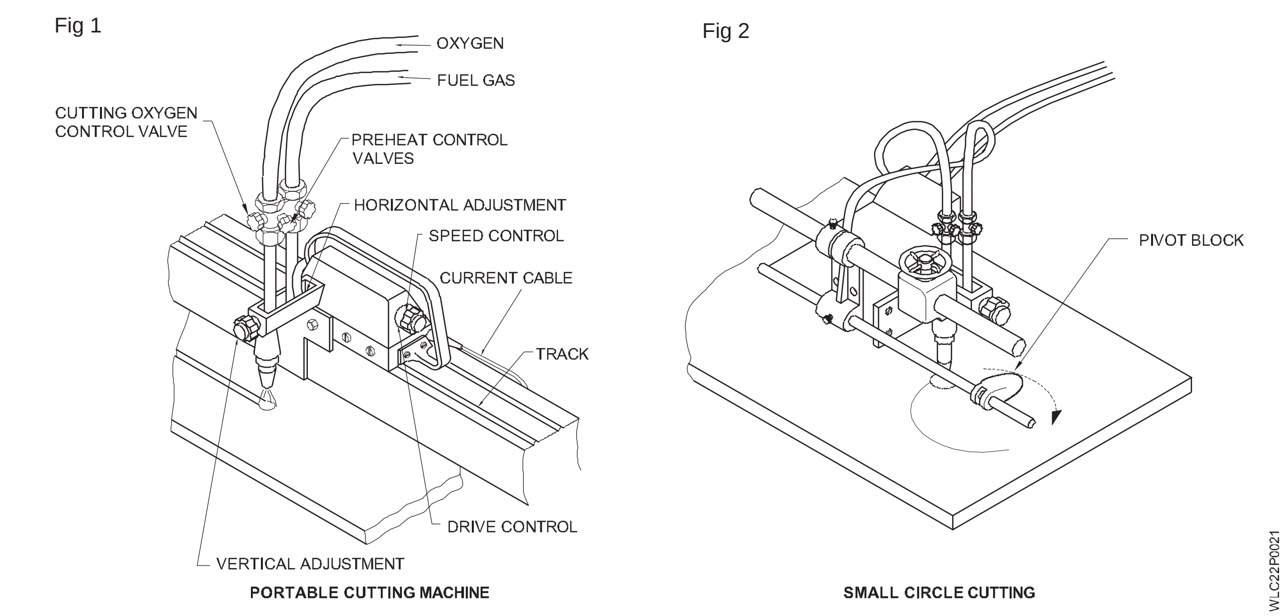
Set the nozzle tip to a correct distance from the surface of the plate to be cut i.e. about 7 to 8mm.

Start the machine and run to the required distance to cut the metal.

Switch ‘off’ the machine and extinguish the flame at the end of the cut.

Remove the plate, clean the iron oxide slag and inspect the cut surface.

For cutting a bevel edge tilt the cutting torch nozzle to the required angle and follow the same skill sequence followed for straight line cutting. (Fig 2)

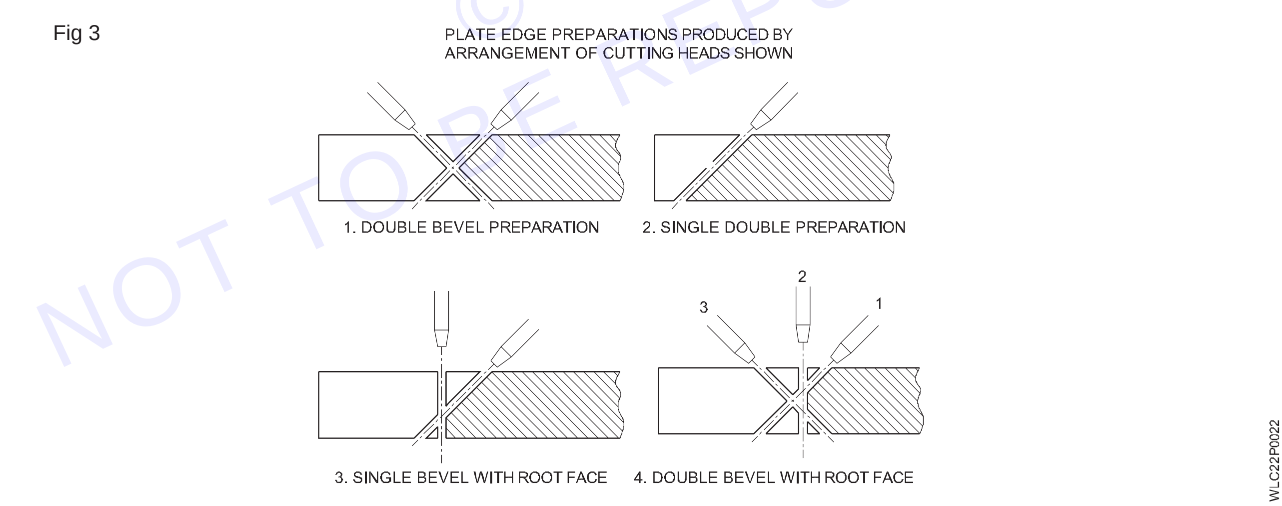


PORTABLE CUTTING MACHINE

SMALL CIRCLE CUTTING

For cutting a circle, attach cutting torch nozzle to the pivot block (Fig 3) and follow the same method used to cut straight line and bevel. It is important to pierce a small hole inside the circumference of the circle to be cut and then move the torch to the nearest point on the circumference. Then use the pivot block to move the flame along the circumference of the circle.

To cut a profile the same sequence used for circle cutting is followed except that a template similar to the profile to be cut is mounted on the table and a tracer attached to the cutting head will follow the template profile. The torch flame will cut the profile on the job

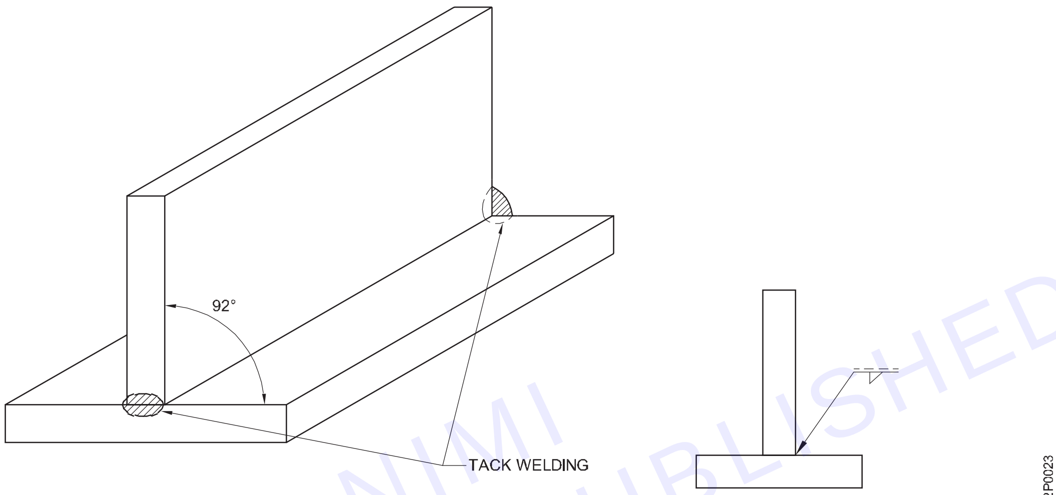


EXERCISE 05: Assess weld joint preparation for fillet "T" weld (Cutting to size, fit up, tack weld etc (SMAW)

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.

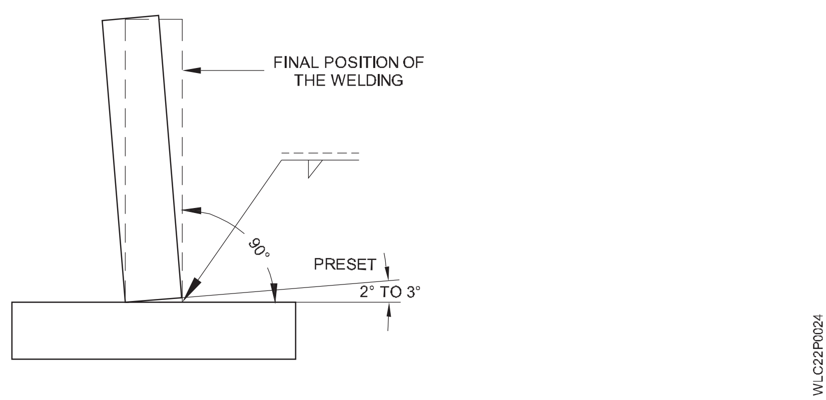


SETTING AND TACKING A TEE JOINT

Job Sequence

- Cut the plate by gas cutting/hacksaw cutting as per drawing.
- Grind the edges square.
- Use goggles while grinding.
- Clean the joining edges and surface of the plates.
- Wear protective clothing.
- Set the pieces in the form of Tee as per drawing and Tack-weld on both ends.
- Preset the pieces to have 92° to 93° angle between the plate surfaces. (Fig 1) i.e. give a distortion allowance of 2 to 3°.

Fig 1



Skill Sequence

Fillet 'T' joint in flat position (1F)

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

- prepare and make 'T' joint in flat position.

Set the pieces in alignment forming 92° between the plates Fig 1.

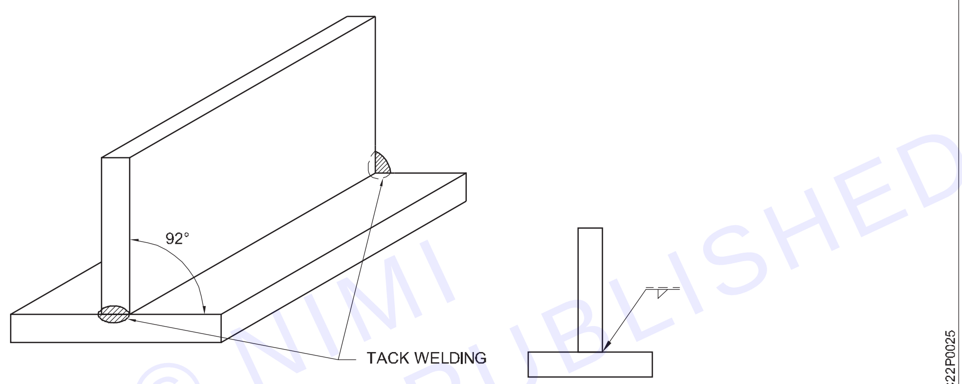
This presetting to 92° is done to compensate the effect of shrinkage forces when weld deposit cools down.

Tack-weld the pieces at both ends of the Tee joint by using a 3.15mm dia. medium coated M.S. electrode and 110/120 amps welding current.

Ensure the tacks are well fused at the root.

Check the alignment of the Tee joint after tacking.

Fig 1



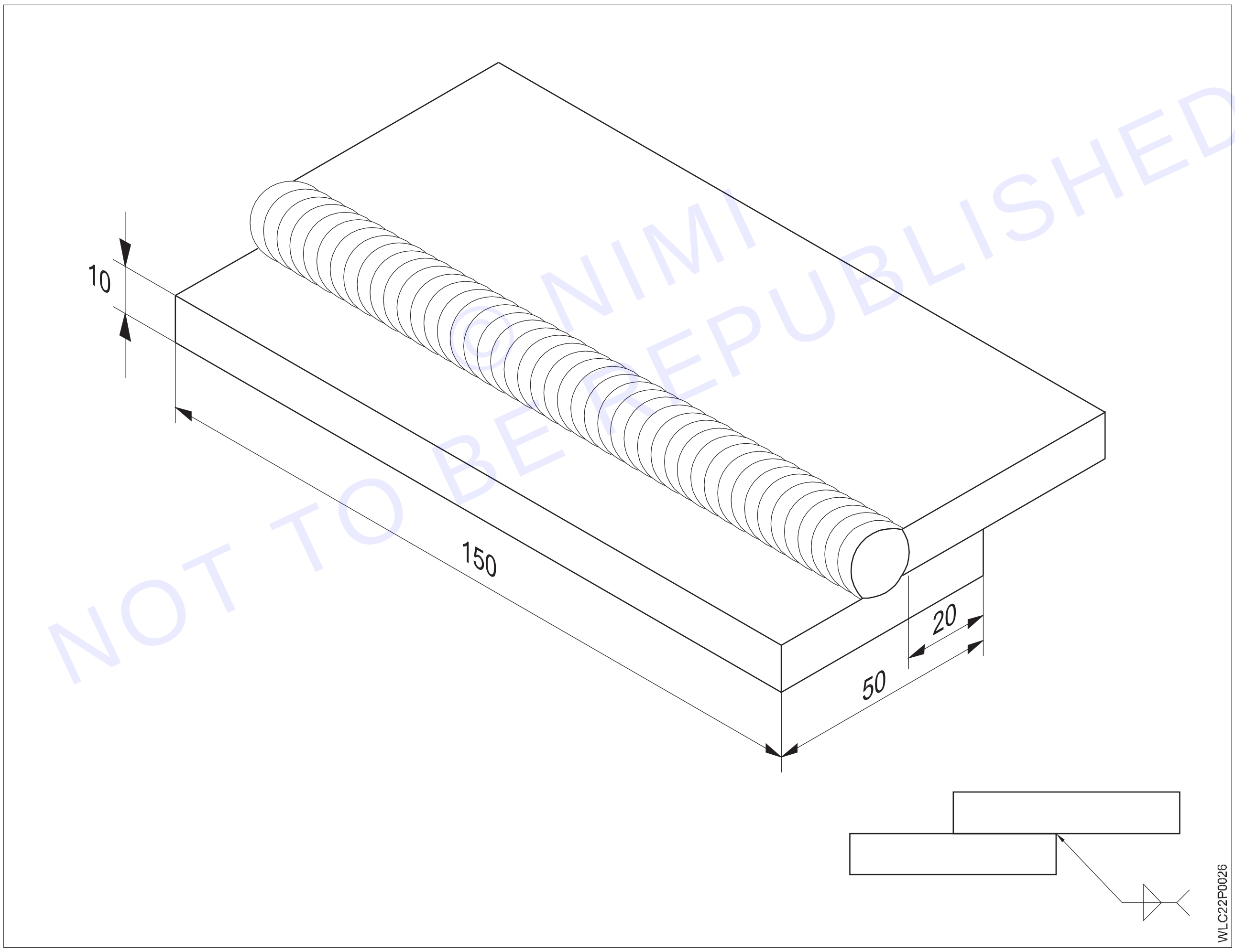
SETTING AND TACKING A TEE JOINT

EXERCISE 6: Fillet lap joint on MS plate 10mm thick in flat position (SMAW)

Objectives

At the end of this exercise you shall be able to

- prepare plate pieces by gas cutting and by grinding to size
- set plates as a lap joint and tack weld at both ends
- place the lap joint in a flat position for welding
- deposit root run of proper size and ensure penetration
- deposit the final covering run in the lap joint of proper leg size.



Job Sequence

- Clean and inspect the lap fillet weld for surface defects.
- Cut the plate pieces by gas cutting as per drawing.
- Grind the gas-cut edges to square.
- Remove the grinding burrs and clean the surfaces by Wire brush.
- Set the pieces in the form of a lap joint as per drawing.
- Select DCEN polarity, in case of a DC machine.

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by using a 3.15mm dia. Medium coated M.S. electrode with 100-110 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion using a 4.00 mm dia. Medium coated M.S. electrode with 150-160 amps welding current.

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.
- Inspect the lap fillet weld for surface defects and size.

Skill Sequence

Lap fillet joint in flat position

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

- prepare and weld lap fillet joint in flat position.

Setting and tacking the lap joint (Fig 1)

Set the lap joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. (Fig 1) Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly. Use a 3.15mmø MS electrode with 120-amp current for tacking.

Set the joint in a flat position using angle iron (Fig 2).

Welding the lap fillet joint in flat position

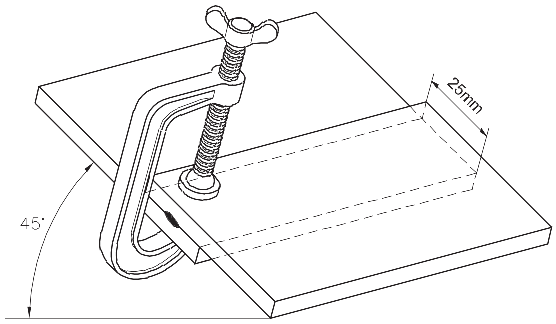
Deposit root run with a 3.15mmø medium coated MS electrode with 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces. (Fig 2)

Maintain a short arc to get uniform fusion and root penetration.

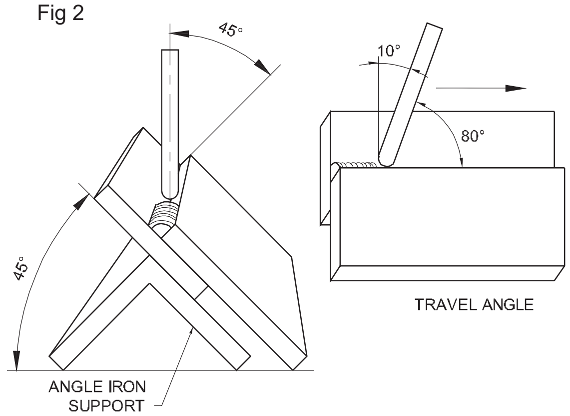
Note: Avoid side-to-side movement of the electrode.

Fig 1



SETTING TACKING A LAP JOINT.

Fig 2



Deslag and clean the root bead thoroughly.

Deposit the final covering run with a 4mmø medium coated MS electrode and 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

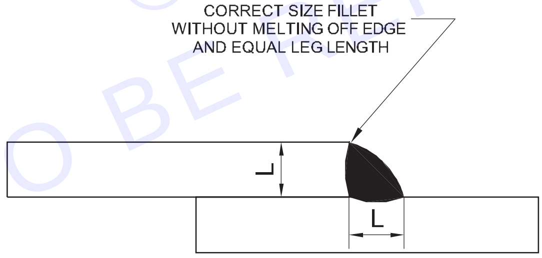
Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld (Fig 3) and ensure:

Fig 3



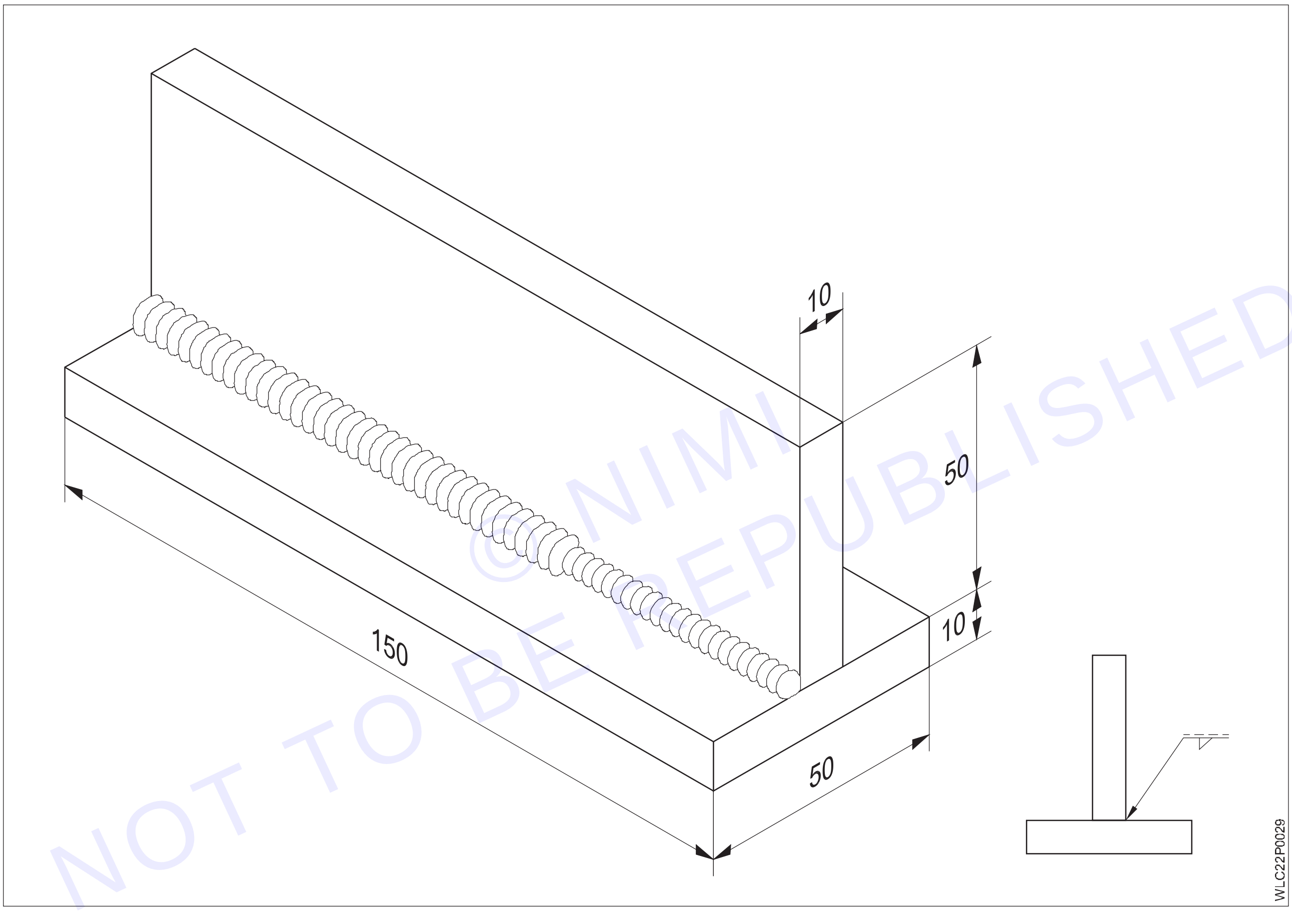
INSPECTION OF LAP FILLET WELD

- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- it is free from surface defects.

Fillet "T" joint on MS plate 10mm thick in flat position (SMAW)

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

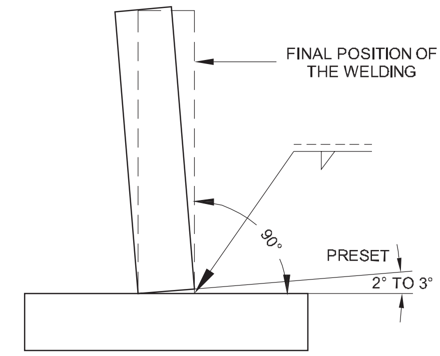
- set and tack plate pieces in alignment as tee joint and by keeping distortion allowance
- set the 'T' joint in flat position for welding
- deposit root run in 'T' joint of proper size and penetration
- deposit final covering run in the 'T' joint of proper leg size
- clean the weldment and inspect surface defects on the fillet weld.



Job Sequence

- Cut the plate by gas cutting/hacksaw cutting as per drawing.
- Grind the edges square.
- Use goggles while grinding.
- Clean the joining edges and surface of the plates.
- Wear protective clothing.
- Set the pieces in the form of Tee as per drawing and tack-weld on both ends.
- Preset the pieces to have 92° to 93° angle between the plate surfaces. (Fig 1) i.e. give a distortion allowance of 2 to 3°.

Fig 1



- Set the Tee joint in a flat position.
- Connect the electrode cable to the negative terminal, if a DC machine is used.
- Deposit root run using a 3.15mm dia. Medium coated M.S. electrode and 110 amps welding current.
- Ensure uniform root penetration and an electrode angle of 45° between the plates and 80° with the weld line.
- Wear chipping goggles.
- Remove the slag from the root run with a chipping hammer and clean with a wire brush.
- Deposit covering run with a weave motion using a 4mm dia. Medium coated M.S. electrode and 160 amps welding current.
- Remove the slag from the final bead and clean the weld.
- Use weld gauge for checking the leg size of the weld. If you do not get the required 10mm leg length in 2 runs of weld deposit then deposit a third run using the same technique adopted for the second run.
- Inspect the Tee fillet weld for defects.

Skill Sequence

Fillet ‘T’ joint in flat position

Objectives: At the end of this exercise you shall be able to
- prepare and make ‘T’ joint in flat position.

Setting and tacking of a Tee joint (Fig 1)

Set the pieces in alignment forming 92° between the plates Fig 1. This presetting to 92° is done to compensate the effect of shrinkage forces when weld deposit cools down.

Tack-weld the pieces at both ends of the Tee joint by using a 3.15mm dia. Medium coated M.S. electrode and 110/120 amps welding current.

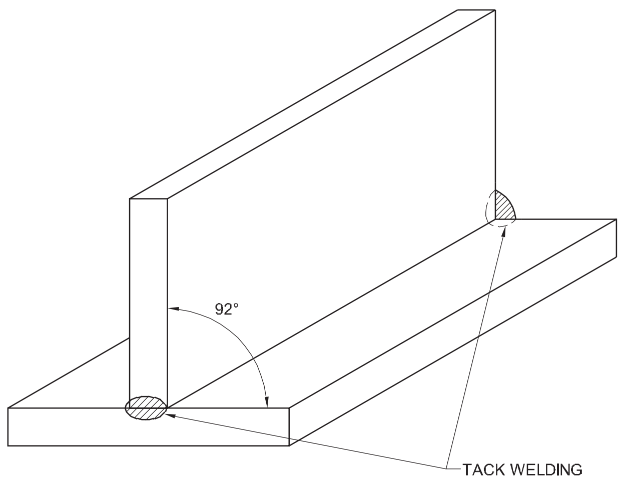
Ensure the tacks are well fused at the root.

Check the alignment of the Tee joint after tacking.

Welding a tee fillet joint

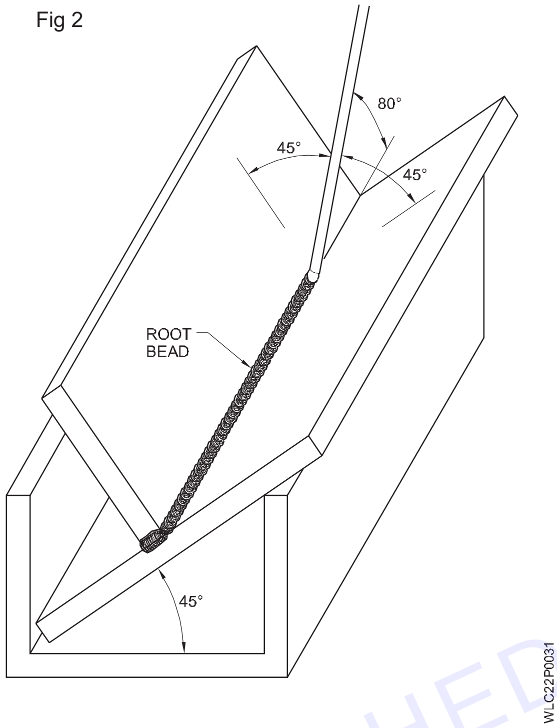
Use a channel to place the joint in a flat position. (Fig 2)

Fig 1



SETTING AND TACKING A TEE JOINT

Fig 2



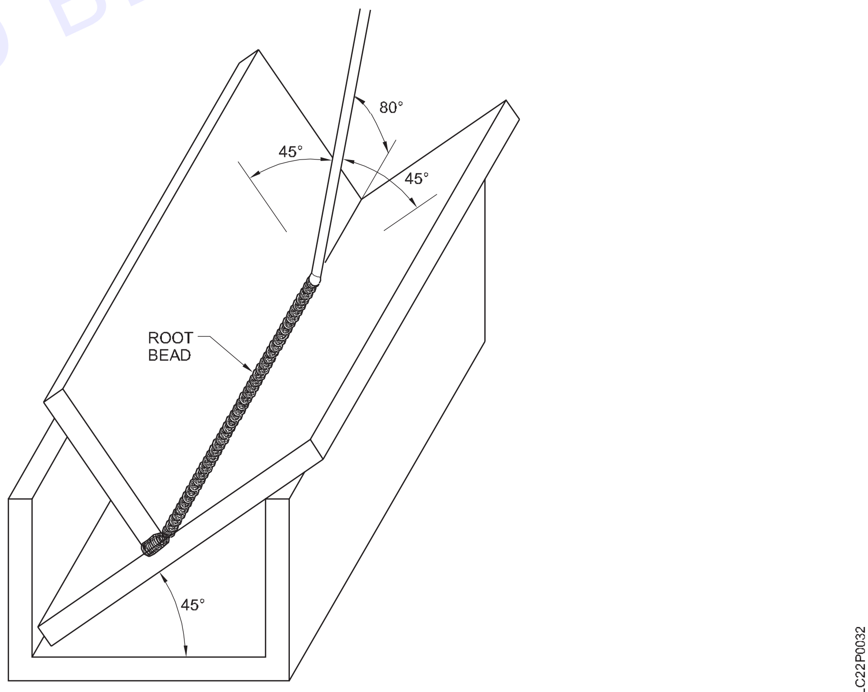
The electrode angle of 45° will help to fuse both plates equally and the 80° angle will help to get a good root penetration.

Proceed along the welding line with uniform travel speed and short arc to get uniform fusion and root penetration.

The slag has to be removed thoroughly from the root run so that the slag inclusion defect can be avoided in the next run.

Use a slightly side-to-side weaving motion. (Fig 3) The width of weave should give a leg size of 10mm.

Fig 3



Maintain the same electrode angle as in the root bead.

If the leg size is less than 10mm then deposit a third run using the same technique used for the second run.

Clean the final covering bead thoroughly.

Stop the electrode weaving for a moment at the toes of the weld to avoid undercut. Fill the crater at the end of the bead.

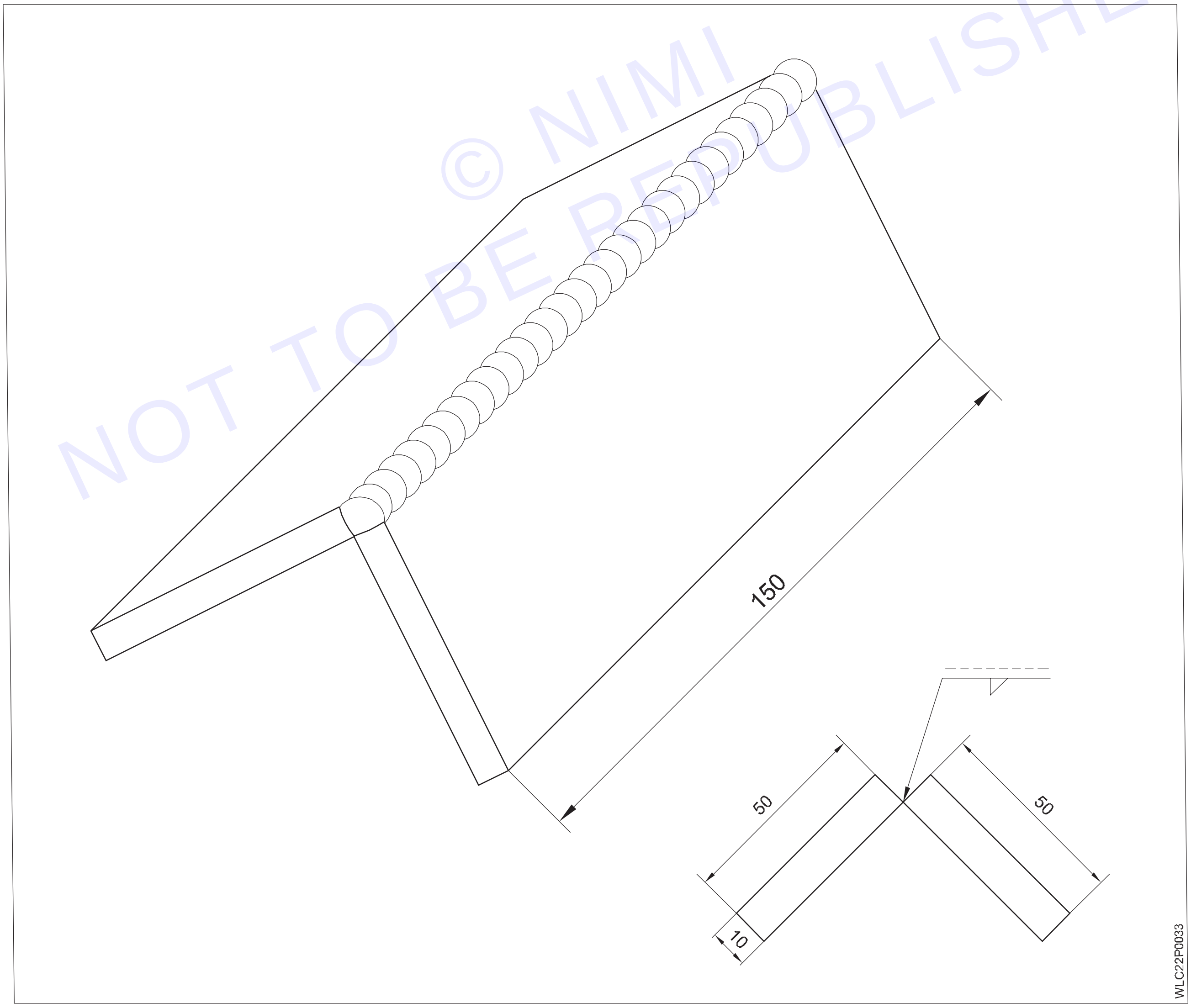
Inspection of fillet weld

Inspect the fillet welds for defects, correct shape and size of fillet and equal leg length on either side of the weld.

Open corner joint on MS plate 10mm thick in flat position (SMAW)

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

- set the plates to form an open corner joint at 90° with specified root gap in flat position
- tack weld the pieces as an open corner joint at both ends
- deposit root run in the corner joint with the formation of a KEYHOLE and obtain complete penetration
- deposit uniform covering layers in the corner joint using weaving of electrode and complete the weld
- inspect the welded joint for penetration, reinforcement and throat thickness.



Job Sequence

- Prepare job plates to size as per drawing.
- Clean the joining edges and surfaces of plates.
- Set the plates as an open corner joint with a root gap of 2.5 mm using an angle iron jig.
- Select DCEN polarity, if a DC generator is used.
- Tack the joint pieces at both ends using ø 3.15 mm medium coated MS electrode and 100-110 amps current at the inside of the joint.
- Ensure safety apparels are worn. Use a proper method to control distortion.
- Clean the tacks, check alignment and reset the joint, if required.
- Set the joint on the welding table in a flat position.
- Deposit root run in the joint by forming a keyhole and obtain complete penetration.
- Deslag and clean the root run and inspect root penetration.

Ensure the crown of penetration is not more than 1.6 mm in height.

- Grind and dress the face of the root run, if required.
- Set the welding current 160 amps for 4mm ø medium coated M.S. electrode.
- Deposit an intermediate layer i.e. second run over the root run with slight weaving motion using 4mmø electrode.
- Clean the intermediate layer thoroughly and inspect for faults. Rectify the defects, if any.
- Deposit the final layer to the weld size using the same current setting, electrode and weaving motion as used for the second layer.
- Clean the final layer for inspection.
- Inspect the corner fillet weld:
  - To ensure uniform and correct reinforcement
  - To ensure that the weld face is free from porosity, Slag inclusion, unfilled crater, overlap and edge of Plate melted off/insufficient throat thickness.

Skill Sequence

Open corner joint on MS plate 10mm thick in flat position

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

- prepare and weld corner joint on MS plate 10mm thick in flat position.

Setting and tacking plate pieces for open corner joint (Fig 1)

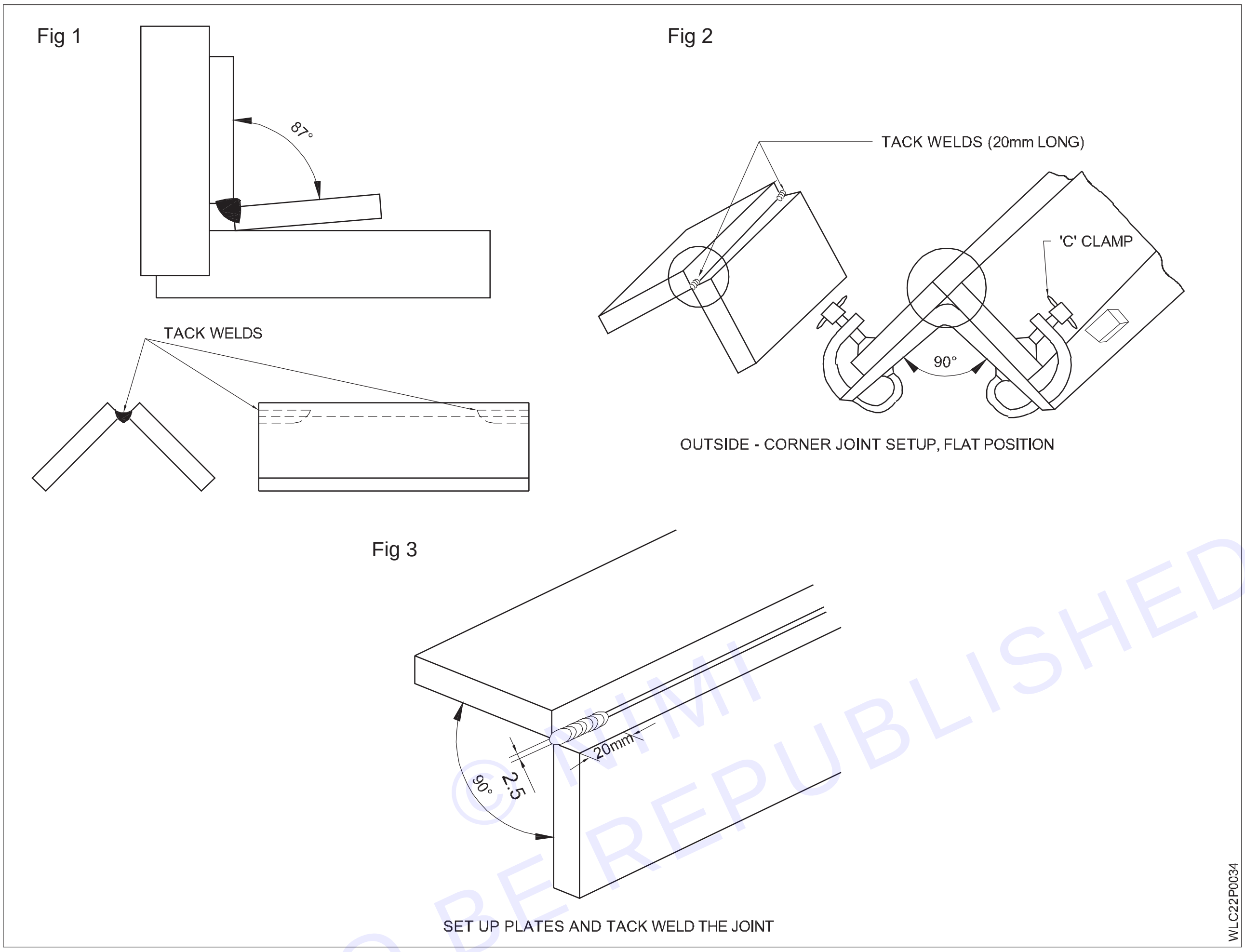
Set the plates as an open corner joint on the table with parallel root gap of 2.5mm throughout the joint. The angle between the plates is kept at 87° to control the distortion.

The angular distortion is normally taken as 1° per run.

Check the alignment of the joint with a try square. (Fig 1)

Another method to control distortion is, set the angle at 90° and use a right-angled iron fixture to minimize the distortion.(Fig 3)

Tack weld the corner joint from inside using a MS electrode ø 3.15mm and 100 – 110 amps current range. tack weld at both ends with max tack length of 20mm each. (Fig 2)



Note: Ensure that the joining edges are perfectly clean and safety apparels are worn.

Deslag and clean the tacks using chipping hammer and wire brush.

Deposition of root run

Se the joint in a flat position.

Deposit root run in the bottom of the corner by

- Using a M.S. electrode ø3.15 and welding current110 to 120 amps.
- Maintaining a slightly short arc
- Positioning the electrode vertically between the edge and 60° - 70° with the weld line. Fig 4
- Forming a keyhole near the weld crater of the tack weld to ensure complete penetration. Fig 5
- Maintaining travel speed similar to the speed used for straight beading. Clean the root run thoroughly and observe penetration.

Ensure no slag particles are adhering on the root run.

The crater is to be properly filled in each run.

Deposition of covering layers

Deposit 1st covering layer i.e., the second run using a Ø 4.00 mm medium coated MS electrode and 160 amps welding current. A weaving motion for the electrode has to be given to ensure enough metal is deposited in the groove and both edges of the plates are fused.

Ensure that the electrode angles are as shown in Fig 4. Uniform medium arc length, uniform normal travel speed should be maintained.

Clean the slag from the 1st covering layer thoroughly.

Ensure all the surface defects are rectified.

Deposit 2nd (final) covering layer i.e. the third run using:

- Ø 4 mm M.S. electrode and 160 amps welding current
- Wider weaving motion to the sides of corner joint
- A slower rate of travel that the 1st covering layer.
- Use the same angle of electrode and arc length as used in 1st covering layer.(Fig 4)

Fig 4

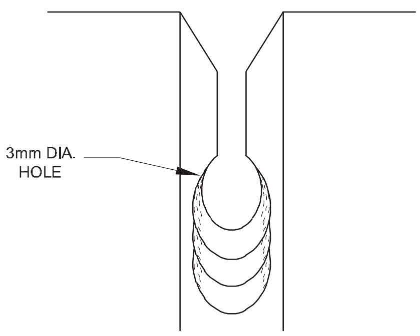
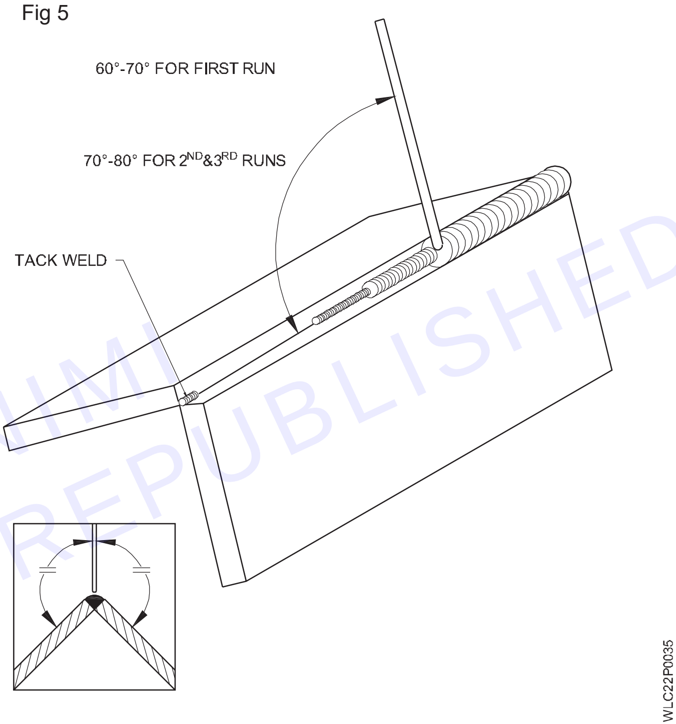


Fig 5



Each movement of the weave from one side to the other will deposit more metal, and that takes more time.

Ensure restarting and stopping of the beads correctly.

The usual defect on the final layer of weld is 'edge plate melted off'. This can be eliminated if care is taken to weave the electrode to the required extent so that the edges are just fused. The arc should not be focused on the edges at all.

Inspection of fillet weld in corner joint (Fig 6)

Clean the weldment thoroughly.

Check the angle between the plates for 90°.

Check each run/layer for the following weld characteristics.

Width and height: Uniform.

Appearance: Smooth with close ripples.

Size: Full fillet without excessive reinforcement.

Face of welds: Root run and 1st covering layer flat, final layer slightly convex.

Edges of welds: Good fusion, no undercut, no overlap.

Starts and stops: Free of depression and high spots, craters filled.

Back side: Complete and uniform penetration. (Fig 7)

Surrounding plate surfaces: Free of spatter.

Fig 6

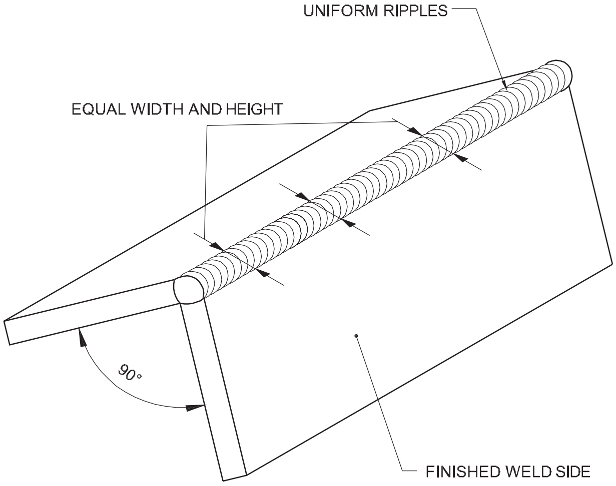
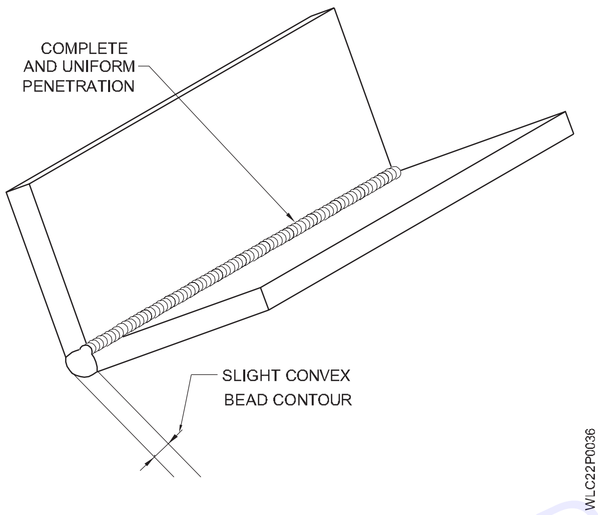


Fig 7

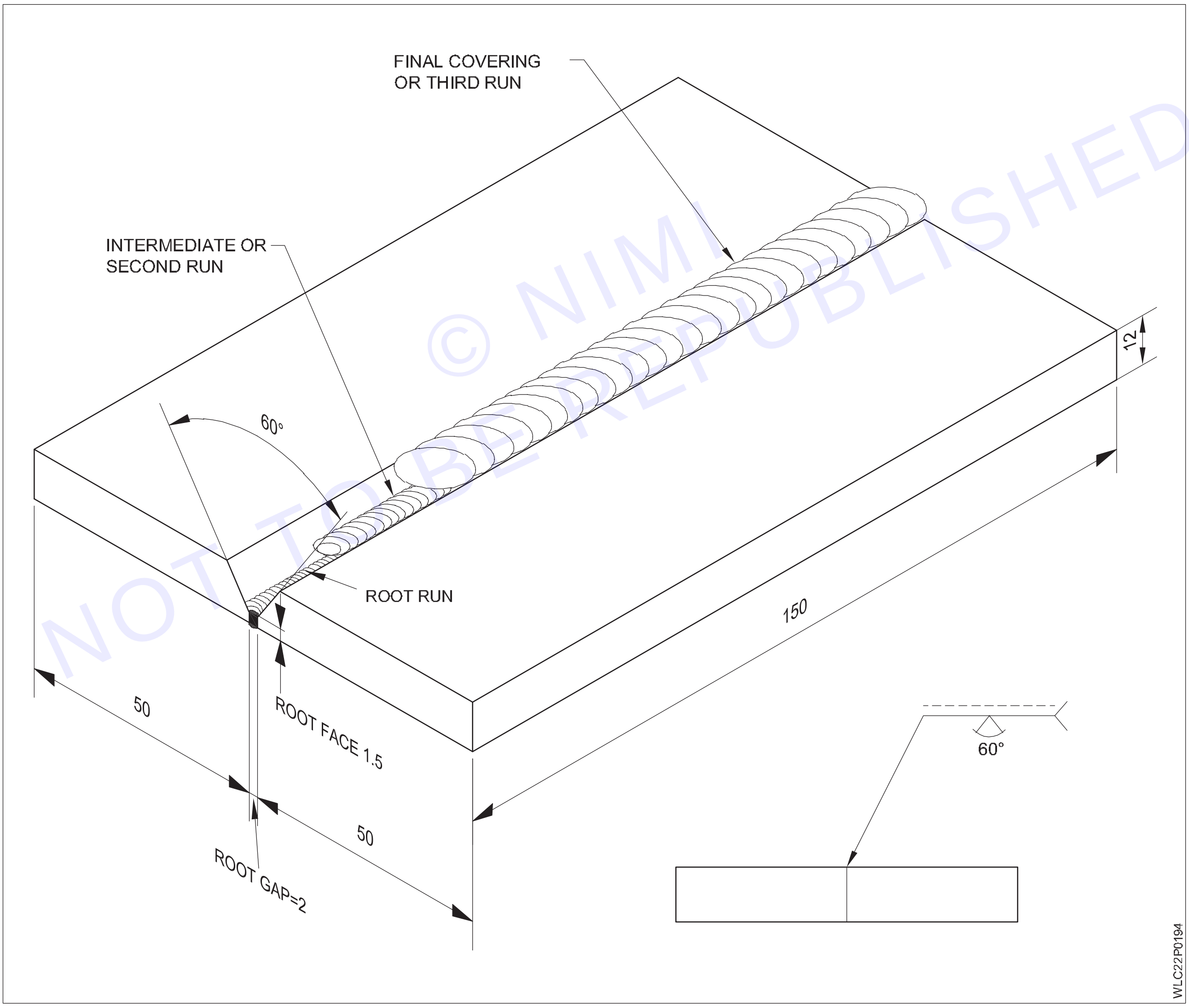


EXERCISE 7: Single "V" butt joint on MS plate 10mm thick in flat position (SMAW)

Objectives

At the end of this exercise you shall be able to

- bevel the plate edges by gas cutting for single V butt joint
- grind the gas-cut bevel edges with proper root face for single V butt joint
- set the plates with a root gap of 2mm and proper distortion allowance for single V butt joint
- control arc blow
- deposit root run in single V butt joint to ensure complete penetration
- deposit intermediate and final covering runs in single V butt joint to obtain proper fusion and reinforcement
- clean and inspect the groove weld for surface defects and uniform root penetration.



Job Sequence

- Straight cut two 10mm thick plates by gas cutting as per drawing and grind them to size.
- Bevel the edges of each plate to 30° angle by gas cutting and file the root face as per drawing.
- Clean the plates from dirt, water, oil, grease, paint etc.
- Keep the plates inverted in the form of a butt joint with proper root gap.
- Maintain a distortion allowance of 1.5° on each side of the joint.
- Wear all protective clothing.
- Use a 3.15mm medium coated MS electrode and set 110 amperes current. In case of DC welding machine connect the electrode cable to the negative terminal of the machine.
- Tack weld on the back side of the plates at the ends. the length of tack should be 20mm.
- Deslag the tack weld and clean.
- Position the tack welded job on the table in flat position (the single V portion facing up)
- Deposit the root run and fill the crater as done for welding square butt joint. (Ex.No.3.06)
- Take special care to maintain key hole to ensure proper melting of root face and root penetration.
- Deposit the second run/intermittent run using 4mm ø medium coated electrode and 150-160 ampere current, short arc and proper weaving of the electrode. Avoid excessive weaving and ensure normal travel speed.
- Fill the crater wherever necessary.
- Deslag.
- Deposit the third run/covering run using the same parameter and technique used for 2nd run. Ensure a proper reinforcement of 1 to 1.5mm and avoid undercut.
- Inspect for any surface weld defect.

Skill Sequence

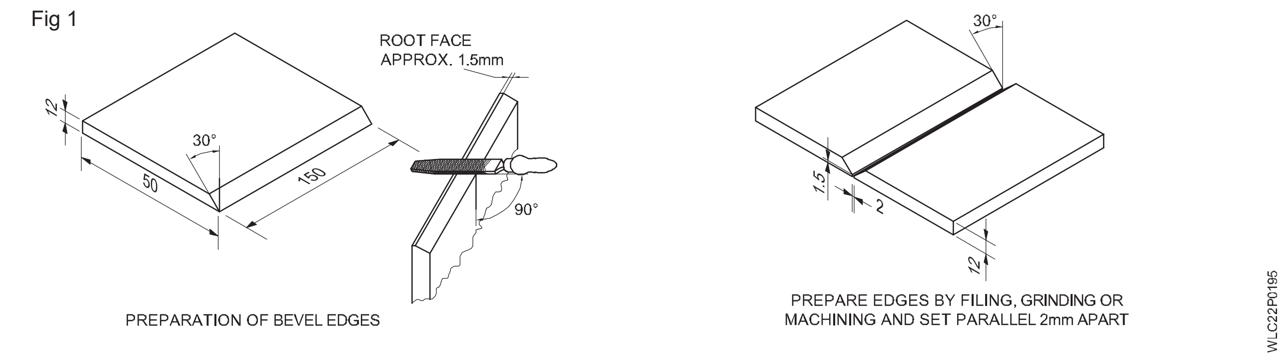
Welding of single 'V' butt joint MS plate 10mm thickness in flat position

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

- weld single V butt joint MS plate 10mm in flat position.

Preparation of the pieces (Fig 1)

Fig 1



Cut a 30° bevel on each piece using oxy-acetylene cutting.

Grind the bevel edges to remove oxide deposits on the bevel.

Prepare a uniform root faces 1.5 mm by filing on both the

Beveled edges.

Setting the single V butt joint and tacking

Keep the bevel edges upside down with a root gap of 2mm, and 3° distortion allowance. (Fig 2) using suitable support. i.e. 1.5° on each side of the joint.

Tack-weld on both ends. (20mm long)

Note: Ensure safety apparels are worn.

Place the joint in flat position after tacking.

Deposition of root bead (Fig 3)

Deposit root bead using a 3.15 dia. M.S. electrode and 110 amps welding current.

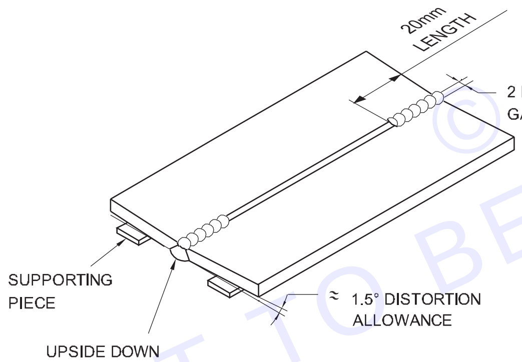
Proceed with a uniform normal speed holding a short arc.

Keep the electrode angle (as shown in Fig 3) at 80° to the line of weld.

Give a whipping motion to the electrode to maintain the size of the KEYHOLE for correct penetration.

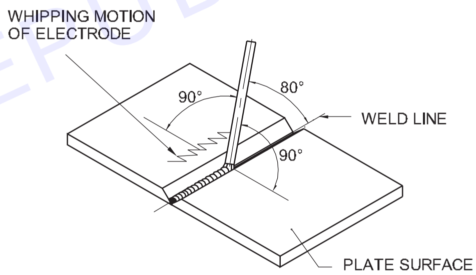
Clean the root bead, and observe penetration.

Fig 2



SETTING THE SINGLE VEE BUTT JOINT AND TACKING

Fig 3



ELECTRODE ANGLE AND MOTION FOR SINGLE VEE BUTT JOINT IN LAYING ROOT BEAD

WLC22P0037

Deposition of hot pass & covering beads (Fig 4)

Deposit the 1st covering bead using a 4.00mm dia medium coated M.S. electrode and 160 amps welding current.

Proceed with a uniform speed, holding a normal arc and a side-to-side weaving motion to the electrode.

Ensure the electrode angle is the same as it was for the root bead.

Clean the bead thoroughly and grind the humps in beads (if present).

Rectify possible defects, if any.

Deposition of final/covering bead (Fig 5)

Deposit the final covering bead using a 5.00mm M.S. electrode, 220 amps welding current, and imparting a wider side-to-side weaving motion to the electrodes. Pause (stop) the electrode weaving at the toes of the weld so that undercut defect will get eliminated.

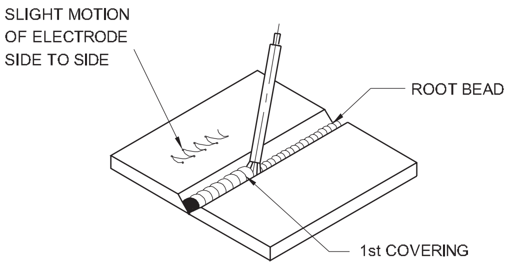
Follow the other steps as done for the 1st covering bead.

Cleaning and inspection

Clean the welded joint thoroughly from both sides.

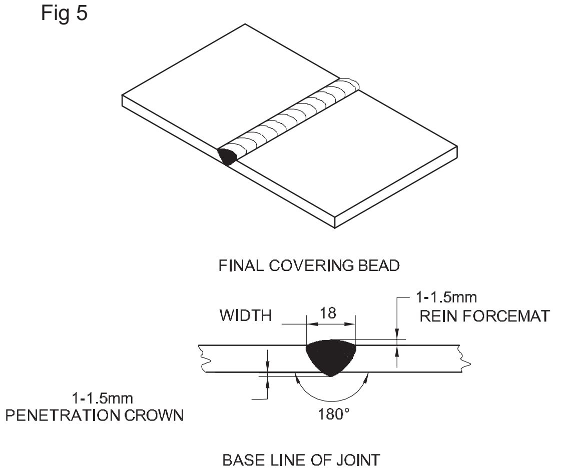
Inspect the weld size, surface defects, root penetration and distortion.

Fig 4



ELECTRODE MOTION IN DEPOSITING
1st COVERING BEAD

Fig 5

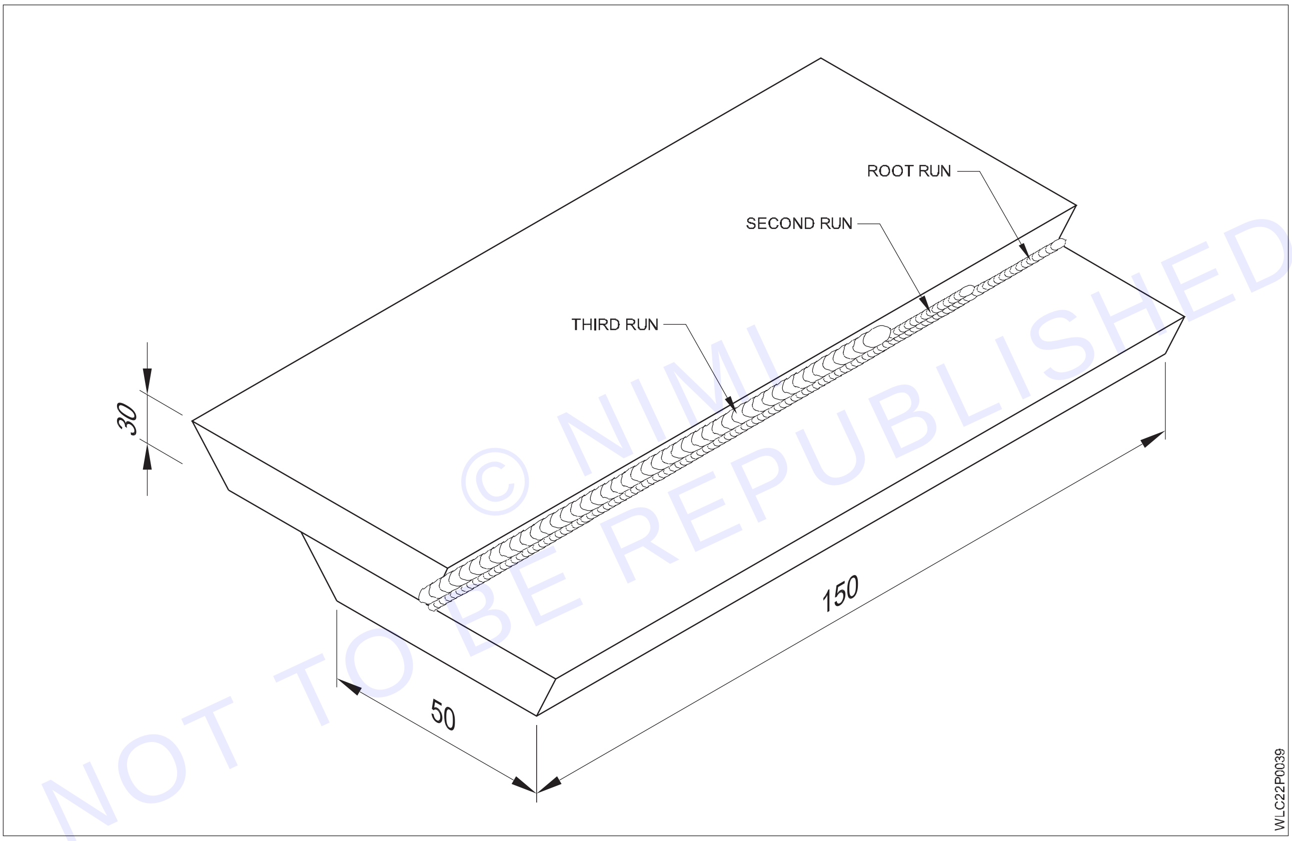


EXERCISE 8: Fillet lap joint on MS plate 10mm thick in horizontal position (SMAW)

Objectives

At the end of this exercise you shall be able to

- select electrode, current, polarity and arc length
- use distortion control and arc blow control methods
- weld the lap joint with a short arc and uniform travel speed
- inspect the weldments for external defects.



Job Sequence

- Prepare and clean the plates as per given dimensions.
- Set the Lap joint as per drawing and tack weld.
- Fix the joint in horizontal position.
- If DC machine is used, connect the electrode to the negative and use short arc to control arc blow.
- To avoid distortion due to contraction preset the plates such a way that the angle of the tack welded joint is decreased to 87° on the Back side.
- Deposit the root run without weaving.
- Hold the electrode at the centre of the joint and start
- From leftward and use proper technique to avoid

- Excessive metal deposition at the bottom of the plate.
- Deslag and clean the root run.
- Deposit the second and third run using stringer bead technique covering the previously laid bead partially and the plate surface.
- Ensure to fill the crater and to clean the bead.
- Check for the size of fillet, bead profile, weld defects and rectify them.

Skill Sequence

Fillet weld lap joint MS plate 10mm horizontal position

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

- prepare and weld lap joint on MS plate 10mm in horizontal position

Fix the joint in a horizontal position. For this the bottom plate should be kept parallel to the ground and the other plate perpendicular.

Welding Lap joint (fillet) in horizontal position: Deposit root run with 3.15 mm dia. Electrode and 110 amps welding current, maintaining the electrode angle 70° to 80° to the line of weld and 40° to 50° between the vertical plate and electrode.

Deslag and clean the root bead thoroughly. Use safety

Goggles while deslagging to protect the eyes from

Flying slag particles.

Deposit second run with a 4mm electrode and 160 amps welding current, the angle of electrode to the bottom plate to be 55° - 65° and 25° - 35° to the vertical plate and 70° to 80° to the line of weld.

This second run has to be deposited partly covering the root run and partly on the bottom plate.

Give a steady movement to the electrode using a short arc.

Deslag and clean the weld bead.

Deposit the third and final run with a 4 mm dia. Electrode and 160 amps welding current. Angle of the electrode to the line of weld is 70° to 80° and 40° - 50° on both plates. The third run has to be deposited in such a way that the bead covers partly the root run and the second run and partly the vertical plate. Also, there should not be a valley at the bottom toe line of the third run in order to maintain necessary throat thickness. If two pass technique is adopted second run should be done in a weaving motion.

Deslag and clean the weld bead.

Note: Avoid over-deposition and side undercut by using a proper angle and travel speed of the electrode.

Inspection of Tee joint

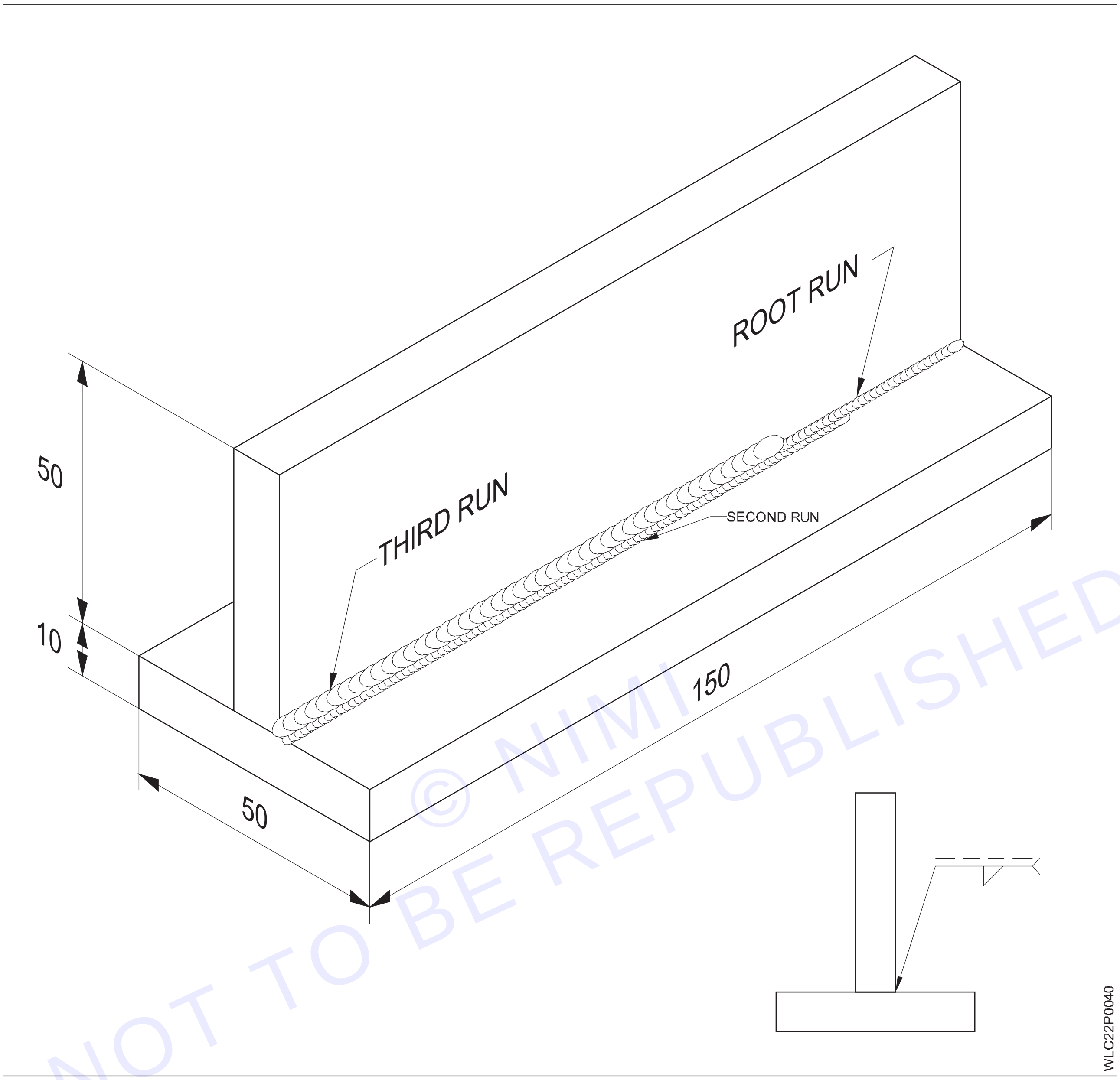
Inspect the fillet weld for equal leg length and correct size.

Inspect to ensure the fillet weld is free from undercut and excessive lapping on bottom plate.

Fillet - 'T' joint on MS plate 10mm thick in horizontal position (SMAW)

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

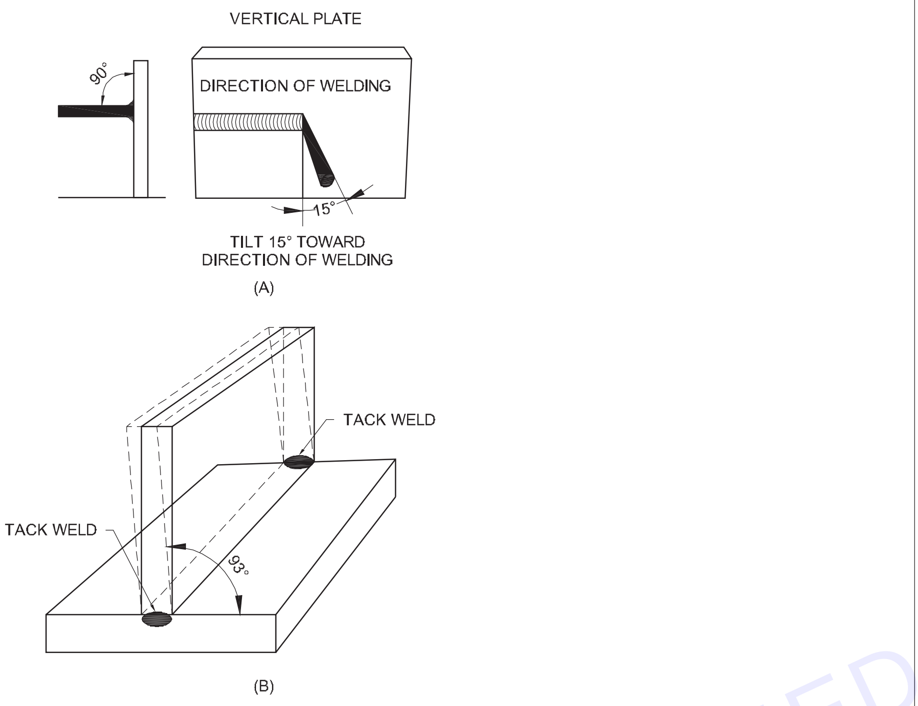
- select electrode, current, polarity and arc length
- use distortion control and arc blow control methods
- weld the 'T' joint with a short arc and uniform travel speed
- inspect the weldments for external defects.



Job Sequence

- Prepare and clean the plates.
- Set the Tee joint as per drawing and tack weld (Fig 1)
- Fix the joint in horizontal position.
- If DC machine is used, connect the electrode to the negative and use short arc to control arc blow.
- To avoid distortion due to contraction preset the plates such a way that the angle of the tack welded joint is increased to 92° to 93° on the welding side.
- Deposit the root run without weaving.
- Hold the electrode at the center of the joint and start from leftward and use proper technique to avoid excessive metal deposition at the bottom of the plate.
- Deslag and clean the root run.
- Deposit the second and third run using stringer bead technique covering the previously laid bead partially and the plate surface.

Fig 1



(A) HOW TO HOLD AN ELECTRODE WHILE MAKING A HORIZONTAL WELD BEAD ON A VERTICAL PLATE
(B) HOW TACK WELDS CAN BE USED TO HOLD A T JOINT IN PLACE UNTIL IT IS FULLY WELDED

- Ensure to fill the crater and to clean the bead.
- Check for the size of fillet, bead profile, weld defects and rectify them.

Skill Sequence

‘T’ joint weld on MS plate 10mm in horizontal position

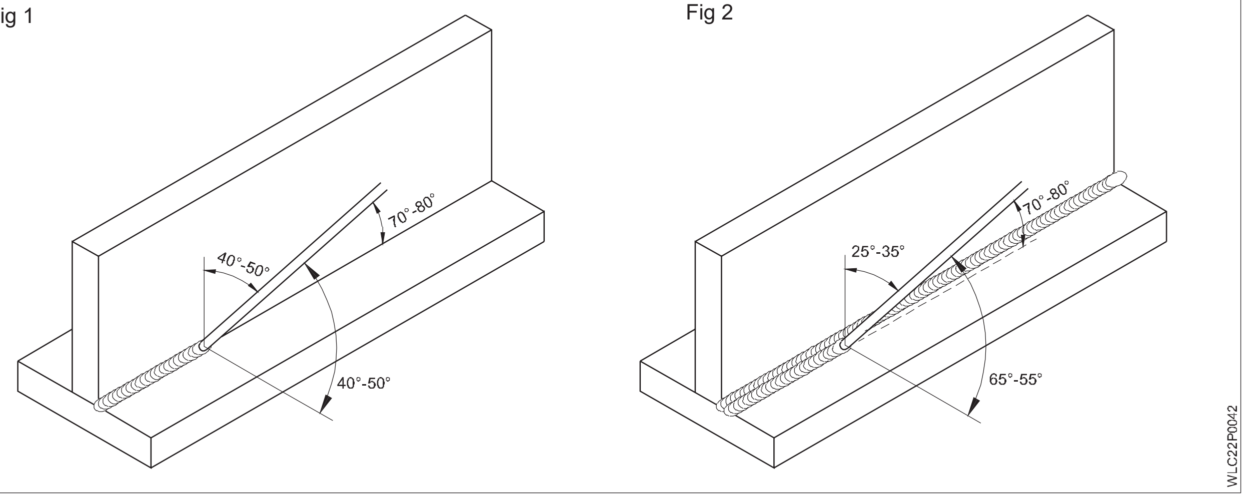
Objectives: At the end of this exercise you shall be able to

- set and weld ‘T’ joint on MS plate 10mm thick in horizontal position.

Fix the joint in a horizontal position. For this the bottom plate should be kept parallel to the ground and the other plate perpendicular. Fig 1.

Fig 1

Fig 2



Welding Tee joint (fillet) in horizontal position: Deposit root run with 3.15 mm dia. electrode and 110 amps welding current, maintaining the electrode angle 70° to 80° to the line of weld and 40° to 50° between the vertical plate and electrode (as in Fig 1).

Maintain a short arc to get uniform fusion and proper root penetration.

Deslag and clean the root bead thoroughly. Use safety goggles while deslagging to protect the eyes from flying slag particles.

Give a steady movement to the electrode using a short arc.Deslag and clean the weld bead.

Deslag and clean the weld bead.

Deposit the third and final run with a 4 mm dia. Electrode and 160 amps welding current. Angle of the electrode to the line of weld is 70° to 80° and 40° - 50° on both plates. (Fig 3) The third run has to be deposited in such a way that the bead covers partly the root run and the second run and partly the vertical plate (Fig 4). Also there should not be a valley at the bottom toe line of the third run in order to maintain necessary throat thickness. If two pass technique is adopted second run should be done in a weaving motion. (Fig 5)

Fig 3

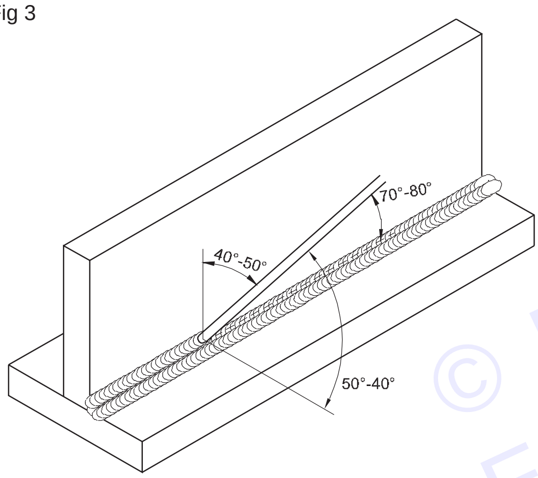
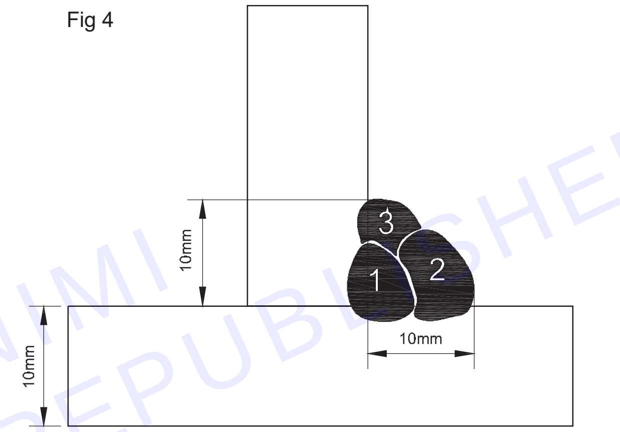


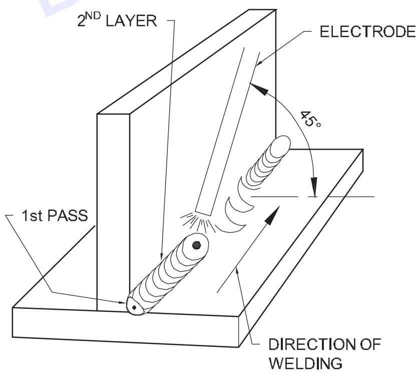
Fig 4



OREDER OF MAKING STRINGER BEADS FOR A "T" JOINT IN HEAVY PLATE

WLC22P0043

Fig 5



WEAVING MOTION USED FOR 2ND RUN OF FILLET WELDS (HORIZONTAL POSITION)

WLC22P0044

Deslag and clean the weld bead.

Note: Avoid over-deposition and side undercut by using a proper angle and travel speed of the electrode.

Inspection of T joint

Inspect the fillet weld for equal leg length and correct size.

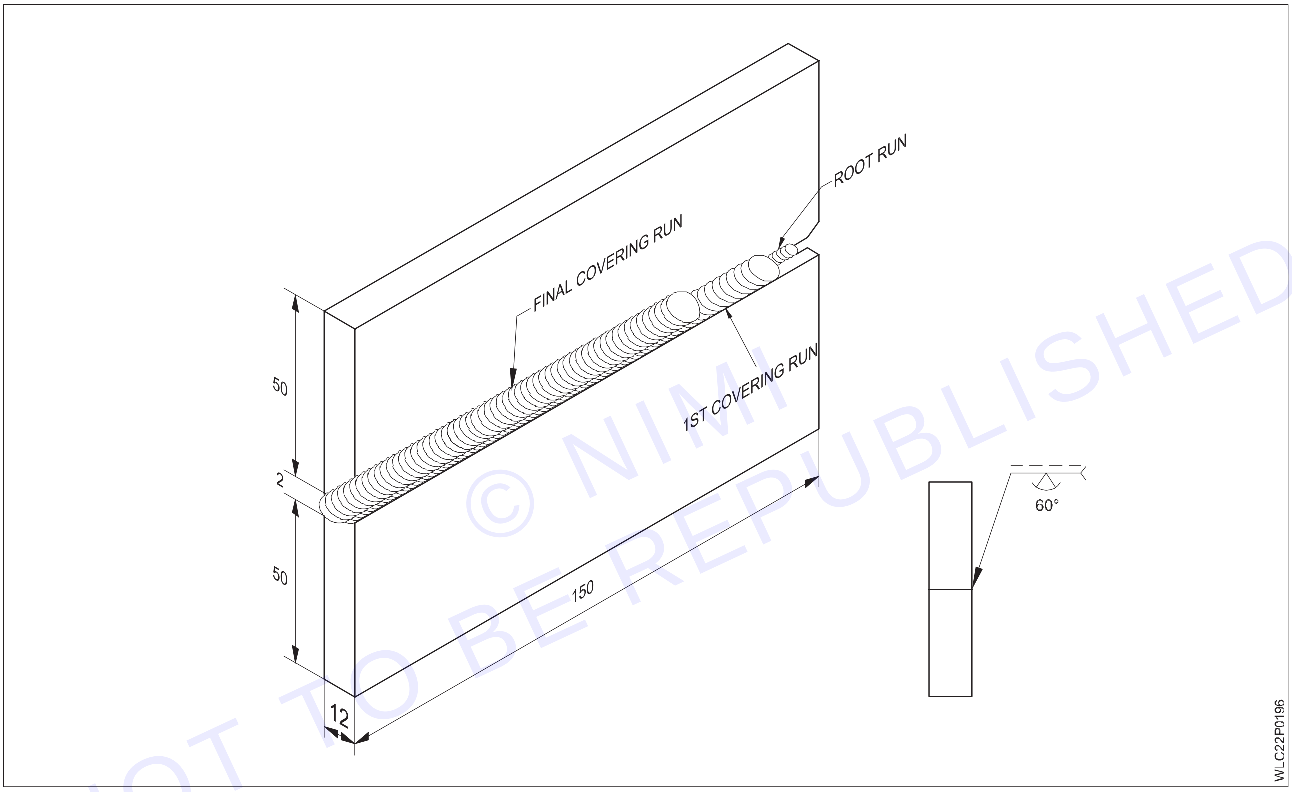
Inspect to ensure the fillet weld is free from undercut and excessive lapping on bottom plate.

EXERCISE 9: Single “V” butt joint on MS plate 12mm thick in horizontal position (SMAW)

Objectives

At the end of this exercise you shall be able to

- prepare the plate edges to prevent effect of gravity on deposited metal
- maintain root penetration by the manipulation of electrodes
- weld single ‘V’ butt joint in horizontal position preventing sagging of weld metal
- clean and inspect for surface defects.



Job Sequence

- Cut the MS plates 10mm thick to size.
- Bevel the edges.
- One of the plates is beveled to 45° by gas cutting.
- The second plate is beveled to 15° by gas cutting.
- Clean the edges and remove all the burrs.
- Preset the single ‘V’ for controlling the distortion.

Note: Wear safety clothing.

- Tack the beveled plates with a root gap of 2 mm.
- Fix the joint in horizontal position such that the member with 45° bevel as the top member with 15° beveled member as the bottom member.
- Deposit the root run starting from top plate and fuse the bottom plate also. Maintain uniform penetration throughout.

- Deposit 2nd and final 3rd run to complete the joint in horizontal position.
- Deslag each run and clean the bead.
- Inspect the welded joint for defects.

Skill Sequence

Single 'V' butt joint on MS plate 12mm thick in horizontal position

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

- prepare and weld single V butt joint on MS plate 12mm thick in horizontal position.

Prepare the beveling by gas cutting and filling.

Prepare the plate and make 45° bevel for the top member and 15° bevel for the bottom member with a root face of 1.5 mm by filling.(Fig 1)

Then file the bevel and keep the root face 1.5 mm. (Fig 1) Set the job with a 2 mm root gap and tack weld onboth ends.

This type of beveling is used specially for welding single 'V' butt joint in horizontal position to deposit the metal against the effect of gravity.

Deposit a root run without weaving motion and hold the electrode angle 90° to the vertical plate and 65° to 75° to the line of the joint.

Maintain the keyhole to obtain uniform penetration.

Deposit the 2nd run by reducing the electrode angle to the upper vertical plate 55° to 65° using slight weaving motion. (Fig 2)

Fig 1

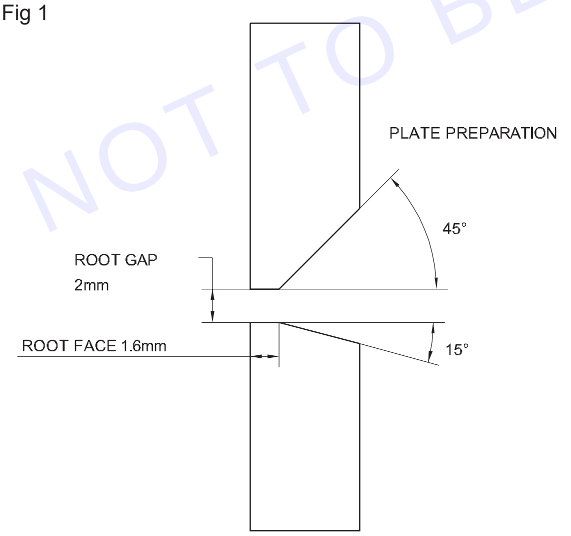
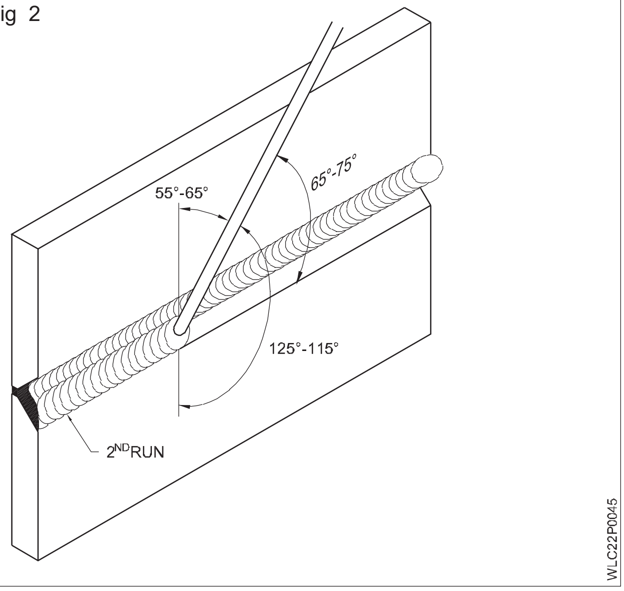
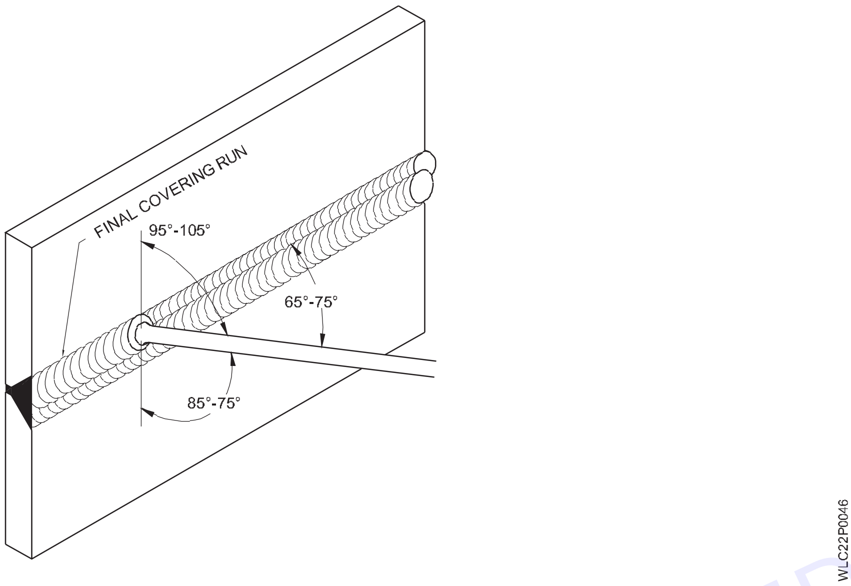


Fig 2



Deposit the 3rd run by increasing the electrode angle 95° to 105° to the upper vertical plate using slight weaving motion. (Fig 3) Deposit the outer edge of the upper fusion face and the junction of the 2nd run.

Fig 3

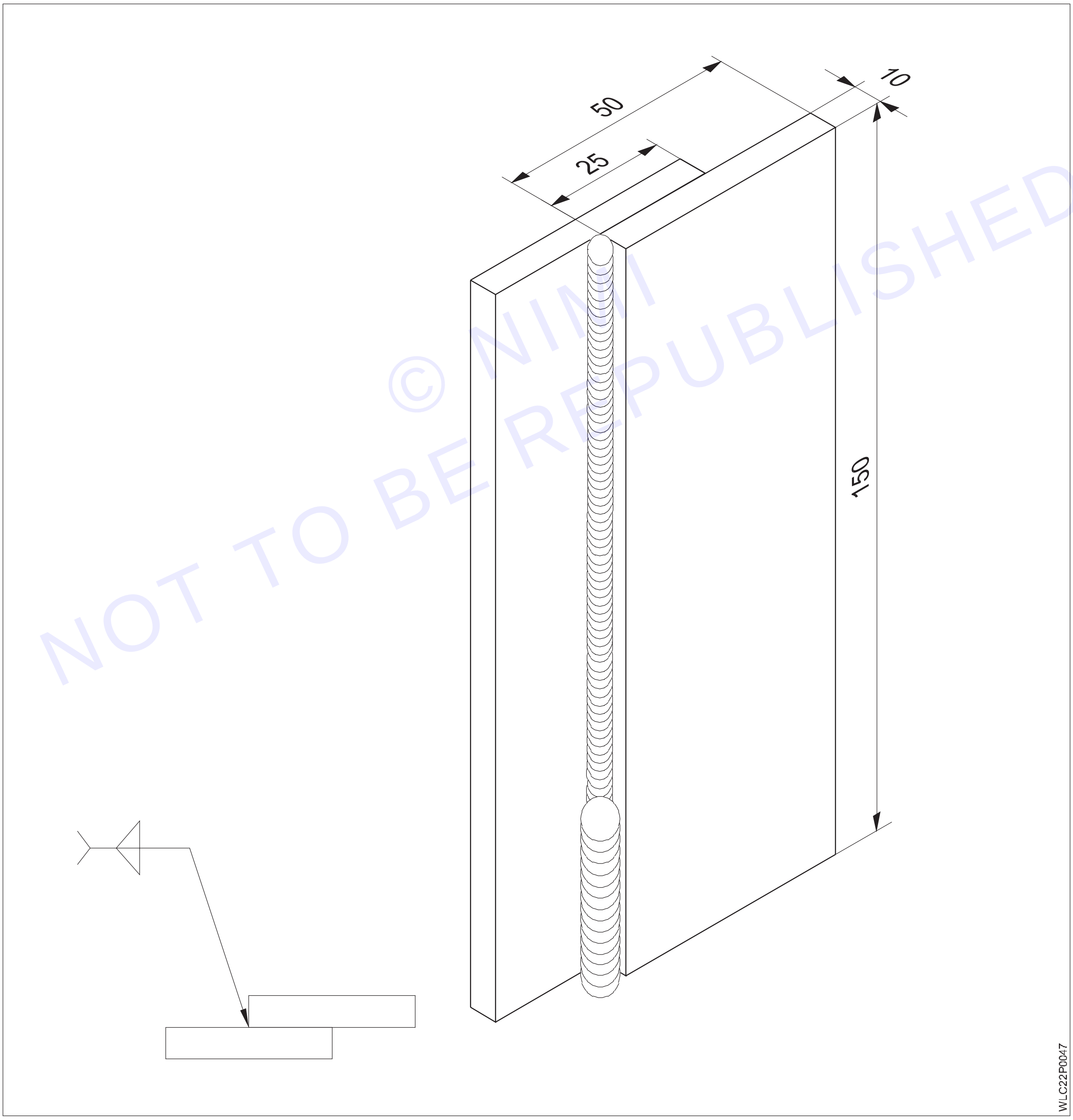


EXERCISE 10: Fillet lap joint on MS plate 10mm thick in horizontal position (SMAW)

Objectives

At the end of this exercise you shall be able to

- deposit bead at the bottom of the joint to the required size of the weld
- control the sagging of the molten metal with an oscillating motion of the electrode
- deposit root run to ensure fusion and penetration in lap section
- complete the weld by depositing second run on the lap joint without edge of plate melted off defect.



Job Sequence

- Gas cut the plate "C" to size as per drawing.
- Prepare square edges.
- Clean the flat surface and the edges of plate C.
- Take the T fillet joint already welded under exercise no.
- Assemble/clamp the plate C with the bottom side of plate B of the T fillet joint to form a lap joint as shown in the job drawing. The lapping distance should be 25mm.
- Select a 3.15mm dia. Medium coated MS electrode and set 110 amp current.
- Use electrode negative polarity if a DC machine is used for welding.
- Set the assembled job on the welding table and tack weld the plate C with plate B at their ends.
- Ensure that the surfaces of plates B and C are parallel to each other and that there is no gap between them after tacking.
- Remove slag and fix the job on the welding positioner in vertical position.
- Deposit the root run with short arc length and by a very slight weaving motion to the electrode.
- Give whipping action to the electrode to prevent sagging of molten metal and slag.
- Deslag with a chipping hammer and clean the joint and bead thoroughly with a wire brush, particularly at the toes of the weld.

Note: Use goggles while deslagging.

- Select a 4mm dia. Medium coated MS electrode and set 150 to 160 amp. Current.
- Deposit the 2nd run with short arc and weaving motion.
- The weaving motion and the movement of the arc in the upward direction should be at uniform speed.
- Ensure the correct fillet size with proper bead profile is obtained and the edge of the plate B is not melted off. also ensure that there is no undercut at the toe of the weld on the bottom plate C.
- Remove the welded joint from the positioner after filling the crater.
- Clean the joint using a wire brush and inspect for any external defect.

Note: Follow the necessary safety precautions during welding.

Skill Sequence

Fillet lap joint on MS plate 10mm thick in vertical position

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

- prepare and weld fillet lap joint on MS plate 10mm thick in vertical position.

Welding a lap joint in vertical position has always been a problem – one of the upper edges of the plate being burnt (edge melted off). This can be overcome by using proper electrode manipulation.

Method of depositing bead in vertical on lap joint

Set a minimum current so as to maintain a small molten Pool.

Use a short arc for depositing root run with whipping motion So as to prevent sagging of the weld metal. (Fig 1 and 2) deposit the 2nd run with weaving motion and this will avoid sagging of the molten metal. The angle of the electrode should be 75° - 80°. (Fig 3)

Fig 1

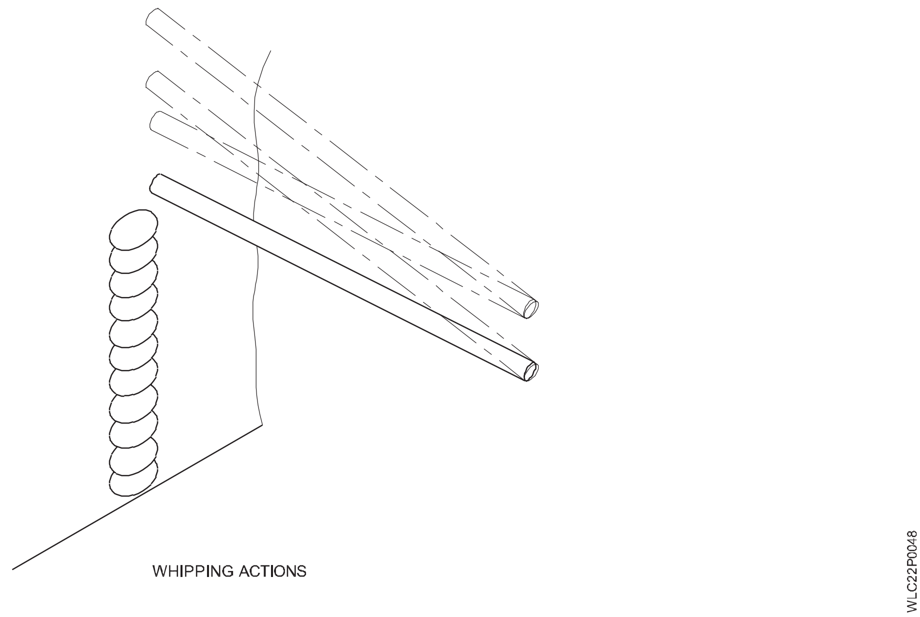


Fig 2

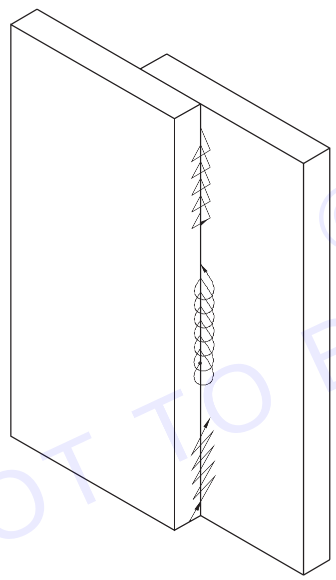
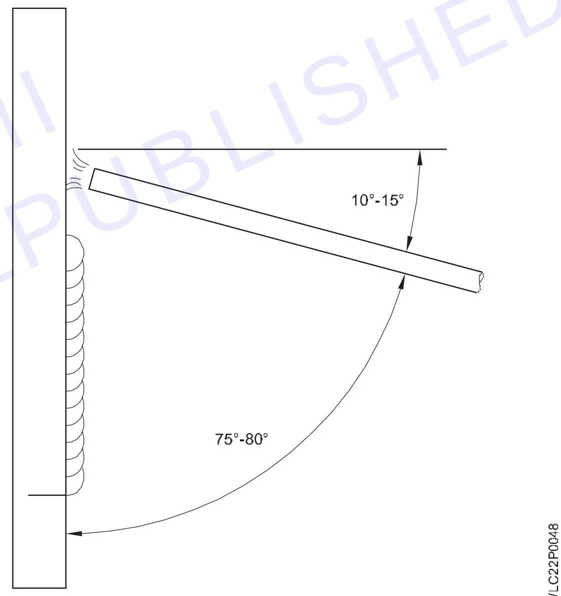


Fig 3



Any one of the weaving motions shown in Fig 2 can be Used.

Note: Do not break the arc while moving in the Upward direction.

The motion of the electrode should be a weaving motion.

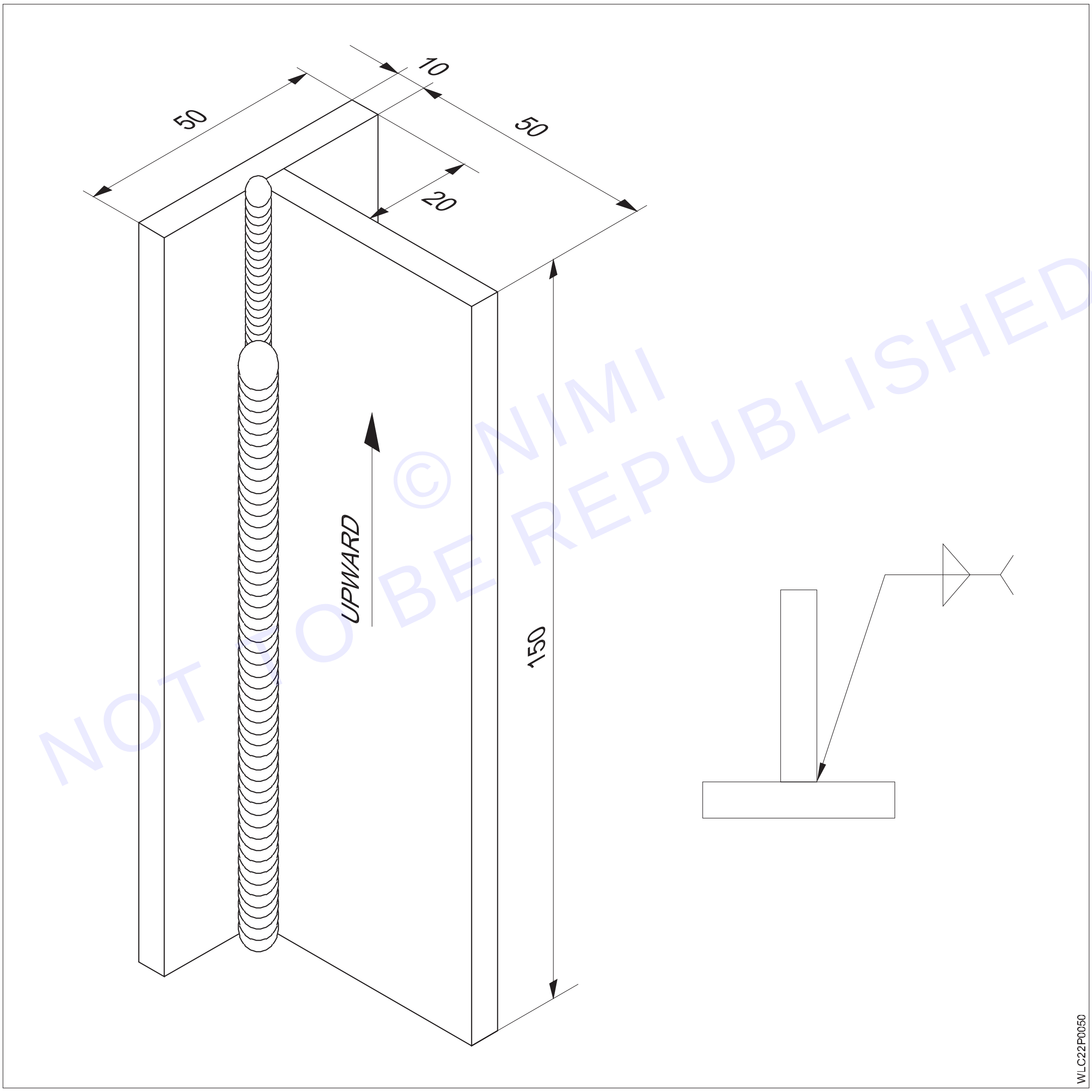
Keep the electrode motion confined to the weld width so that the edge of the upper plate is not melted off.

The rate of travel should be even for obtaining a uniform bead with a good appearance.

Note: Overlapping distance should not be more than 3 times the thickness of the base metal.

Fillet – "T" joint on MS plate 10mm thick in vertical position (SMAW)

Objectives: At the end of this exercise you shall be able to
- fix the joint in vertical position
- deposit the root run in vertical position ensuring root penetration with short arc
- deposit the second run evenly to get the required fillet size without defects
- inspect for surface defects like undercut, lack of penetration etc.



Job Sequence

- Mark the plate to size and cut as per drawing.
- Prepare square edges.
- Set the work piece as a 'T' joint.
- Select a 3.15 mm electrode and set 110 amps current.
- Connect electrode cable to-ve terminal.
- Tack-weld the work pieces at the ends. preset the plates to 2° to take care of distortion.

Note: Position the joint in vertical in the welding positioner.

- Deposit the root run with short arc length and by a slight weaving up and down motion to the electrode.
- Use whipping action for the electrode.
- Deslag and clean thoroughly with a wire brush.

Use goggles while Deslagging.

- Select a 4 mm ø electrode and set 160 amps current.
- Deposit 2nd run with short arc using a weaving motion and uniform speed of metal deposition.
- Avoid undercut.
- Ensure proper crater filling.
- Remove the welded joint from the positioner, clean and inspect for defects.

Follow the necessary safety precautions during welding.

Skill Sequence

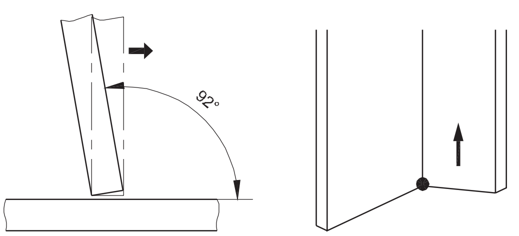
Fillet weld 'T' joint on MS plate 10mm thick in vertical position

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

- prepare and fillet weld 'T' on MS plate 10mm thick in vertical position.

In vertical welding the difficulty to be overcome is the inclusion of slag in the weld metal, undercut and control of molten metal from sagging. These are avoided by using a short arc and proper weaving technique with a correct electrode angle. Preset the plate at 1° per run as shown in Fig 1 to take care of angular distortion. While depositing the root run start from the lowest part of the work piece. (Fig 2)

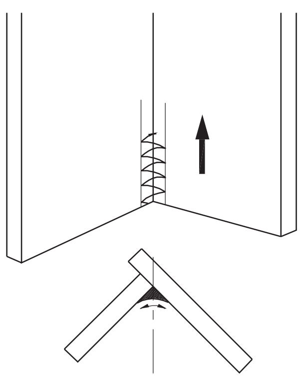
Fig 1



PRE-SETTING THE VERTICAL MEMBER OF A TEE JOINT TO BE WELDED ON ONE SIDE PROIR TO WELDING.

THE MEMBERS SHOULD BE SQUARE AFTER THE ANGULAR DISTORTION HAS TAKEN PLACE

Fig 2



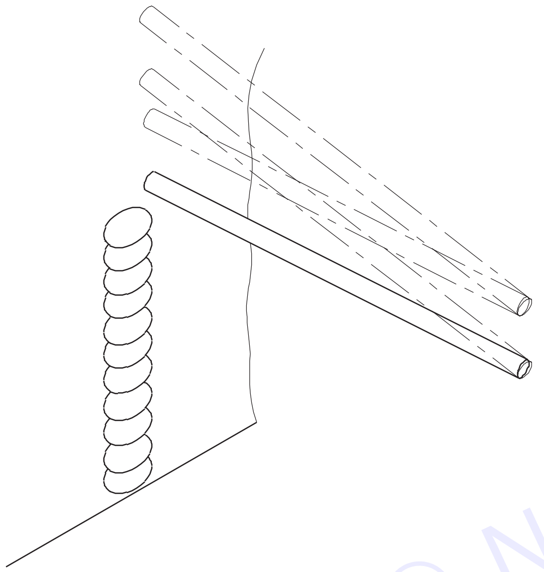
WLC22P0051

Depositing root run: Ensure equal deposit of weld metal on both the plates by giving a slight weaving motion.

Use whipping action for the electrode (Fig 3). During whipping action, the electrode is raised away from the molten pool a little with a long arc and again brought back closer to the molten pool with a short arc. When the electrode is raised from the molten pool, the weld metal cools a little and partly solidifies which helps in reducing the sagging effect of the molten weld metal.

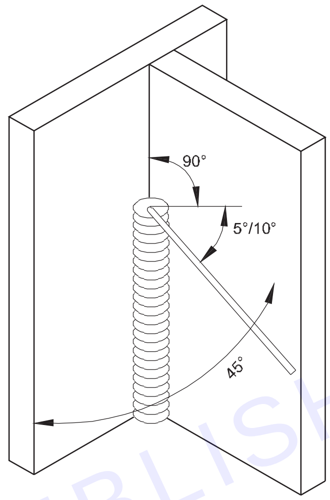
Move the electrode from side to side and stop for a short moment at each side to avoid undercut. Keep the angle of the electrode as shown in Fig 4 to deposit the metal at proper place in the joint without sagging.

Fig 3



WHIPPING ACTIONS

Fig 4



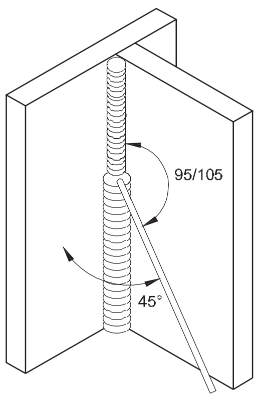
VERTICAL 'T' FILLET ELECTRODE ANGLES

WLC22P0052

Clean thoroughly the root run, and specially any slag at toes should be removed.

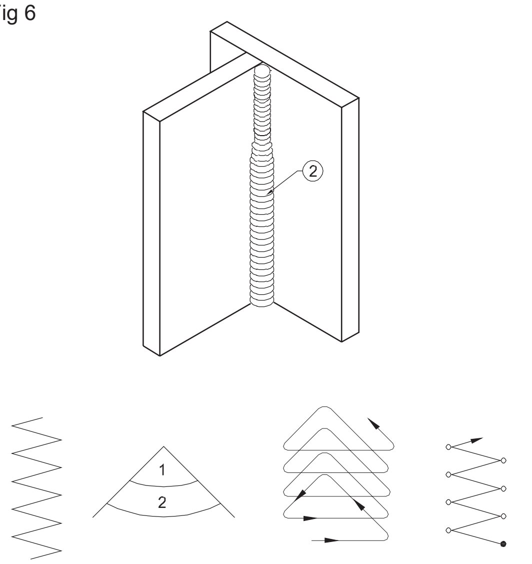
Weld the second run to get a uniform bead of required size. Use a zigzag or triangular movement of the electrode as shown in Fig 6. Use short arc length and stop a while at the sides to fill the weld at the toes. The electrode tip pointing upwards due to the electrode angle Fig 4 and the use of short arc and the weaving technique will control the sagging of the weld metal and the slag inclusion. The stoppage of the electrode at the toes of the weld for a moment in the weaving motion will help to avoid undercuts.

Fig 5



VERTICAL ' T ' FILLET

Fig 6



WLC22P0053

Open corner joint on MS plate 10mm thick in vertical position (SMAW)

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

- weld root run on open corner joint in vertical upward
- deposit 2nd and 3rd layer by weaving motion on open corner joint in vertical upward
- clean and inspect for surface defects and angle between the members.

Job Sequence

- Mark the plate to size and gas cut as per drawing.
- Prepare square edges and clean the parts to be welded.
- Set the 2 pieces as an open corner joint and use spacers to maintain a uniform root gap of 1.5 to 2mm. Then tack weld the two pieces together to form an 87° angle between the inner faces of the plates.
- Remove the spacers and set or fix the weldment in vertical position on the weld positioner.
- Select 3.15ø electrode and set 110 Amps DCEP.
- Deposit root run with short arc length.
- Deslag and clean thoroughly with a wire brush.

Note: Use goggle while deslagging.

- Select 4mmø electrode and set 160 amps.
- Deposit 2nd run using short arc and slight weaving motion.
- Deslag and deposit third and final run with 4mm dia electrode.
- Avoid undercut.
- Clean the joint and inspect for defects.

Skill Sequence

Open corner joint on MS plate of 10mm thick in vertical position

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

- prepare and weld open corner joint on MS plate of 10mm thick in vertical position.

Setting and tacking of the fillet open corner joint

Mark and punch the plates, to cut square by gas cutting.

Grind or file the gas-cut edges to square.

Remove the grinding burrs and clean the surfaces by filing and with a wire brush.

Note: Wear goggles while cutting, grinding.

Set the fillet open corner joint with a 1.5 to 2mm root gap and an angle of 87° between the inside surfaces of the plates to control the distortion. Fig1.

Tack-weld on the root side of the joint on both ends.

Use a 3.15 mm dia. M.S. electrode and 110 amps current.

Position the joint in vertical and the angle of the line of weld with the top of the table should be 90°. (Fig 1)

Welding fillet open corner joint in vertical position

Deposit root run with a 3.15 mm dia. Electrode and 110 amps welding current. (Fig 2)

Fig 1

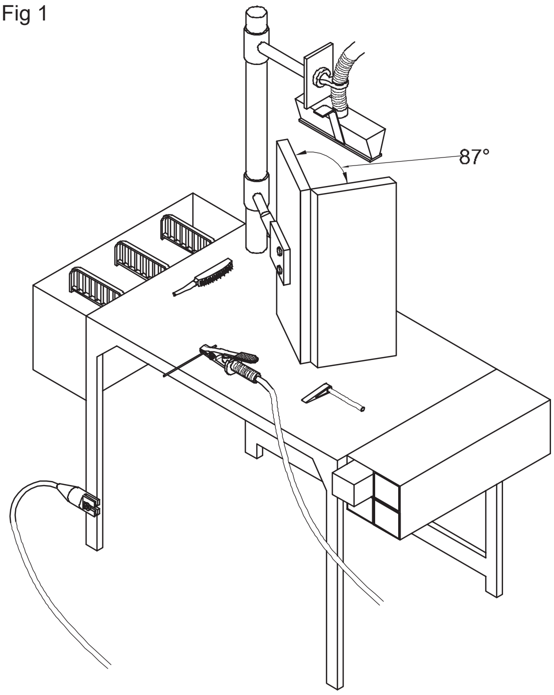
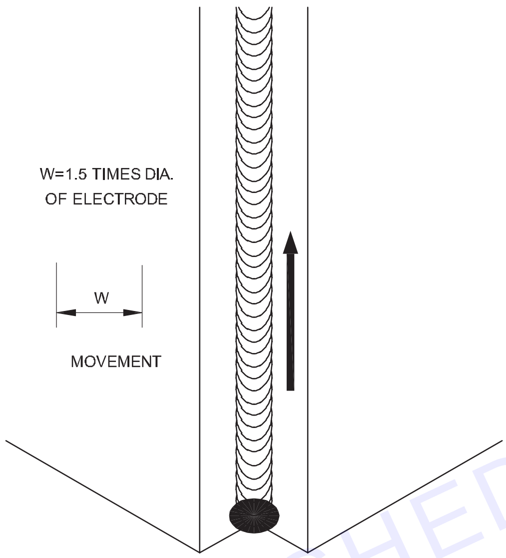


Fig 2



WLC22P0055

Maintain an electrode angle of 80° to the line of weld and the electrode movement slightly sideways, and deposit weld bead from the bottom to the top. Give whipping motion to the electrode.

Maintain a short arc to get uniform fusion and a keyhole to ensure proper root penetration.

Keep 1.6 mm root penetration depth.

Deslag and clean the root bead at the toes thoroughly; also, Deslag and clean the weld bead.

Note: Wear safety goggles.

Deposit the second run with a 4 mm dia. Electrode and 160 amps welding current. The angle of electrode should be 80° to the line of weld and the arc length should be short.

Move the electrode steadily upwards and sideways as none in exercise No.

Deslag and clean the weld bead.

Deposit the third and final run with a 4 mm dia electrode and 160 amps welding current with short arc length and sideways movement. (Fig 3)

Deslag and clean the weld bead.

Note: Avoid over-reinforcement height and edge burning.

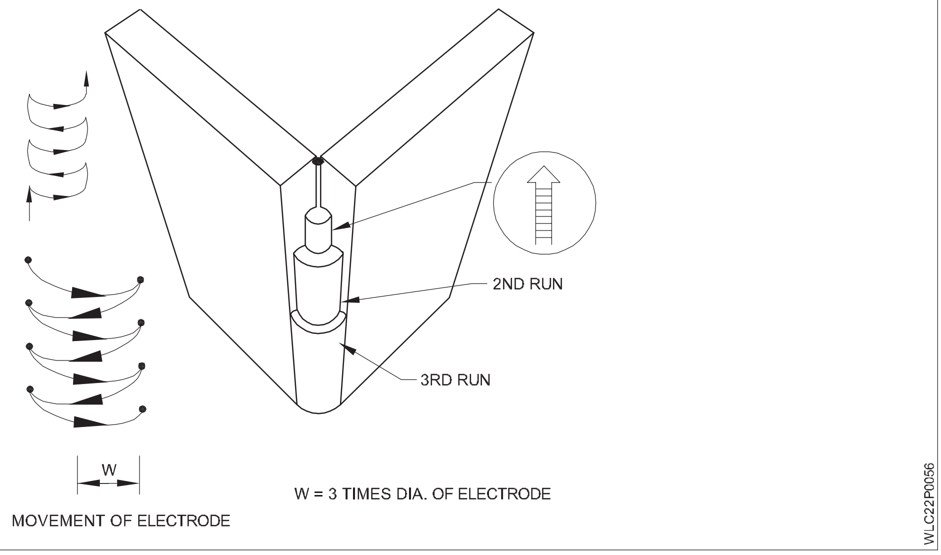
Inspect the open corner fillet weld for:

External weld defect

Edge burning and reinforcement height

Depth of root penetration.

Fig 3

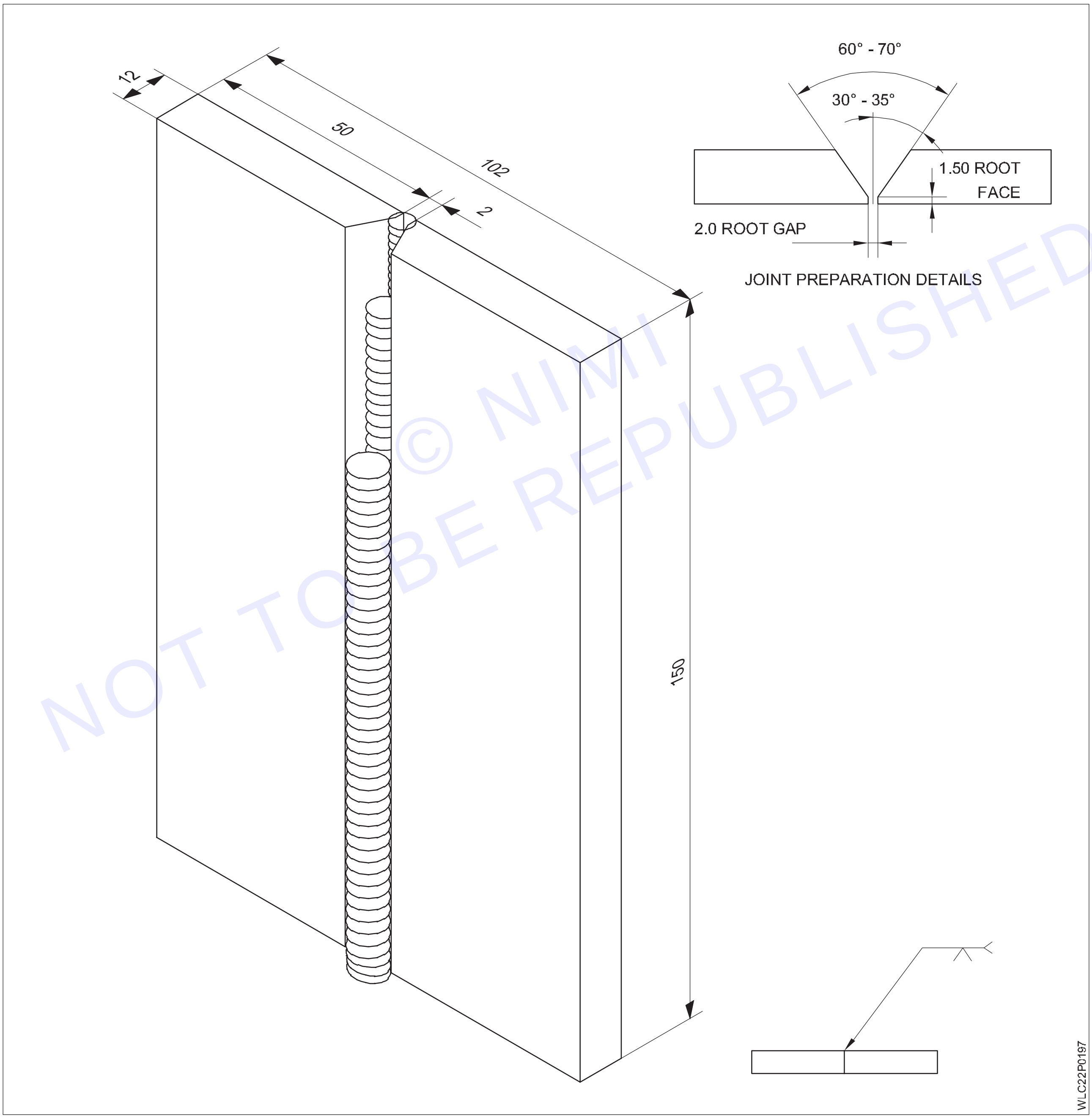

2ND RUN
3RD RUN
W
MOVEMENT OF ELECTRODE
W = 3 TIMES DIA. OF ELECTRODE
WLC22P0056

EXERCISE 11: Single "V" butt joint on MS plate 10mm thick in vertical position (SMAW)

Objectives

At the end of this exercise you shall be able to

- set and tack-weld single 'V' butt joint
- deposit root run ensuring root penetration in vertical position
- deposit the second and third runs with a weaving movement of electrodes and without weld defects.



Job Sequence

- Cut the MS plate 10mm thick to size (2 Nos.).
- Bevel the edges as per drawing.
- Both plates will have 30 to 35° bevel angle and 1.5mm root face and with no burr at the edges.
- Using spacers maintain a uniform gap of 2mm throughout and tack weld the plates.
- Preset the plates to 177° on the root side of the joint.
- Set the tack welded joint in vertical position
- Use ø3.15mm MS electrode and DCEN polarity for DC welding.
- Deposit the root run starting from bottom of the plate upward and maintain a uniform root penetration.
- Use short arc.
- Remove slag etc. and clean the weld with wire brush.
- Use ø4mm MS electrode and 150-amp current.
- Deposit 2nd, 3rd run using proper weaving technique and complete the weld in vertical position.
- Check the proper root penetration and other external weld defects.
- Rectify the defects whenever possible.

Skill Sequence

Single 'V' butt joint on MS plate of 10mm thick in vertical position

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

- prepare and weld single 'V' butt joint on MS plate of 10mm thick in vertical position.

Preparation of pieces

Cut and bevel the edges to an angle of 30 to 35° by using oxy-acetylene cutting.

Grind the bevel edges to remove oxides, and get smoothness.

Note: Use goggles while cutting and grinding.

Prepare a 1.5mm root face throughout the length by filing.

Setting and tacking of single 'V' butt joint

Keep the bevel edges parallel with the 2.5mm root gap. The 2.5mm thick spacers are used to get a uniform and parallel root gap.

Tack-weld on both ends with correct alignment and presetting of 3° to control distortion. (Fig 1) i.e. on the root side the angle between the plates should be 177°.

Position the joint in vertical using the weld positioner.

Deposition of weld beads

Deposit the root run using a 3.15 mm dia. M.S. electrode and 110 amps current with a slight sideways movement of the electrode. (Fig 2)

Note: Ensure a keyhole throughout the root run.

The angle of the electrode in the holder should be 120° so that it is convenient to hold the electrode at 80° to the line of weld.

Fig 1

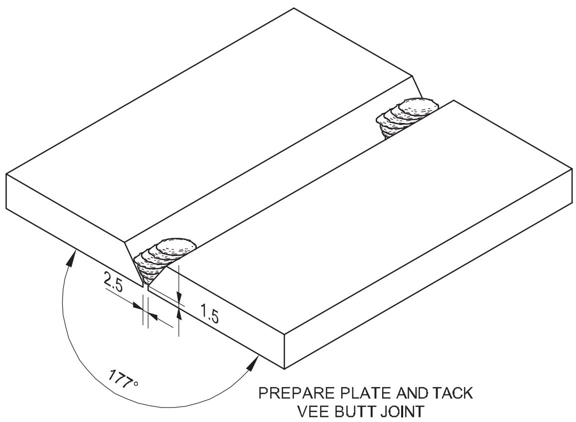
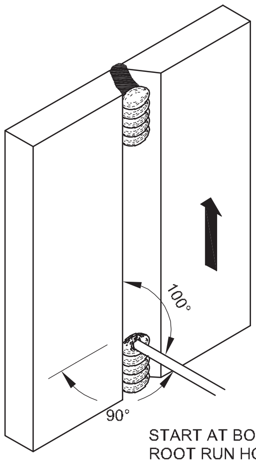


Fig 2



The arc length should be short.

Note: The root penetration depth should not exceed 1.6 mm.

Remove the slag and clean the root run by using a chipping hammer and wire brush.

Deposit the second run using a 4 mm dia. M.S. electrode over the root layer with 160 amps current and an electrode movement slightly sideways. (Fig 3)

Remove the slag and clean the weld bead thoroughly.

Deposit the third layer using a 4 mm dia. M.S. electrode and 160 amps current (Fig 4) pausing regularly at the toes of the weld.

The weaving motion of electrodes can be anyone of the three patterns shown in Fig 3 and Fig 4.

The arc length should be short which helps to control sagging of weld metal.

Avoid undercut and excessive convexity, concavity.

Remove slags with a chipping hammer and clean the weld bead thoroughly with a wire brush.

Inspect for root penetration, undercut, blow holes and excess reinforcement.

Fig 3

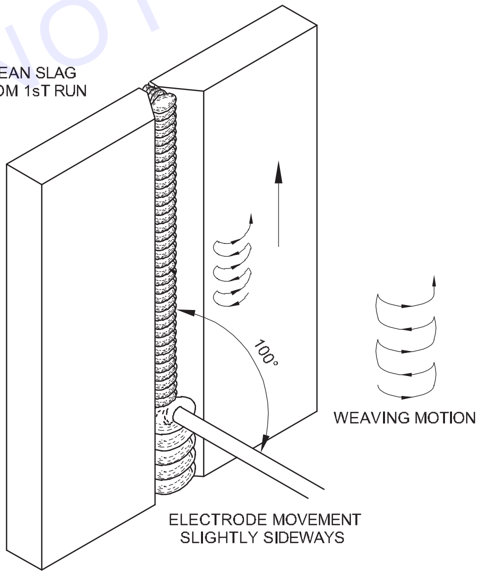
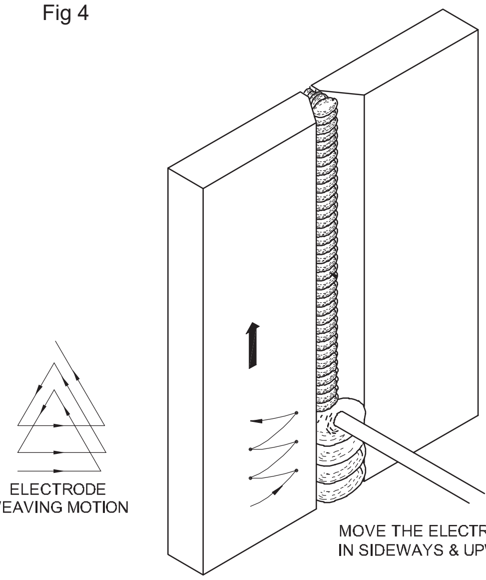


Fig 4

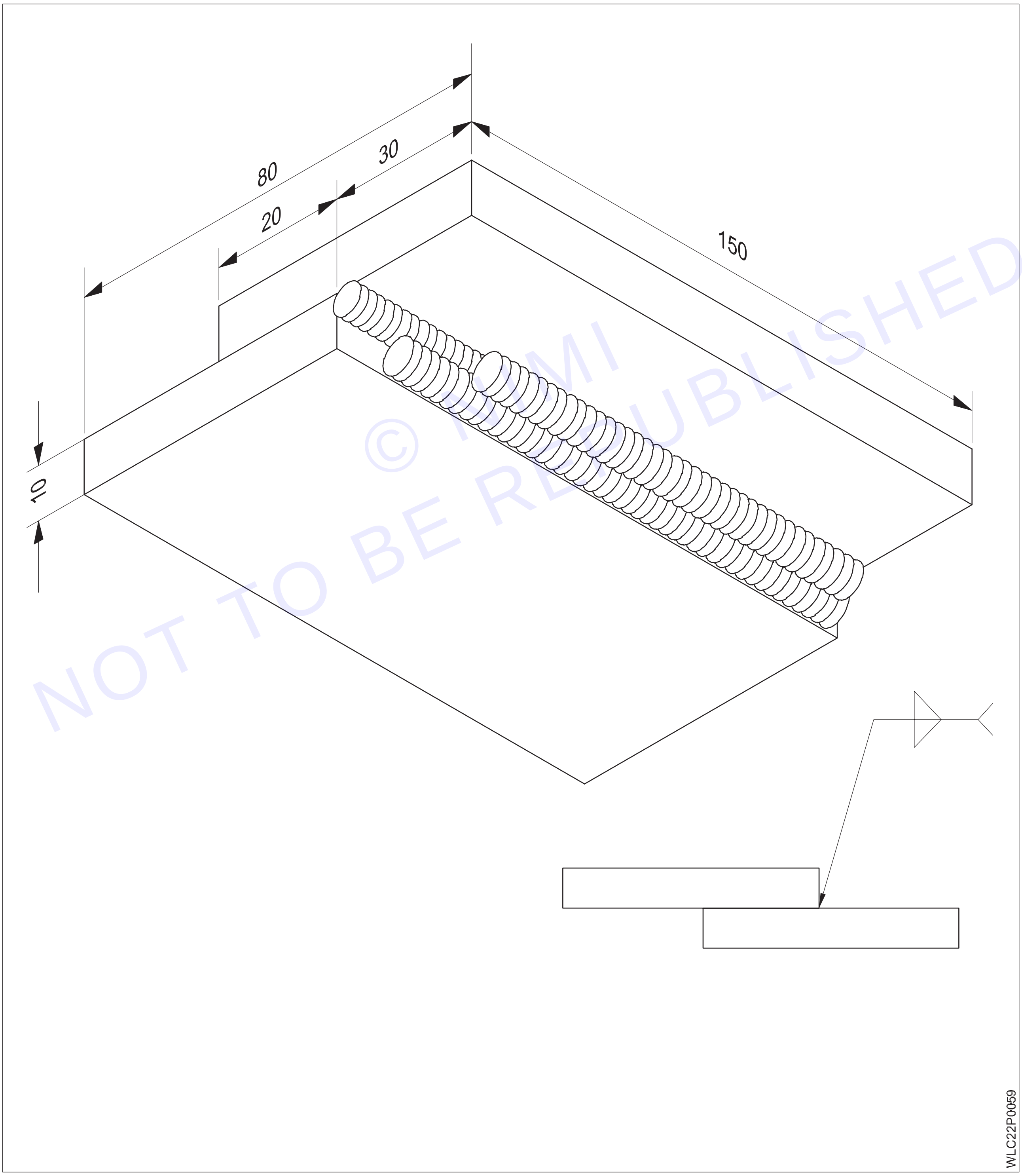


EXERCISE 12: Fillet – lap joint on MS plate 10mm thick in overhead position (SMAW)

Objectives

At the end of this exercise you shall be able to

- weld fillet lap joint in overhead position
- clean and inspect the job for surface defects.



Job Sequence

- Mark the plate and cut to given size.
- Prepare the square edges.
- Set the lap joint without gap and tack the plate on both Ends.
- Clamp the job for overhead lap welding.
- Select 3.15ø electrode and set the current.
- Hold the electrode at an angle of 45° to the plate sur- face and an angle of 15° to the perpendicular to the line of weld.
- Lay the first bead at the root without weaving the electrode.
- Clean the slag using a chipping hammer.
- Deposit 2nd and 3rd run using stringer beads.
- Deslag, clean and inspect the joint

Skill Sequence

Fillet lap joint on MS plate 10mm thickness in overhead position

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

- prepare and weld fillet lap joint on MS plate 10mm thickness in overhead position.

Preparation and job setting

Mark and cut the plate to the given size by gas cutting.

Clean the surfaces of the plates and file to square edge.

Set lap fillet without gap and tack the plates at both ends.

Keep the lapping distance as 20mm.

Note: Wear leather gloves, hand sleeves, apron, leg guard, helmet etc.

Clamp the job for overhead welding.

Select a M.S. electrode 3.15 mm ø and set 110 amps current.

Hold the electrode so that it bisects the angle between the edge of the top plate and the surface of the bottom plate, and is inclined slightly away from the crater, say 15°. (Fig 1)

Lay the first bead at the root of the joint with a short arc without electrode weaving.

Remove the slag from the bead using a chipping hammer and clean with a wire brush.

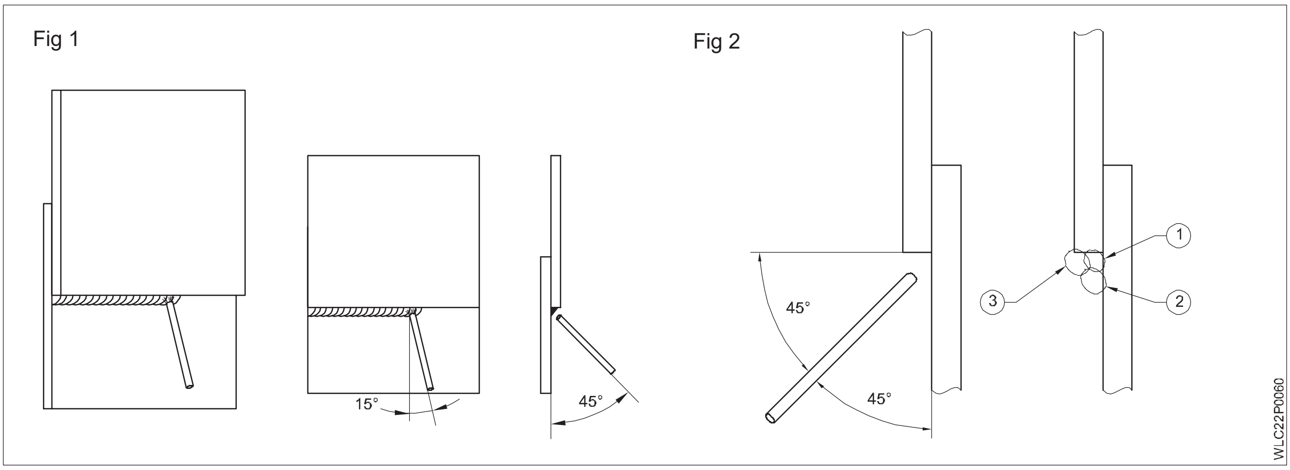
Use a M.S. electrode 3.15 mm ø and deposit the 2nd run with 110 amps. Current, between the 1st bead and the surface of the plate, maintaining a short arc. The electrode angle is the same as the one mentioned for root run.

Deslag the second bead thoroughly.

Use a 3.15 mm electrode and set 110 amps current.

Deposit the 3rd bead in between the first bead and the bottom edge of the top plate (Fig 2) with a short arc and with an electrode angle of 45° to the surface of the plate to pvoid the edge melting off the top plate.

Clean the weld thoroughly and inspect for defects, like undercut, porosity, uneven ripples and the melting off of the edge plate.



Fillet - "T" joint on MS plate 10mm thick in overhead position (SMAW)

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

- deposit root run on T fillet joint in overhead position
- control the molten pool when welding in OH position
- manipulate the electrode angle for a multi-run weld in OH position
- clean and inspect the weldment for surface defects.

Job Sequence

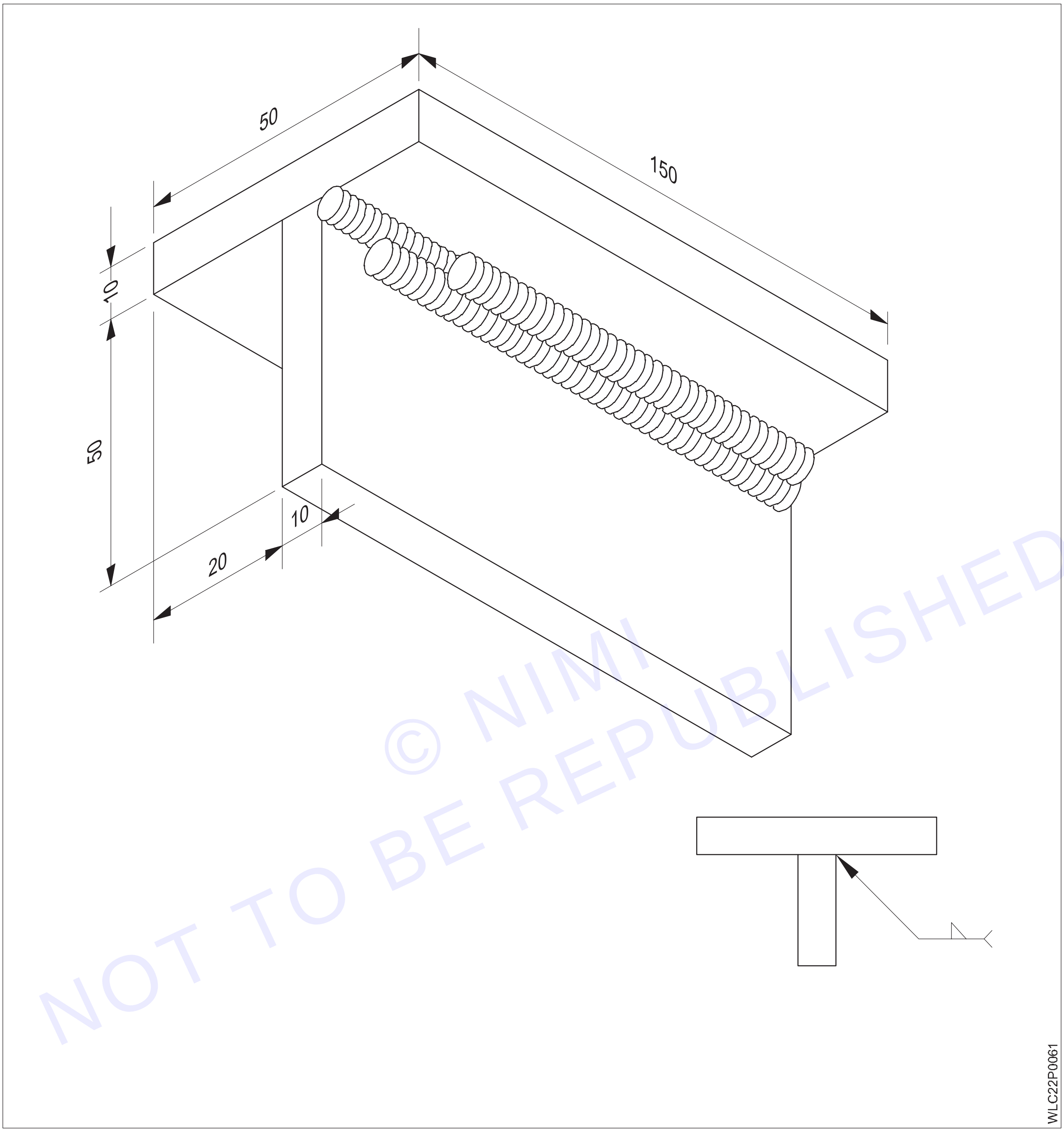
- Prepare and clean the job pieces.
- Set and tack the job pieces at both ends of the Tee joint in flat positions.

Note: Tack the work pieces in outside edges so as to avoid starting defect.

- Set the job in overhead position and adjust its height.

Note: Wear protective clothing i.e. helmet, hand sleeves, apron etc.

- Set a current of 110 amps for a 3.15mmø M.S. electrode.
- Connect the electrode holder in positive pole in the case of a DC machine.
- Deposit root run (first bead) deep in the root of the joint using a 3.15 mm ø electrode.
- Remove the slag and deposit second and third run with a 3.15 mm electrode. (Refer to Skill Information.)
- Remove the hot job by using a pair of tongs.
- Clean the weldments and inspect the surface defects.
- Repeat the exercise until you are able to weld the joint without defect.



Skill Sequence

Single 'V' butt joint on MS plate of 10mm thick in vertical position

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

- prepare and weld fillet 'T' joint on MS plate 10mm thick in overhead position.

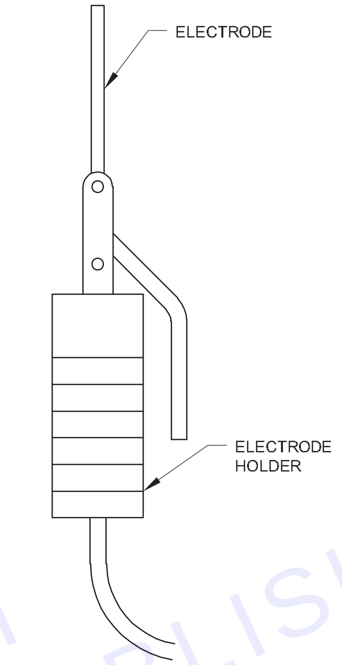
Job setting

Set the job in overhead position on the positioner. (Fig 1)

Fix the electrode as shown in Fig 2.

Fig 1

Fig 2



ELECTRODE ANGLE IN HOLDER.

WLC22P00562

Start the bead at the left side. (Fig 1)

Use a 30° work angle off the vertical plate as shown in Fig 3.

Work angle is the angle between the electrode and the job surface.

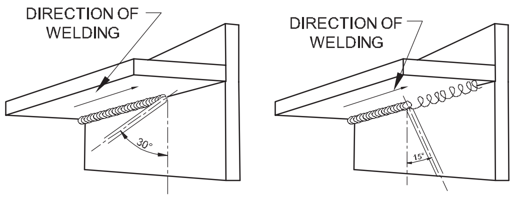
Drag angle is the angle between the electrode and the line of weld.

Maintain a short arc all the time.

When multi-passes are used the second pass should be placed between the first pass and the vertical plate so that the second bead overlaps the first pass, (Fig 4) by about 2/3rd of its width.

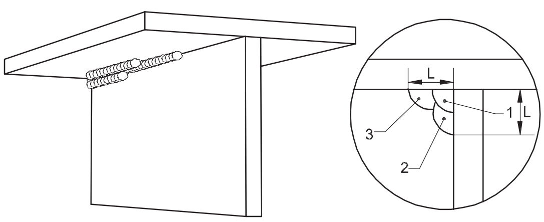
The third bead should cover the top horizontal plate and about two-third of bead two. The leg lengths "L" of the weld should be equal. (Fig 4)

Fig 2



FILLET WELD IN THE OVERHEAD POSITION

Fig 3



T-JOINT IN AN OVERHEAD POSITION

WLC22P0063

Welding in the overhead position is not difficult if you remember to keep the puddle flat and small.

If the molten metal becomes too fluid and tends to sag, whip your electrode away quickly from the crater and allow the metal to solidify.

Note: Do not attempt to deposit too much weld metal at one time.

All the slag must be removed before you deposit the next run.

The process is quite hazardous because of flying spatters and the possibility of molten metal from the puddle dropping on to the operator. By maintaining a short arc length and rapid electrode manipulation this difficulty may be overcome to a great extent.

The discomfort of the cable can be minimized by dropping it over the shoulder if you are welding in a standing position as shown in Fig 1 or over the knees if in a sitting position.

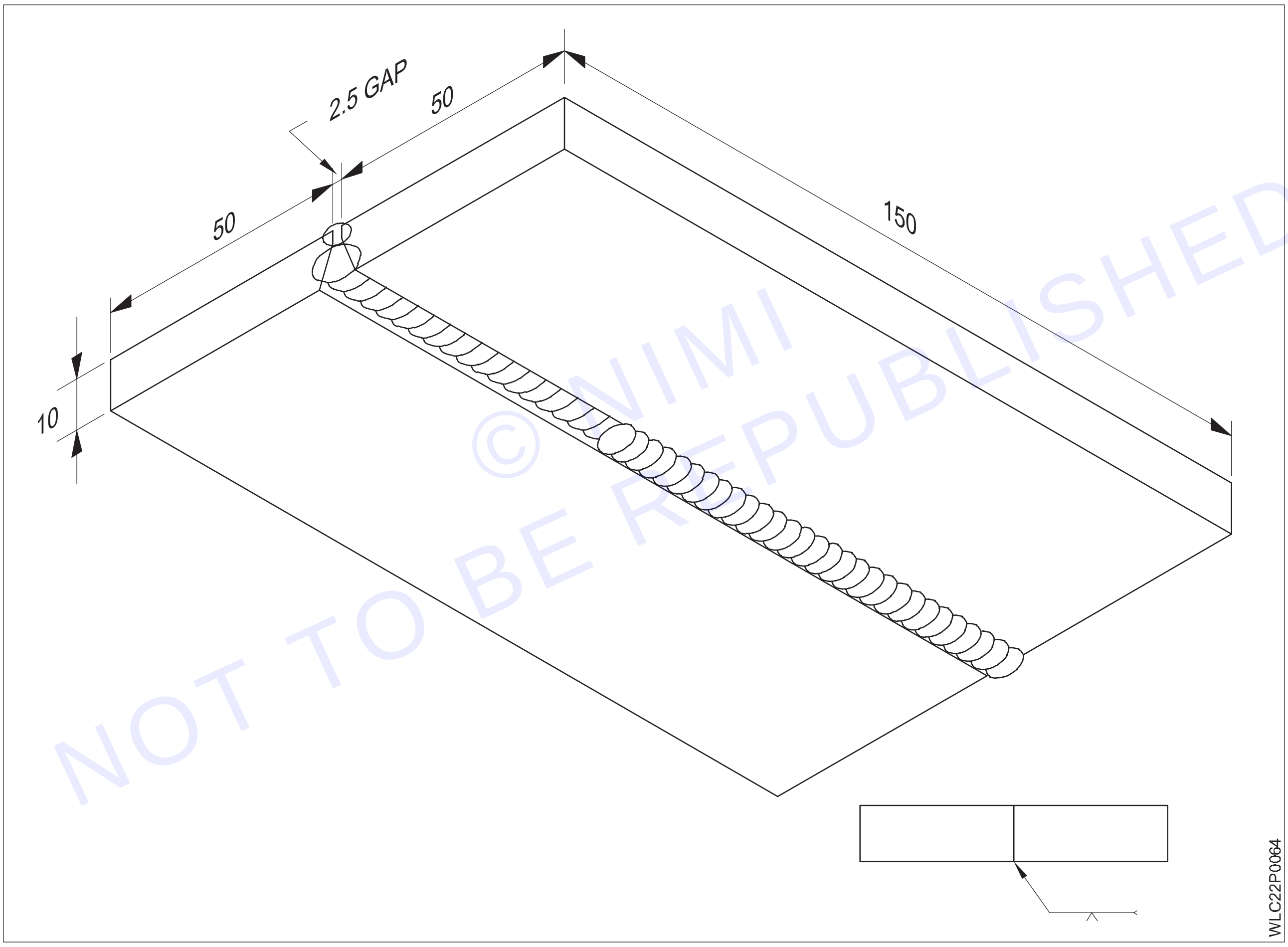
Inspection: Remove the slag from the weld and inspect the joint for surface and external defects.

EXERCISE 13: Single "V" butt joint on MS plate 10mm thick in overhead position (SMAW)

Objectives

At the end of this exercise you shall be able to

- select electrode, current, polarity and arc length
- preset and tack the beveled plate with root gap
- place the joint in overhead position
- deposit root run, 2nd run, 3rd run
- clean the weldment and inspect for surface defects.



Job Sequence

- Prepare the plates to size as per drawing.
- Clean the beveled plate.
- Use spacers, maintain 2.5 mm root gap, tack one end and adjust the gap and tack the other end.
- Preset the plates 3° to take care of distortion as done in Ex. No. E32/3. 16.

Note: Ensure safety apparels are worn.

- Arrange the work piece in overhead position.

- Select a 3.15 mm M.S. electrode and set 110 amps current.
- Weld the root run with short arc with uniform welding speed, so that a uniform root penetration can be obtained.
- Chip the slag and inspect the weld.

Note:

Use a pair of tongs to hold hot jobs.

Use a chipping hammer and wire brush for cleaning.

Use chipping goggles for protection of eyes.

- Deposit second covering run with a weaving motion.
- Use a 3.15 mm electrode with 110 amps current.
- Deposit the third covering run similar to the second run.
- Repeat this exercise until you can produce good welds.

Skill Sequence

Single 'V' butt joint on MS plate 10mm thick in overhead position

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

- prepare and weld single 'V' butt joint on MS plate 10mm thick in overhead position.

This type of joint is used very extensively for welding huge structures as in rail coach, ship building industries and earth moving equipment manufacture and for welding big structures and huge pipes at side.

Setting and tacking

Set the pieces as single V butt joint with 2.5 mm root gap. (Fig 1) Tack at both ends.

Use a 3.15 mm ø M.S. electrode and set a current of 100° amps.

Preset the plates

Fix the work piece in the overhead position. (Fig 2)

Fig 1

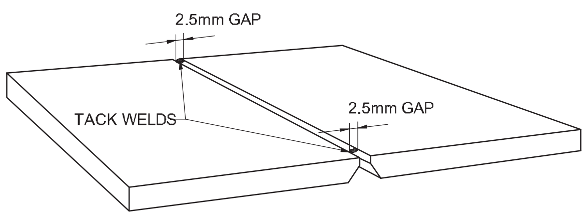
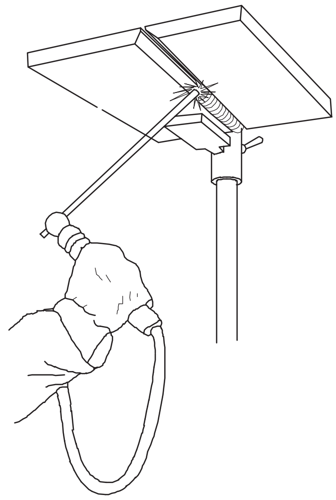


Fig 2



Adjust it to a suitable height.

Use a light welding cable to reduce the load on your arms.

Weld root run

The electrode should be kept as near as possible and square to the surface of the plate and at a small angle to the direction of the weld. (Fig 3) Keep the electrode well up in the gap and control the 'keyhole' to get a small reinforcement on the weld on the root side. (Figs 3 and 4)

Fig 3

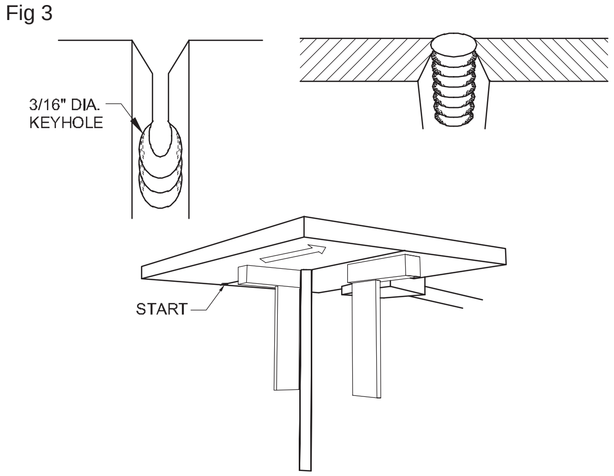
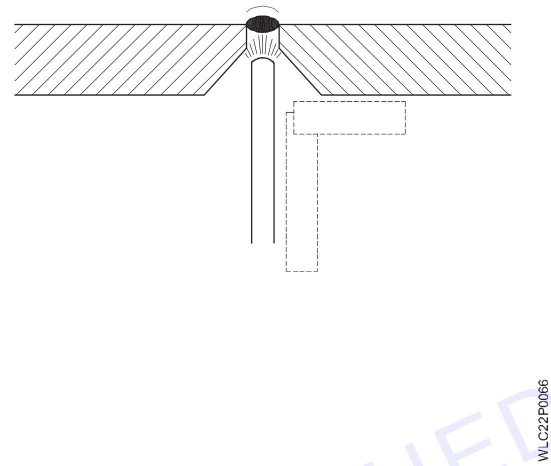


Fig 4



Keep a short arc length. (Fig 4)

Note: Control the slag. The slag must not drop into or flood the weld pool.

Weld up to the end of the work piece, chip off the slag after cooling and inspect the weld.

Weld second and third passes

Select a 3.15 electrode and set 100 amps current.

Use weaved beading technique.

The electrode should be moved across the face of the weld. (Fig 5)

Do not deposit too much metal in the centre of the bead causing it to sag in the centre.

The side-to-side movement should be kept within the required weld size. (Fig 6)

Stop a while at the sides of the weld to prevent undercut. (Fig 7)

Chip off the slag and inspect the weld.

Fig 5

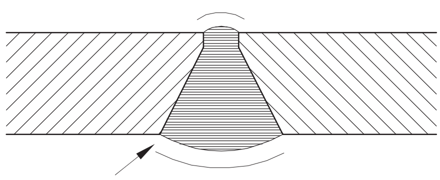


Fig 6

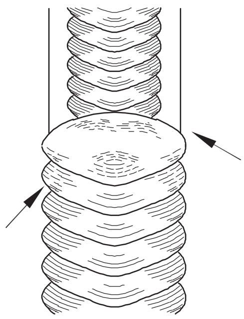
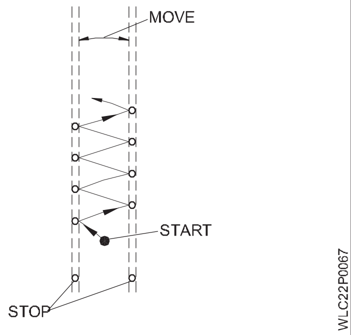


Fig 7



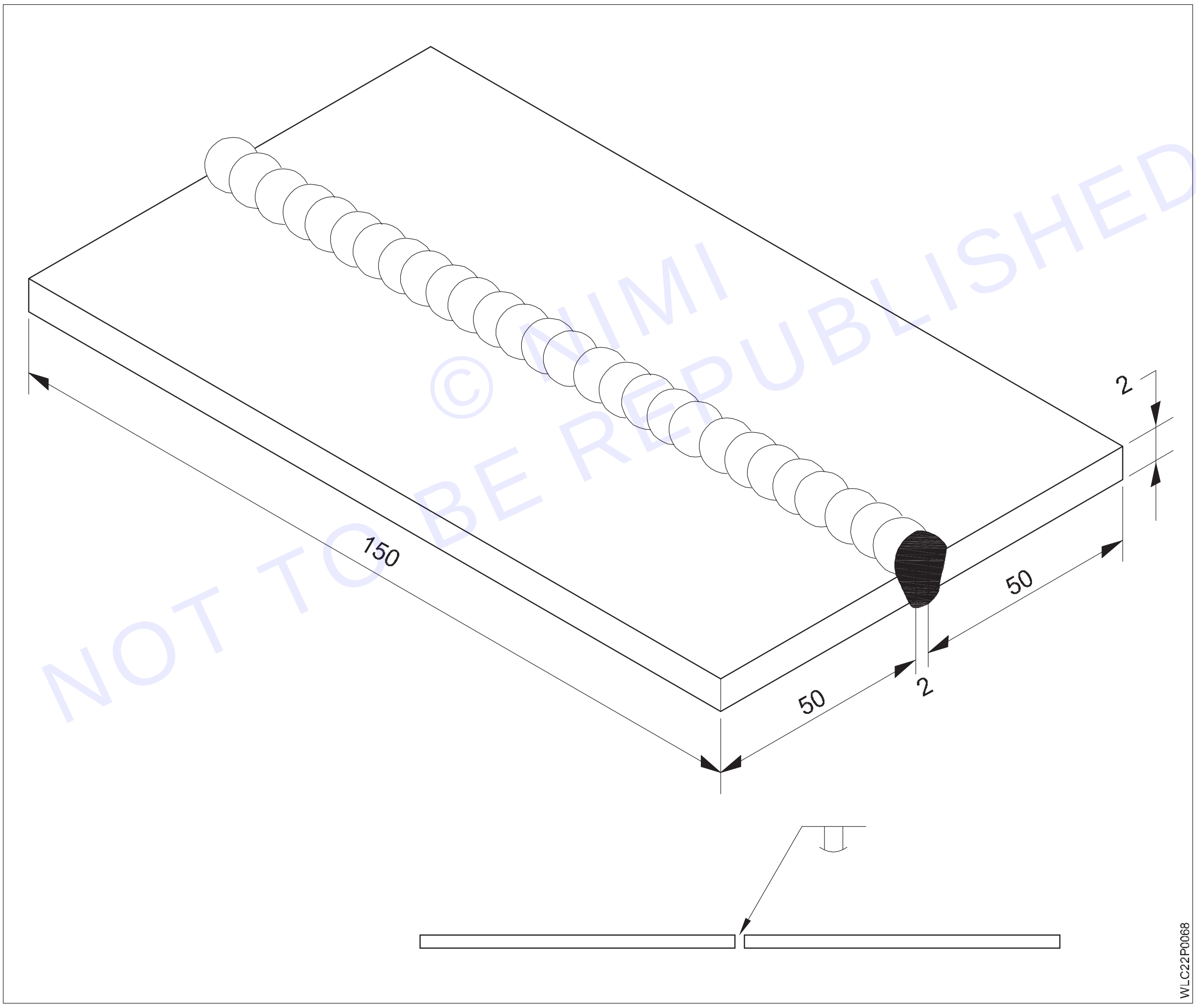
MODULE 3 : Weldability Of Metals (OAW, SMAW)

Exercise 14 : Square butt joint on MS sheet 2 mm thick in flat position (OAW)

Objectives

At the end of this exercise you shall be able to

- prepare the job to the given size as per drawing
- file the edges of the plate to square without burr
- set the job as a square butt joint with proper root gap and tack weld them
- weld the square butt joint in flat position using leftward technique in one run
- clean and inspect the butt weld for root penetration and surface uniformity.



Job Sequence

- Prepare the job pieces as per drawing.
- File the edges to square and ensure thorough cleaning of the joining edges.
- Set the job pieces on the welding table to form a square butt joint with a root gap of 2 mm.
- Set the gas welding plant, fix nozzle No. 7 and set the gas pressure of 0.15 kg/cm2 for both gases.
- Select C.C.M.S. filler rod 3 mm ø for tacking and welding.

Note : Wear safety apparels and gas welding goggles.

- Set neutral flame.
- Tack the pieces at both ends and at centre, using 1.6 mm ø filler rod with 2mm root gap at right end and 3mm root gap at the left end.

Note : Tacks should be well fused and penetrated and done on the bottom side of the joint.

- Check the alignment and root gap and reset if necessary.
- Clean the tacks and set the job on the welding table in a flat position, over fire brick supports.

Note : Turn the tack weld side down.

- Start the weld at the right end of the job.
- Direct the flame at the beginning of the seam (welding line) with the blowpipe nozzle at an angle of 60° - 70° towards right.
- Hold the filler rod at an angle of 30° - 40° with the seam towards left.
- Fuse the edges uniformly and add filler metal by up and down (piston like) motion and proceed to weld towards left.
- Maintain a uniform speed of the blowpipe with slight circular motion.
- Stop at the left end, fill the crater and complete the weld.
- Extinguish the flame, cool the nozzle in water and keep it on the cylinder trolley.
- Clean the welded joint and remove distortion.
- Inspect the joint by visual inspection for:
  - Slight convexity with uniform width and height of bead without undercut.
  - Uniform ripples without porosity.
  - Uniform root penetration.
- Repeat the exercise till you get good results.

Skill Sequence

Square butt joint

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

- prepare and gas weld the square butt joint.

Preparation: Prepare the job pieces of size 150×50×2.0 mm by shearing and then by filing.

Setting and tacking: Set the prepared job pieces on the welding table with a root gap of 2mm at the right end and 3mm at the left end and in alignment. (Fig 1)

The root gap is increasing from right end to the left end because the gap will get closed as the weld proceeds towards the left end, due to expansion of the base metal.

Tack-weld the joint at equal intervals to hold them together, maintaining the alignment. (Fig 1)

Ensure that the

- distance between the tack-welds is 75 mm.
- length of the tack-weld is 6 mm.

Tack welds should be on the back side of the joint to be welded and in line with the joint.

Check the alignment after tacking, and reset, if the sheets are out of alignment. (Fig 2)

Fig 1

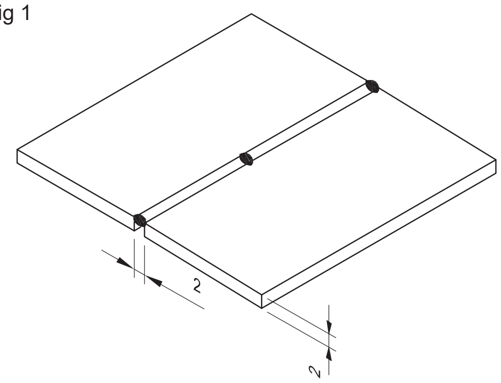
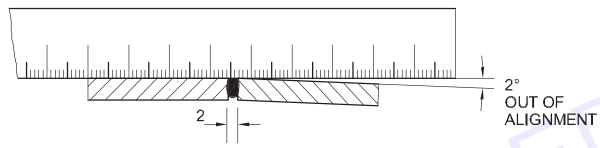


Fig 2



WLC22P0069

Welding: Keep free space under the joint for complete penetration. (Fig 3)

Start the weld at the right end of the joint. (Fig 4)

Fig 3

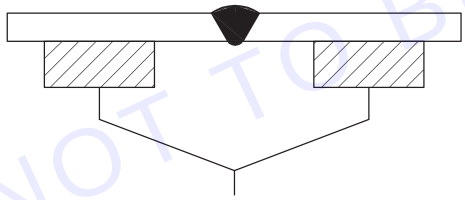
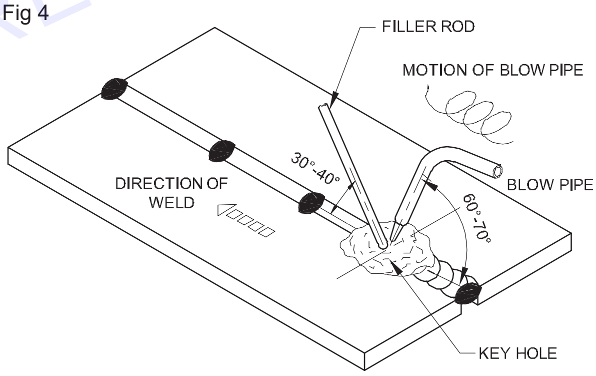


Fig 4



WLC22P0070

Weld a well fused uniform bead with complete penetration using leftward technique. (Fig 4)

Manipulate the blowpipe to maintain necessary motion to the blow pipe and the filler rod and the recommended angle of blowpipe and the filler rod.

Maintain uniform travel speed and feed to the flame and the filler rod.

Maintain a keyhole which is a clear indication that the melting is taking place up to the bottom of the root of the joint ensuring better root penetration. (Fig 5)

Clean the deposited bead using wire brush.

Inspect the quality of weld by:

- Checking the finish of the job
- Checking the alignment (remove distortion if required)
- Checking the uniformity of width and height of the weld bead in size (Fig 6)

- Checking the uniformity of the ripples, fusion and complete penetration (Fig 7)
- Checking that the weld is free from faults such as porosity, undercut, lack of fusion, unfilled crater etc

Fig 5

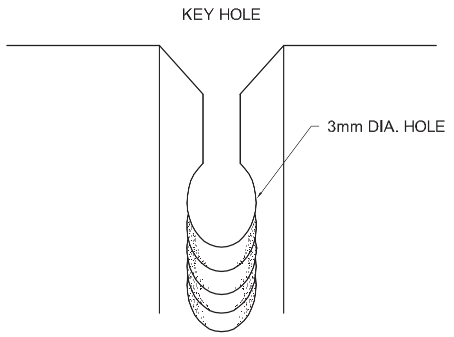


Fig 6

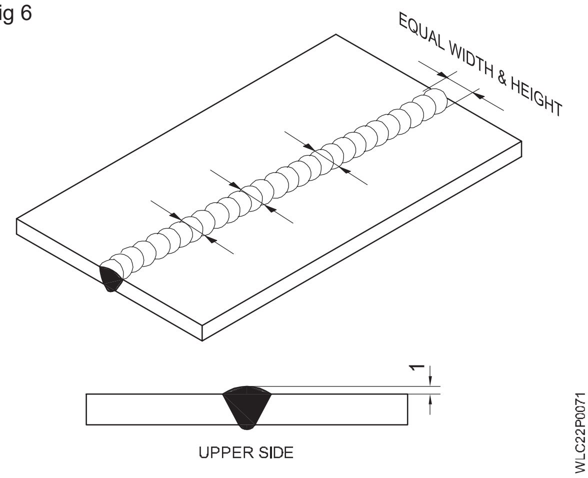
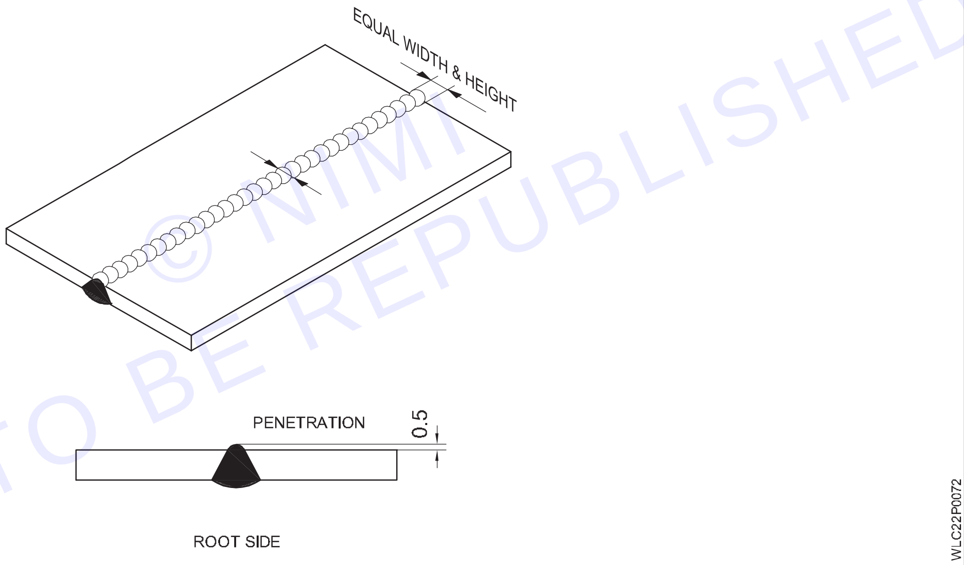


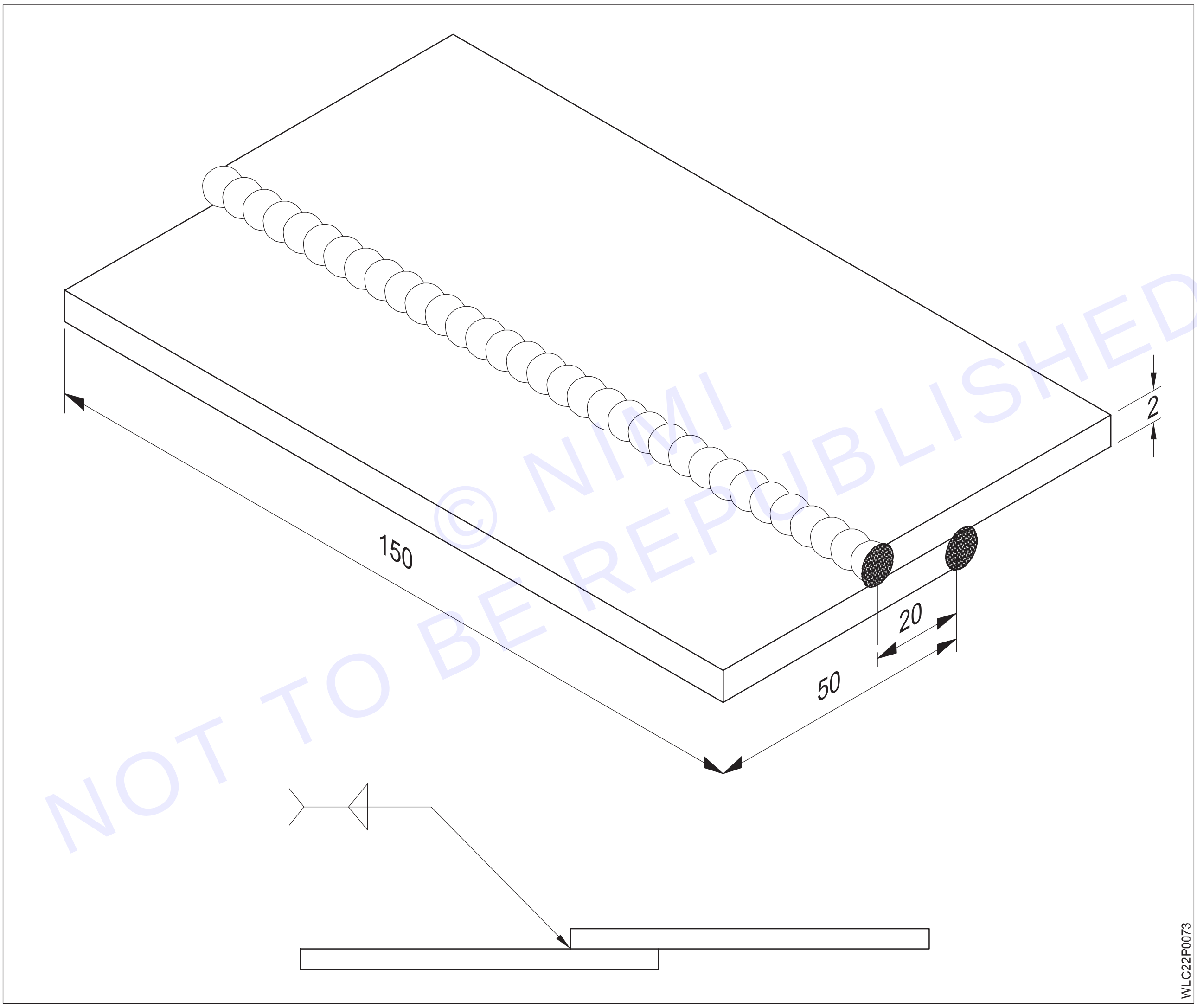
Fig 7



EXERCISE 15 : Fillet lap joint on MS sheet 2mm thick in flat position (OAW)

Objectives

At the end of this exercise you shall be able to
- set and tack the job to form a lap fillet joint with recommended overlap
- weld lap fillet joint using correct size filler rod and nozzle in flat position
- clean and inspect the weldments of the lap fillet for weld defects.



Job Sequence

- Prepare the job as per drawing and clean the edges.
- Set the job on the welding table to form a lap joint.
- Set the gas welding plant, fix nozzle No. 5 and set a pressure of 0.15 kg/cm for both gases.
- Select a C.C.M.S. filler rod 1.6 mm ø for tacking and 3.00 mm ø for welding.

Note : Wear safety apparels and use gas welding goggles.

- Set the neutral flame.
- Tack the pieces at both ends and also in the centre using a 1.6 mm ø filler rod.

- Check the alignment of pieces, clean the tacks, and place on the welding table in a flat position.
- Start welding, using leftward technique with the correct angle of the blowpipe and (3mm ø) filler rod.
- Fuse the edges uniformly, add filler metal to obtain correct root fusion and reinforcement, and proceed towards left. Don't concentrate the flame on the top member in the lap joint.
- Maintain correct travel speed, manipulation of blowpipe and filler rod to produce uniform weld bead.
- Stop at the left end, after filling the crater and complete the weld.
- Extinguish the flame, cool the nozzle in water and place the blowpipe at its place on the cylinder trolley.
- Clean the welded joint with a wire brush.

Visual inspection: Inspect for correct size of fillet weld, slight convexity, uniform width and height, uniform ripples without edge of plate melted off defect and other surface defects.Weld the job from the other side also following the same steps.

Repeat the exercise till you get good results.

Skill Sequence

Lap weld joint on MS sheet 2.00 mm in flat position

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

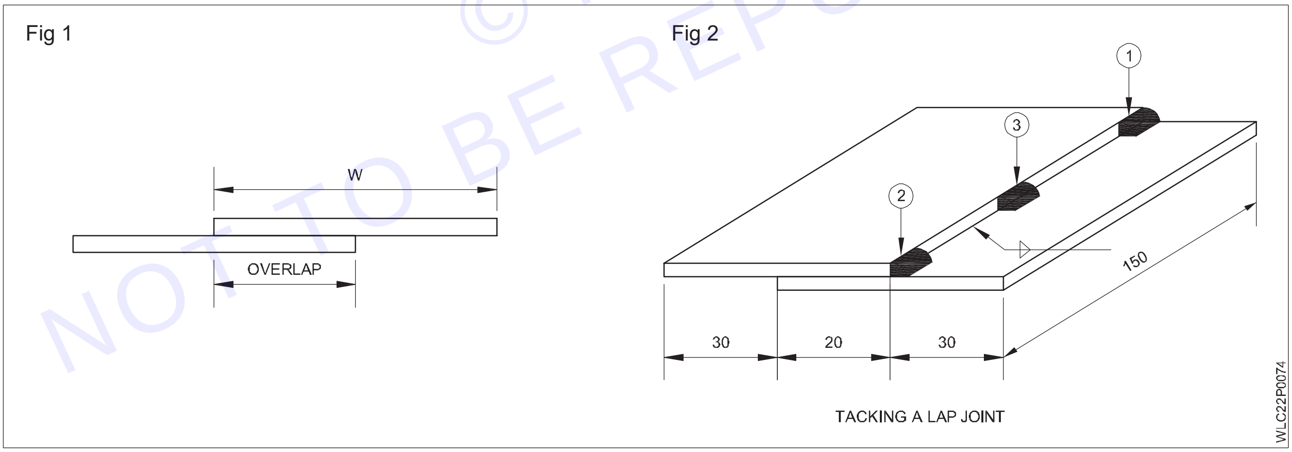
- prepare and lap weld joint on MS plate 2.00mm in flat position.

Set and tack the job pieces in correct alignment with proper overlapping of pieces. (Fig 1)

Place the tack welds at correct locations. (Fig 2)

Weld a uniform, well penetrated, correct size fillet lap weld in flat position by

- Proper positioning of the joint (Fig 2)



- Proper angle of the blowpipe and filler rod (Figs 3 & 4)
- Proper manipulation of the blowpipe and filler rod.
- Using leftward welding technique.

Note : Avoid movement of blow pipe flame nearer to the edge of the top plate. This will avoid edge of the plate melted off defect.

- Maintaining uniform travel speed and feed.

Clean the weldment and inspect for: (Fig 5)

- Uniform weld size and shape of whole length (reinforcement and contour) of the joint.
- Equal leg length
- No undercut at the toe of weld
- No fusing of the top plate edge to undersize
- Smooth ripple appearance
- Proper crater filling.

Fig 3

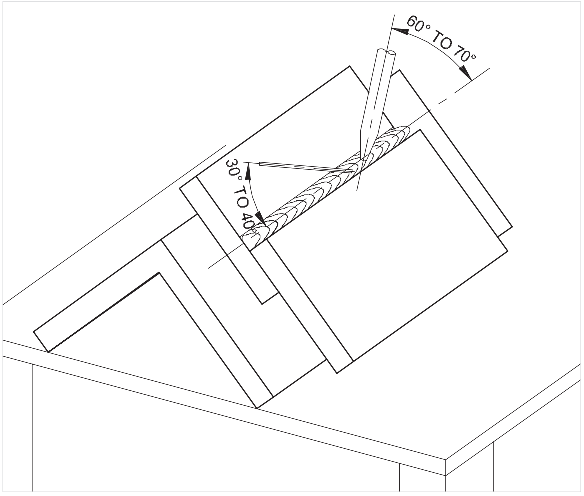


Fig 4

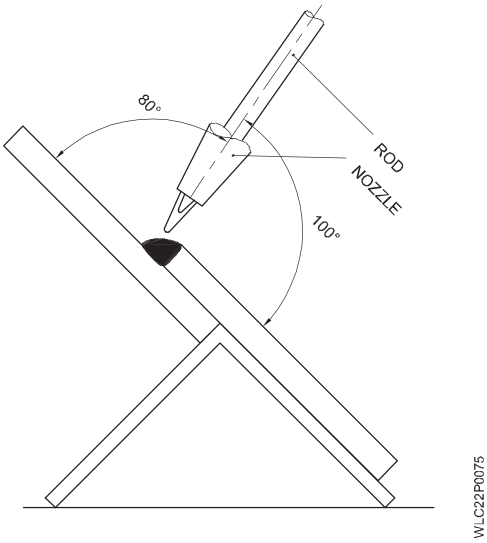


Fig 5

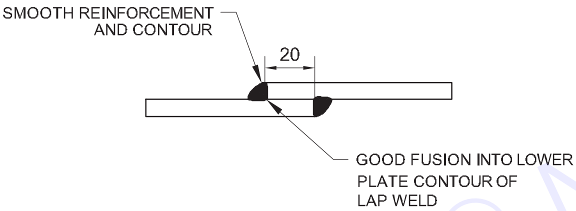
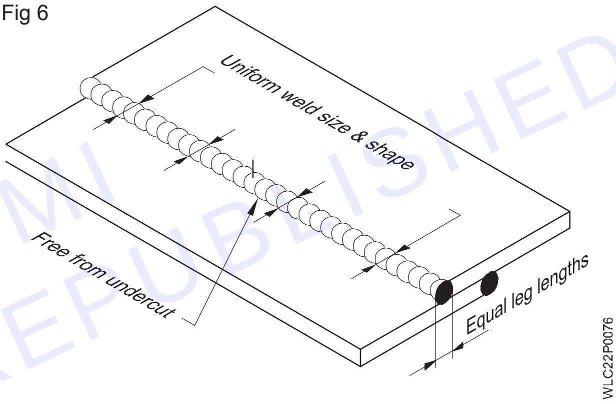


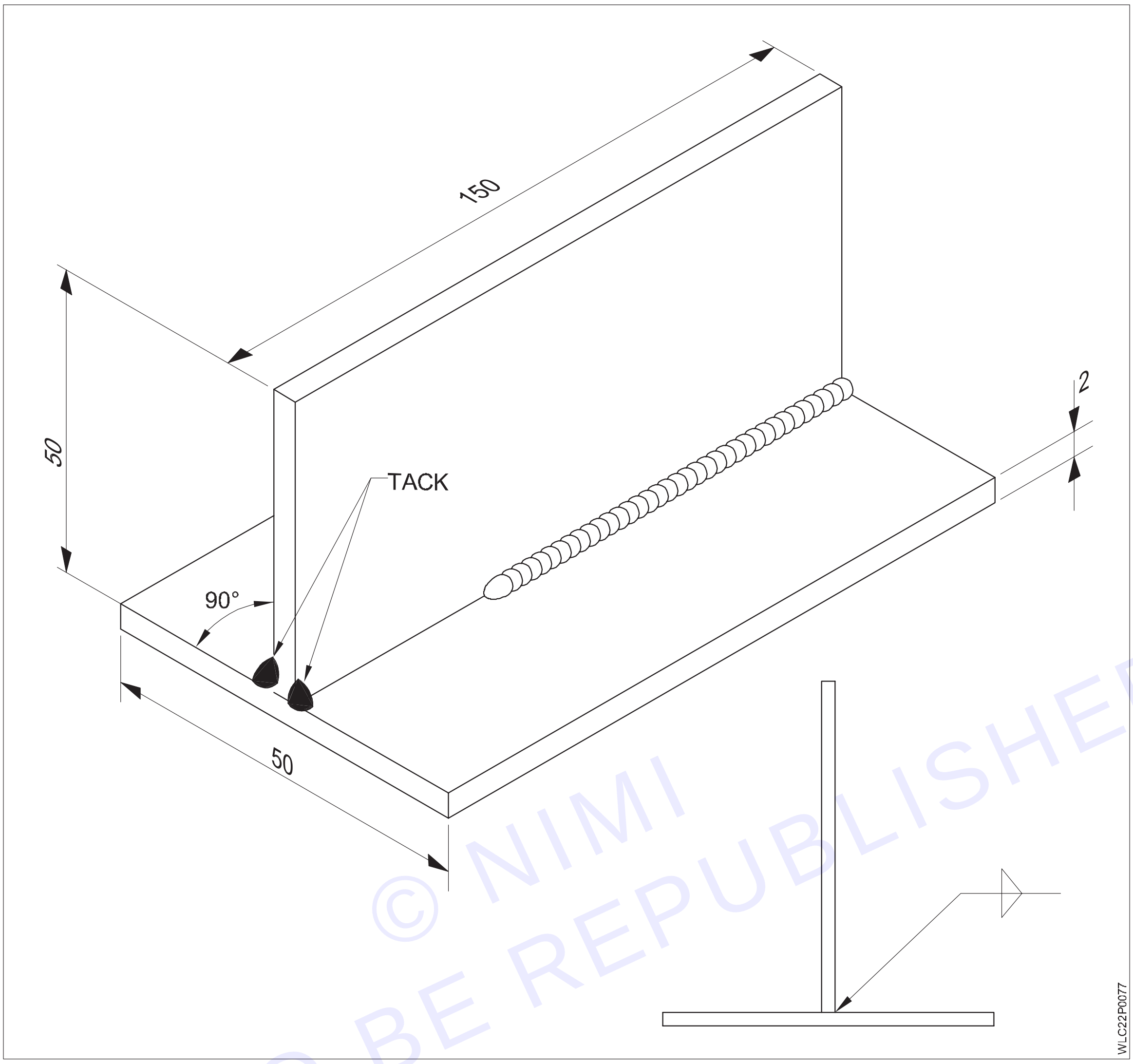
Fig 6



Fillet 'T' joint on MS sheet 2mm thick in flat position (OAW)

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

- set the job pieces and tack as fillet tee joint
- select nozzle size, filler rod and set gas pressure for welding
- manipulate the blow pipe and filler rod to deposit weld metal in flat upward direction
- deposit the weld bead without allowing sagging of molten metal
- ensure the root penetration
- clean the joint and inspect for weld defects.



Job Sequence

- Prepare the material as per drawing and file the edges to square. Clean the surface with a wire brush.
- Select nozzle No. 5 and a 1.5mmø C.C.M.S. rod. Set the neutral flame.
- Set gas pressure at 0.15 kg/cm2.
- Wear protective leather clothing and welding goggles.
- Tack the work piece as a 'T' joint.
- Ensure the joint is clamped properly in the fixture in the vertical position and the line of weld becomes perpendicular to the ground.
- Start welding the joint from the bottom in the upward direction manipulating the blow pipe and filler rod properly.
- Maintain proper angles for the blow pipe and filler rod between the sheet surfaces and to the line of weld so that the root and the surfaces joined will melt properly.
- Ensure the molten puddle does not sag too much due to gravity.
- At the end of the joint fill up the crater and complete the weld.
- Remove the work piece from the fixture and clean the weld bead.
- Inspect the weld bead for equal leg length, uniform ripple and ensure it is free from surface defects.

Skill Sequence

Fillet 'T' weld in MS sheet 2mm in flat position

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

- prepare and weld fillet 'T' weld in MS sheet 2mm in flat position.

Keep one of the sheets vertically at 90° to the bottom sheet (Fig 1) and tack weld using neutral flame at the ends of the joint in proper alignment and at the centre.

Maintain the angle of the blowpipe at 75-80° and filler rod at 40° respectively to the line of weld in vertical upward direction. (Fig 2) Also maintain a blowpipe angle of 45° between the sheet surfaces. (Fig 3)

Fig 1

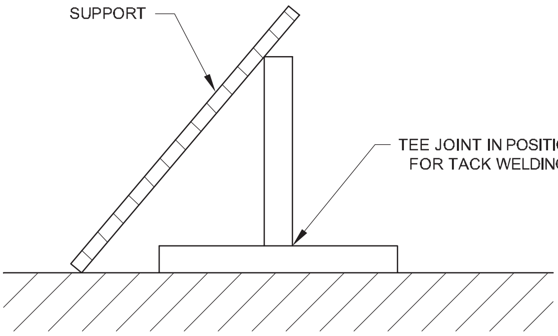
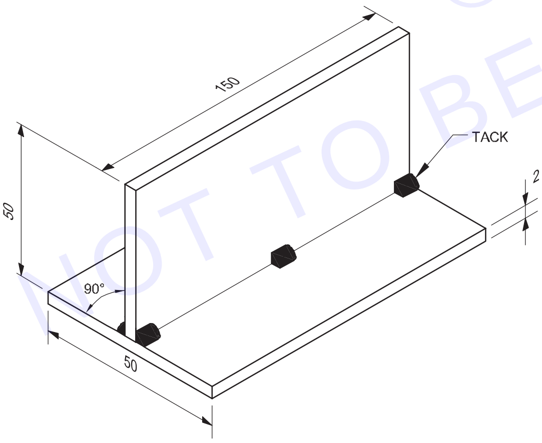
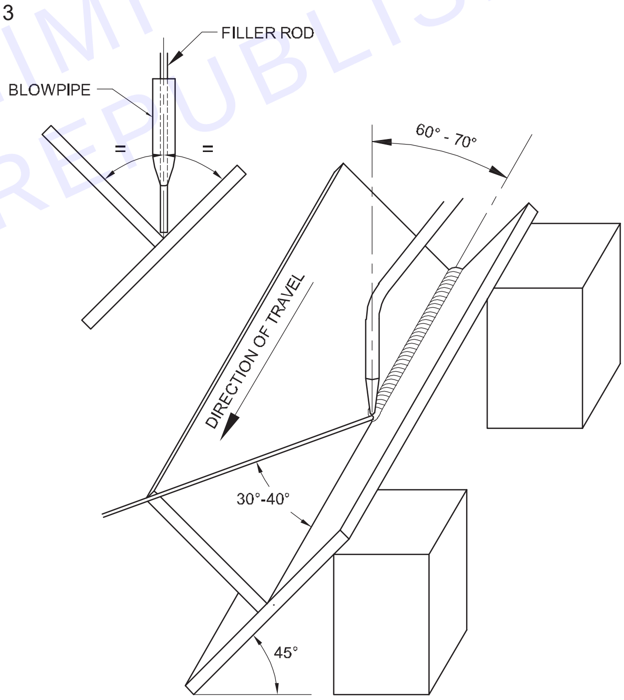


Fig 2



TACK WELDING A TEE JOINT

Fig 3



Control the molten pool steadily and weld the fillet joint on the root by melting both the surfaces to be joined equally.

Dip the end of the filler rod continuously in the molten pool and proceed welding upward.

The above-mentioned procedure will help to fuse the root and both the sheet surfaces of the joint uniformly as well as control sagging of molten metal deposited into the joint.

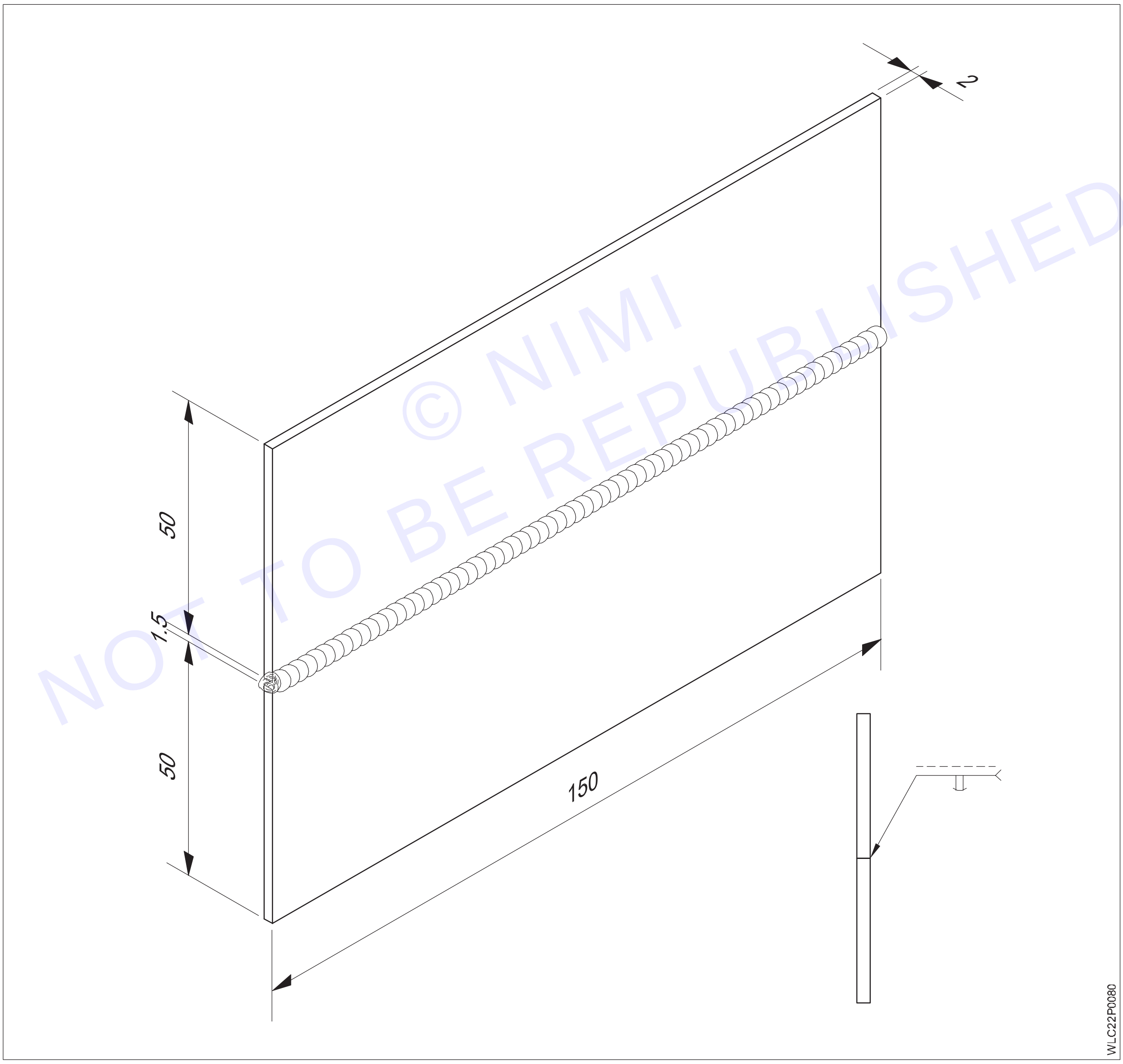
Ensure uniform speed of torch travel against the gravitation pull of the hand due to the weight of blowpipe, hose etc.

EXERCISE 16 : Square butt joint on MS sheet 2mm thick in horizontal position (OAW)

Objectives

At the end of this exercise you shall be able to

- set and tack the job pieces to form a square butt joint with proper root gap
- fix the job in the positioner in horizontal position
- weld square butt joint by proper manipulation of the blowpipe and filler rod using leftward technique
- ensure good root penetration weld reinforcement and bead profile
- clean and inspect the welded joint for weld defects.



Job Sequence

- Prepare the job pieces as per drawing.
- Clean the edges and surfaces of the metal pieces.
- Set the job pieces as square butt joint with a root gap of 1.5 mm.
- Select the nozzle No. 5 and C.C.MS. filler rod dia. 1.6 mm.
- Set a gas pressure of 0.15 kg/cm2.
- Follow necessary safety precautions.
- Tack weld the sheets and check for uniform root gap and alignment.
- Weld the joint with a single run in horizontal position.
- Clean the welded area and inspect the weld for defects.

Skill Sequence

Weld square butt joint 2mm horizontal position (2G)

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

- prepare and weld square butt joint MS plate 2mm in horizontal position.

Position the crossbar of the positioner to the eye level. (Fig 1)

Adjust the pressure of oxygen and that of acetylene at 0.15 kg/cm2.

Set a soft neutral flame.

Tack-weld the job at both ends and at the centre with a root gap of 2.5 mm.

Fix the job on the crossbar of the positioner in horizontal position. (Fig 1)

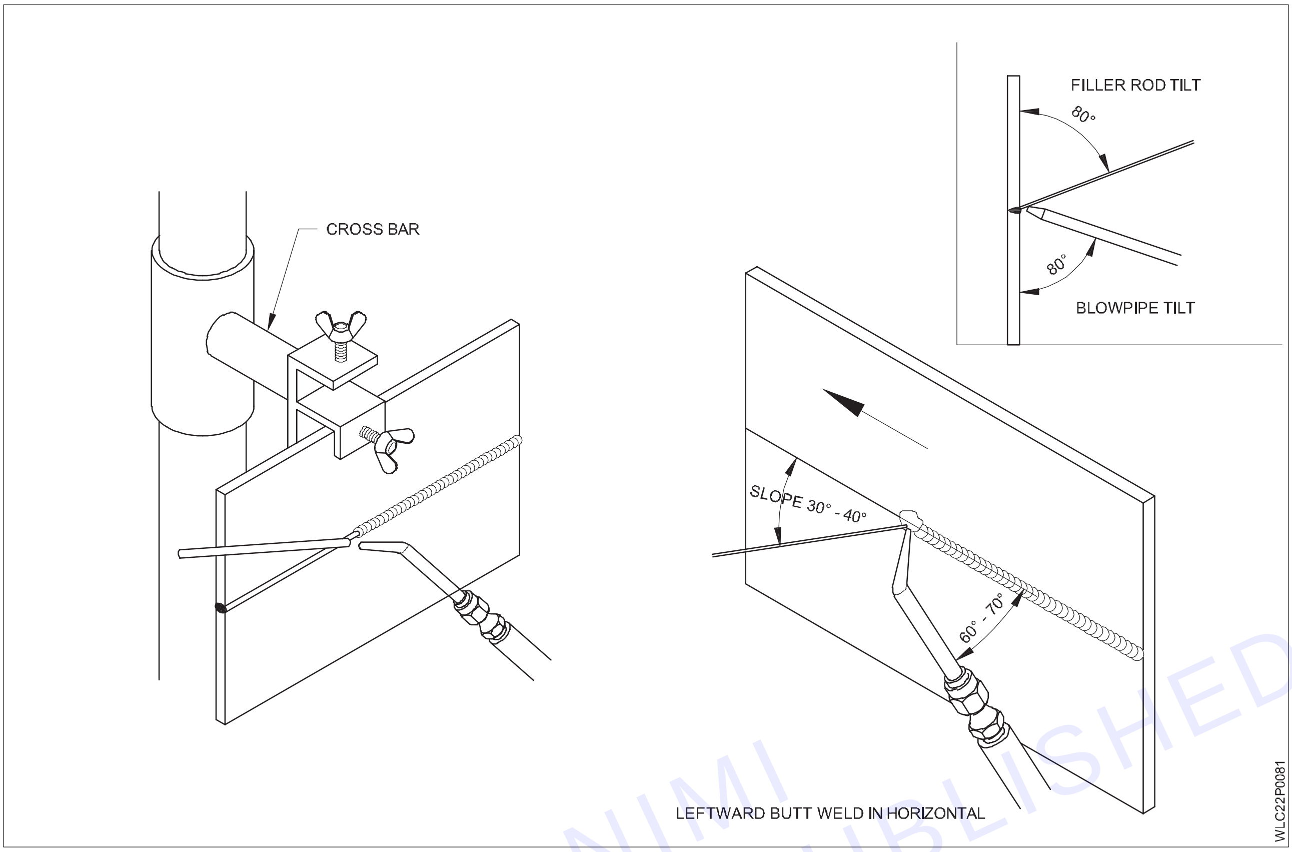
Note : Ensure the job is in horizontal position at a convenient height.

Hold the blowpipe at 60° to 70° and the filler rod at 30° to 40° to the line of weld. Deposit the bead from the right end of the joint by giving a circular motion to the blowpipe and proceed towards the left end.

Note : Ensure both edges melt equally and up to the root of the joint.

Check the weldment for correct profile with complete penetration.

Proper angle between the blow pipe, filler rod and the sheet surface is to be maintained (Fig 2). The filler rod is added when the inner cone of the flame reaches the top edge of the joint. This will help in avoiding the excessive melting of the bottom edge of the joint and will avoid sagging of weld metal.

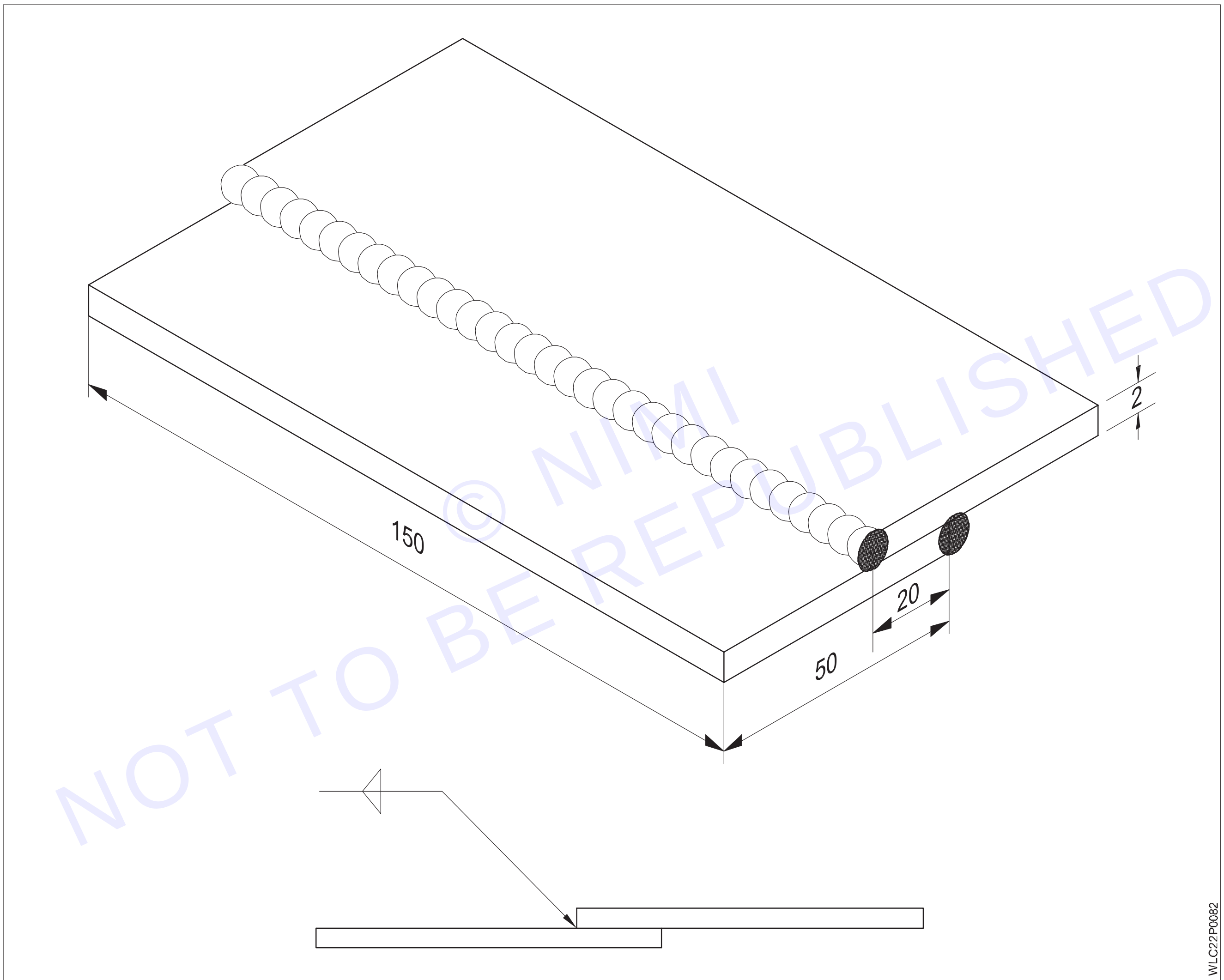

FILLER ROD TILT
80°
80°
BLOWPIPE TILT
CROSS BAR
SLOPE 30° - 40°
60° - 70°
LEFTWARD BUTT WELD IN HORIZONTAL
WLC22P0081

EXERCISE 17 : Fillet - lap joint on MS sheet 2mm thick in horizontal position (OAW)

Objectives

At the end of this exercise you shall be able to

- set and tack the job to form a lap fillet joint with recommended overlap
- weld lap fillet joint using correct size filler rod and nozzle in horizontal position
- clean and inspect the weldments of the lap fillet for weld defects.



Job Sequence

- Prepare the job pieces as per drawing.
- Clean the edges and surfaces of the metal pieces.
- Set the job pieces as lap joint.
- Select the nozzle No. 5 and C.C.M.S. filler rod 3mmø.
- Set a gas pressure of 0.15 kg/m2.
- Follow necessary safety precautions.
- Tack weld the sheets and check for alignment
- Weld the joint with a single run in horizontal position.
- Clean the welded area and inspect the weld for defects.

Skill Sequence

Lap joint on MS sheet 2.00mm in horizontal position (2F)

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

- prepare and weld lap joint on MS sheet 2.00mm in horizontal position.

- Position the cross bar of the positioner to the eye level.
- Adjust the pressure of oxygen and that of acetylene at 0.15 kg/cm2.
- Set and tack the job pieces in correct alignment with proper overlapping of pieces.
- Place the tack welds at correct locations.
- Fix the job on the cross bar of the positioner in horizontal position.
- Hold the blowpipe at 60 to 70° and the filler rod at 30 to 40° to the line of weld. Deposit the bead from the right end of the joint by giving a circular motion to the blowpipe and proceed towards the left end.
- Maintain correct travel speed, manipulation of blowpipe and filler rod to produce uniform weld bead.

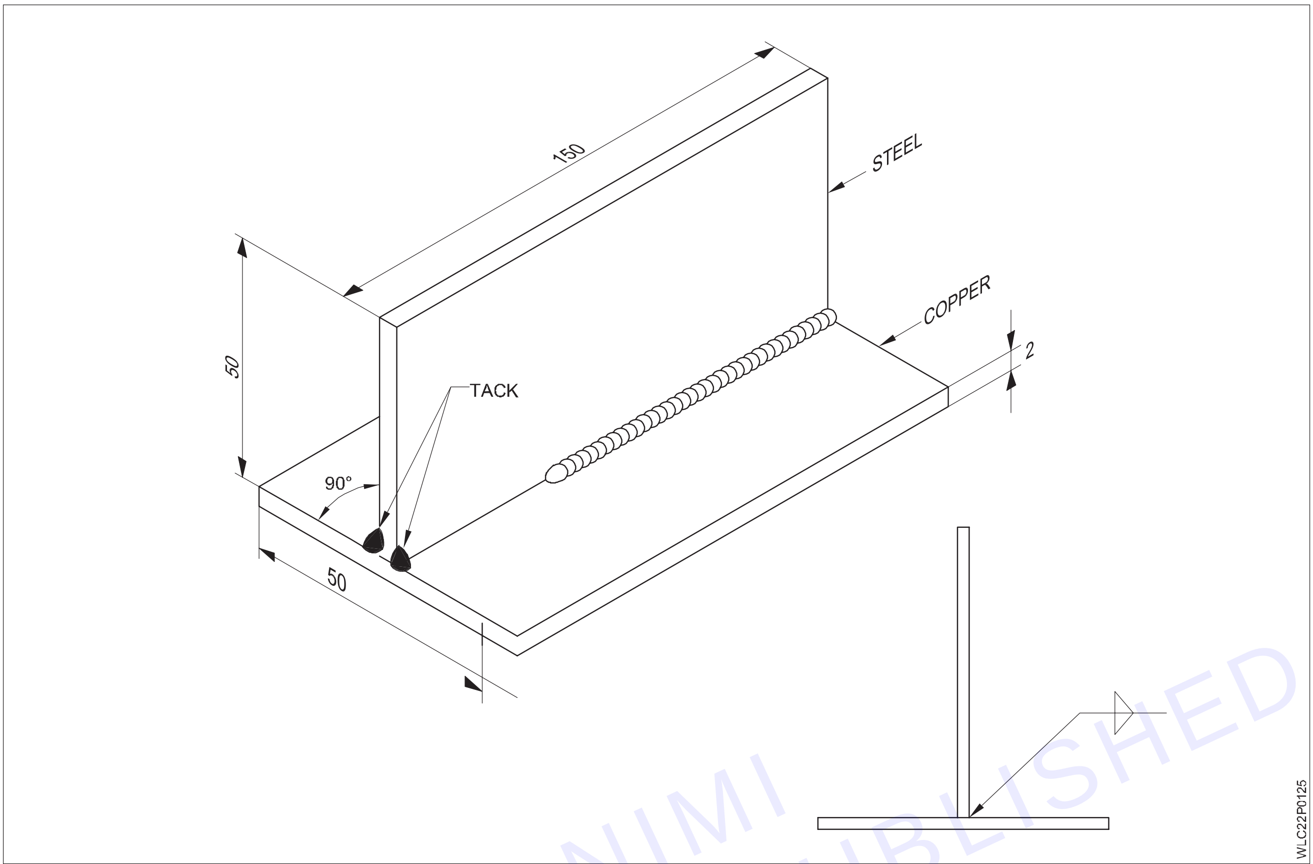
Clean the weldment and inspect for:

- Uniform weld size and shape of whole length (reinforcement and contour) of the joint.
- Equal leg length.
- No undercut at the toe of weld.
- Smooth ripple appearance.
- Proper crater filling.

Fillet weld ‘T’ 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 ‘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.



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.

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.

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 (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.

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.

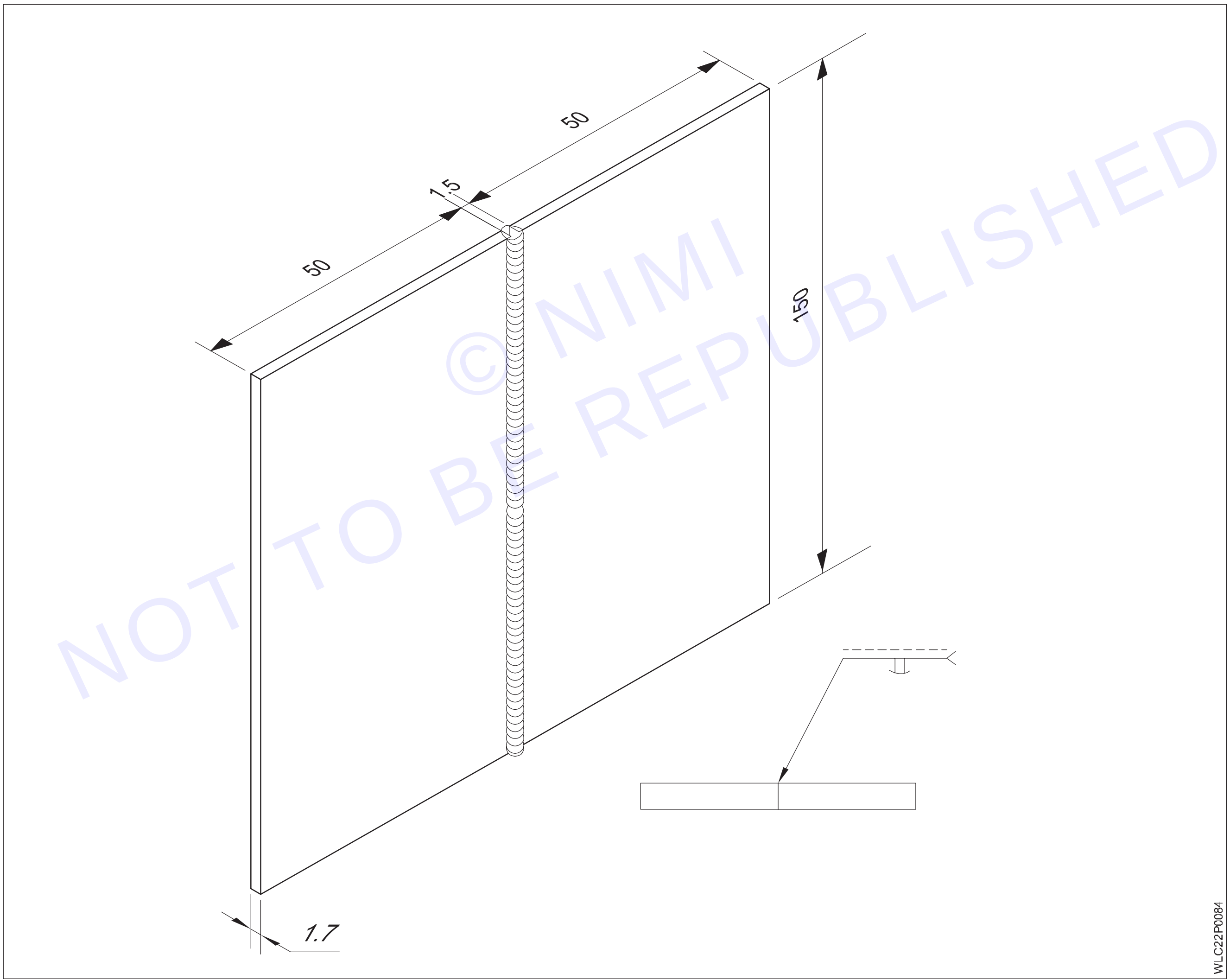
Maintain a uniform travel speed for the torch to get the required bead reinforcement, height and appearance. Use the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unstabilised arc and the Carbon-di-oxide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

EXERCISE 18 : Square butt joint on MS sheet 2mm thick in vertical position (OAW)

Objectives

At the end of this exercise you shall be able to

- prepare and assemble the joint as square butt joint
- set the job in the vertical position with a root gap of 2mm
- select and fix proper size nozzle to the blow pipe
- select proper filler rod and set the gas pressures
- manipulate the blowpipe and filler rod and weld in vertical position by upward method
- ensure proper fusion and root penetration
- clean the job and inspect for weld defects.



Job Sequence

- Shear the plate and file the edges. Clean the surface with a wire brush. Set the plate as a square butt with a 1.5 mm root gap.
- Fix nozzle No. 5 and adjust the gas pressure of oxygen and acetylene at 0.15 kg/cm2.
- Ignite the torch and set the neutral flame.
- Select a C.C.M.S. filler rod of 3 mm ø.
- Tack-weld the two pieces with a 1.5 mm uniform root gap on both ends and in centre.
- Check for correct alignment.
- Fix the sheet in vertical in the ‘C’ clamp with the bottom edge of the sheet at welder’s chest height.
- Melt the tack weld and establish a weld pool at the bottom edge of the joint.
- Keep the blowpipe angle 75° - 80° to the line of travel and the filler rod angle 30° to 40° to the same plane and proceed to weld upwards.
- Continuously dip the filler rod tip in the molten pool and move upwards. Weld the joint with a single run.
- Ensure the edges of both the metals melt equally so as to achieve complete penetration.
- At the end of the joint add sufficient filler metal and fill up the crater. Use a pair of tongs to remove the job from the fixture.
- Clean the weld and inspect for surface defects and root penetration.

Skill Sequence

Square butt joint on MS sheet 2mm in vertical position

Objectives: At the end of this exercise you shall be able to
- prepare and weld square butt joint on MS sheet 2mm in vertical position.

Tack the two sheets together as a square butt joint and fix the job in vertical position. (Fig 1)

Move the torch to the bottom of the square groove and establish a weld puddle. Continue to develop the puddle until you see the keyhole (Fig 2) that indicates complete penetration.

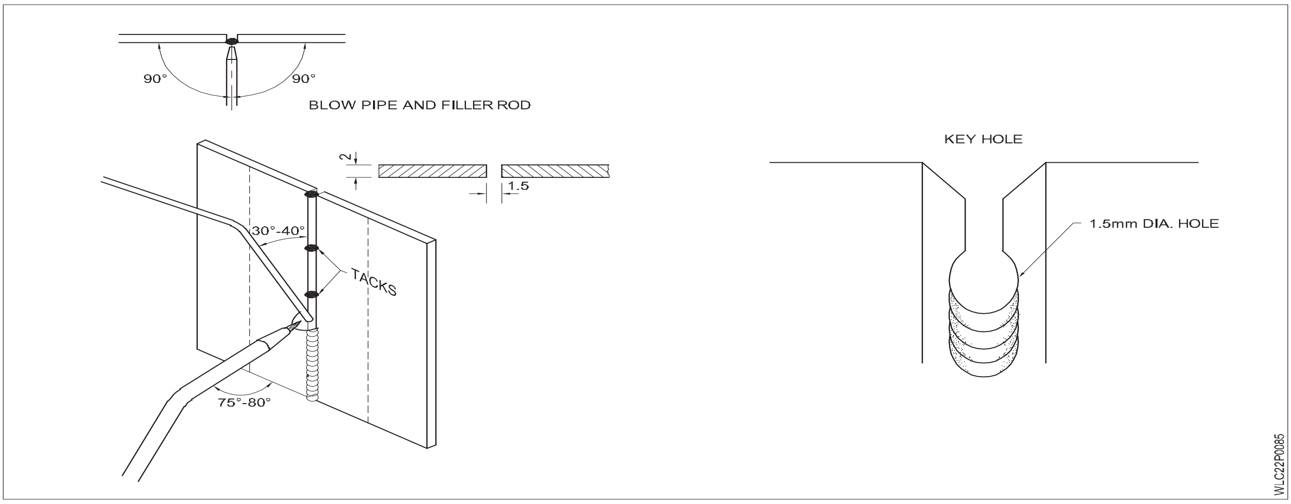
When you achieve the desired penetration, begin adding filler metal and proceed welding upwards. (Fig 1)

Use a slight side to side weaving to the blow pipe to ensure fusion of both the edges of the joint.

Progress upward at a uniform rate of travel and add filler metal to get a bead of even width with good profile and appearance.

End the weld at the top of the joint and ensure to fill the crater.

Clean the bead and check whether there is uniform root penetration for 0.5mm depth, a weld reinforcement of 0.5 to 1mm and no undercut etc

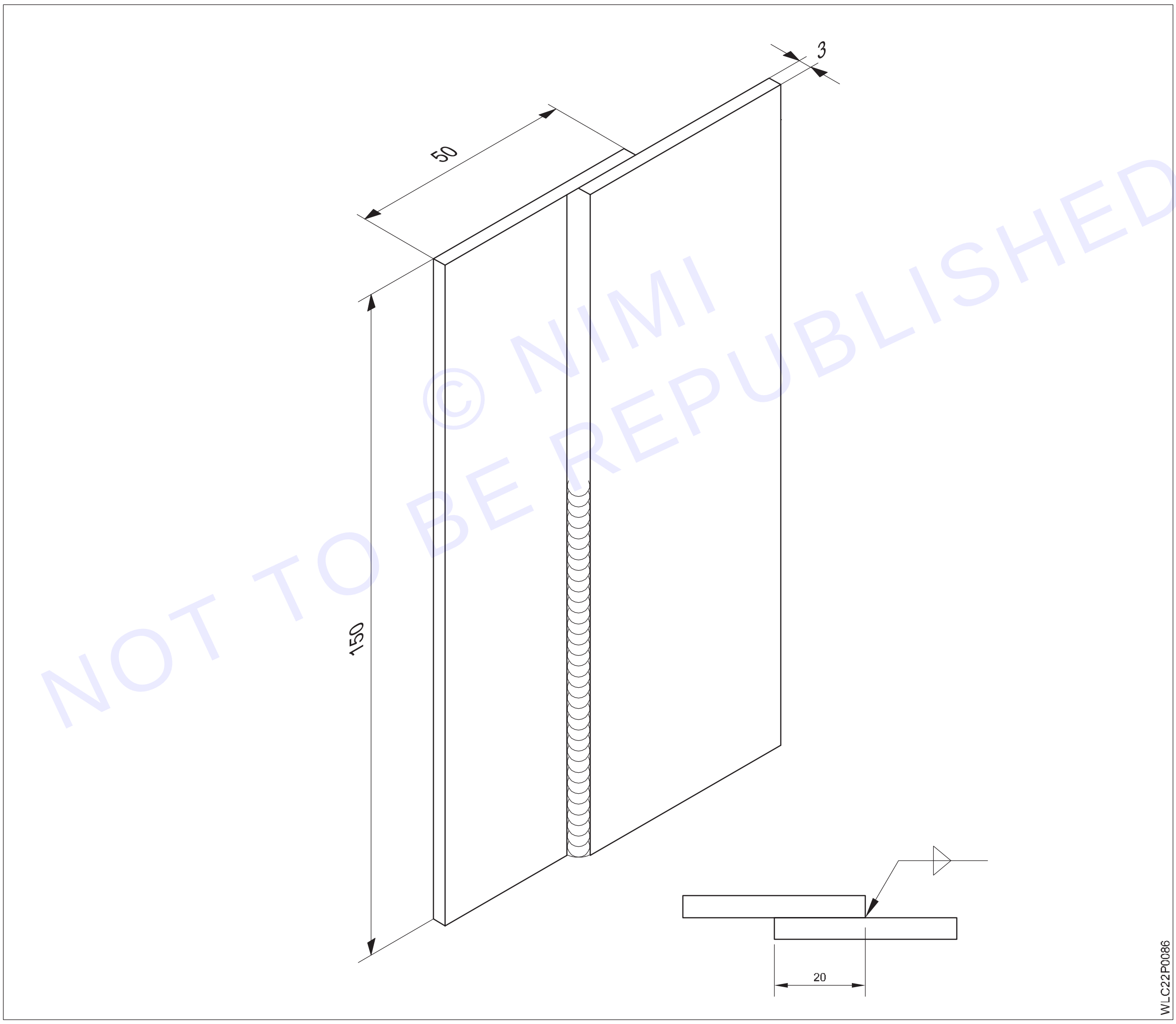


EXERCISE 19 : Fillet weld - Lap joint on M.S sheet 3mm thick in vertical position by dip transfer 3F

Objectives

At the end of this exercise you shall be able to

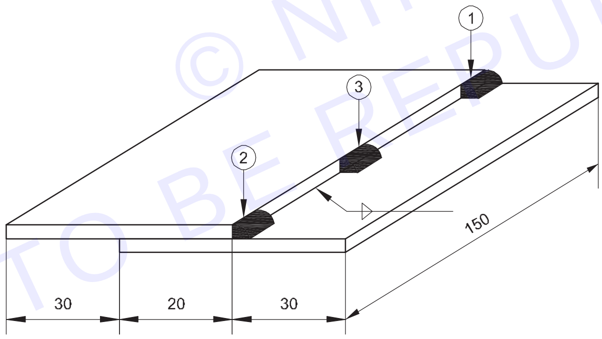
- prepare the plates and tack weld than as lap joint
- set the tack welded joint in the weld positioner in vertical position
- set the root run and 2nd run by weaving bead slightly
- ensure proper cleaning of the plate surfaces and inter bead cleans
- clean and inspect for surface defects on the weld and bead appearance.



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.
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.

Fig 1



TACKING A LAP JOINT

WLC22P0087

Skill Sequence

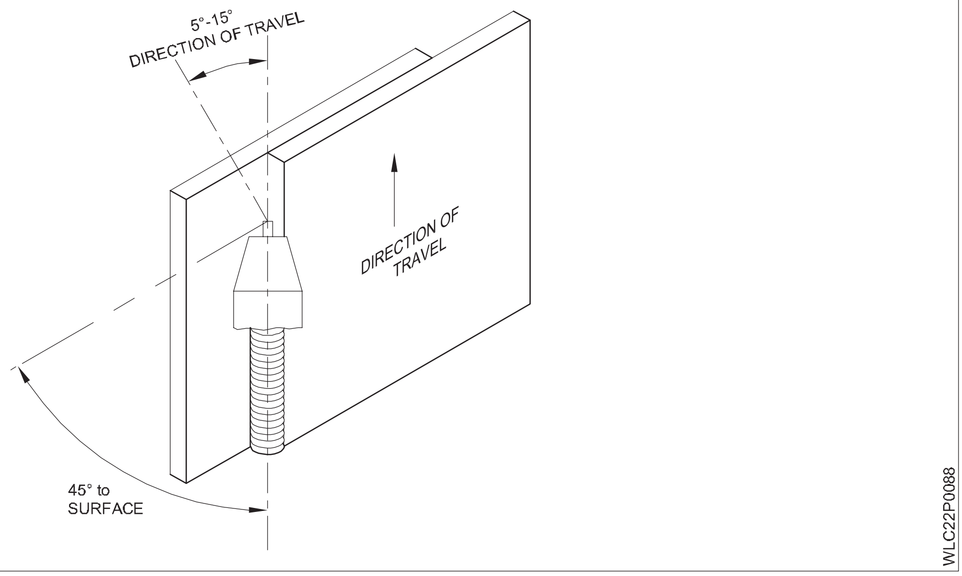
For the lap fillet joints no distortion allowance is recommended

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.

Fig 1

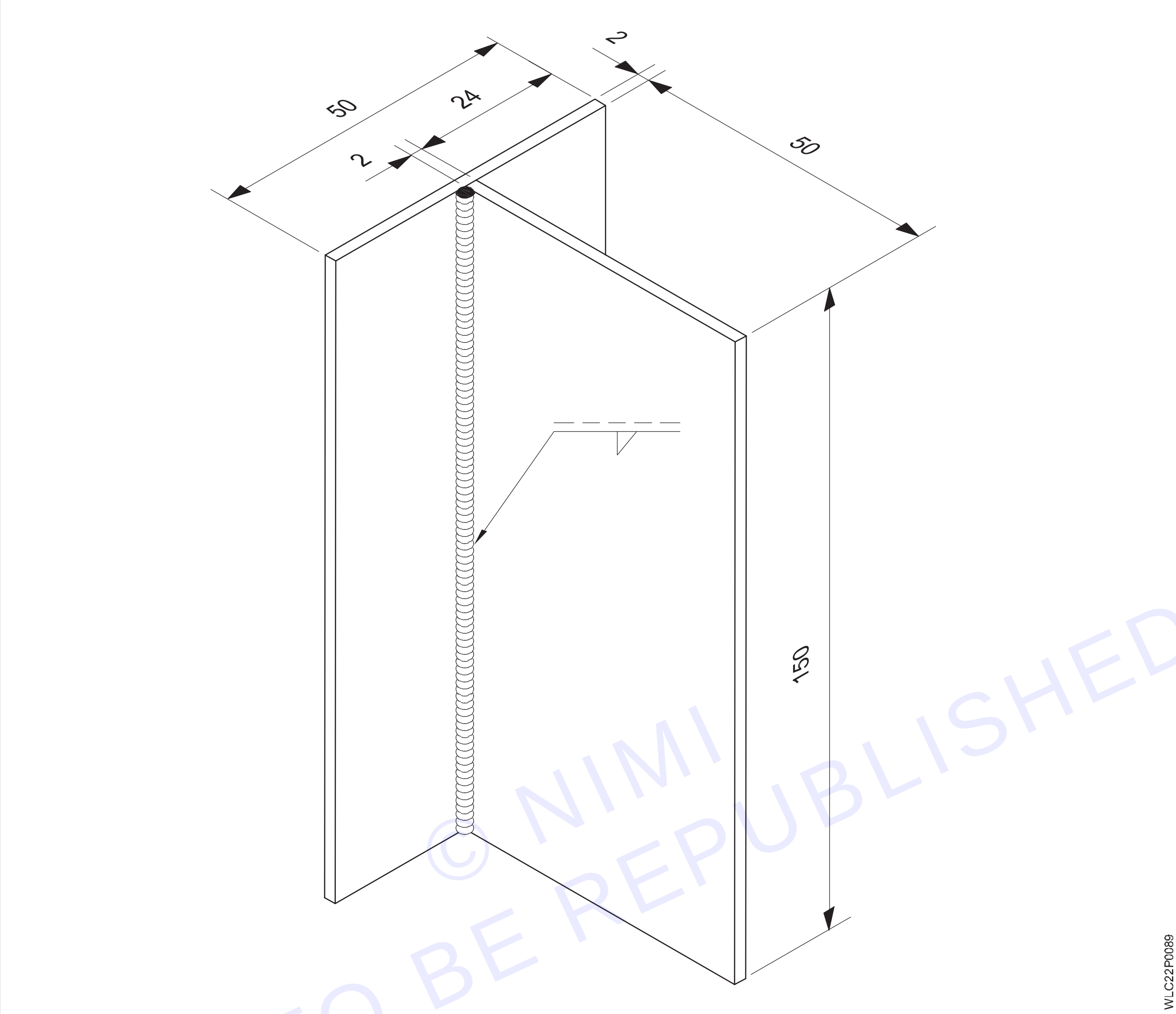


Maintain a uniform travel speed for the torch to get the required bead reinforcement, height and appearance. Use the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unstabilised arc and the Carbon-di-oxide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

Fillet 'T' joint on MS sheet 2mm thick in vertical position (OAW)

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

- set the job pieces and tack as fillet tee joint
- select nozzle size, filler rod and set gas pressure for welding
- manipulate the blow pipe and filler rod to deposit weld metal in vertical upward direction
- deposit the weld bead without allowing sagging of molten metal
- ensure the root penetration
- clean the joint and inspect for weld defects.



Job Sequence

- Prepare the material as per drawing and file the edges to square. Clean the surface with a wire brush.
- Select nozzle No. 5 and a 1.5mmø C.C.M.S. rod. Set the neutral flame.
- Set gas pressure at 0.15 kg/cm2.
- Wear protective leather clothing and welding goggles.
- Tack the work piece as a 'T' joint.
- Ensure the joint is clamped properly in the fixture in the vertical position and the line of weld becomes perpendicular to the ground.
- Start welding the joint from the bottom in the upward direction manipulating the blow pipe and filler rod properly.
- Maintain proper angles for the blow pipe and filler rod between the sheet surfaces and to the line of weld so that the root and the surfaces joined will melt properly.
- Ensure the molten puddle does not sag too much due to gravity.
- At the end of the joint fill up the crater and complete the weld.
- Remove the work piece from the fixture and clean the weld bead.
- Inspect the weld bead for equal leg length, uniform ripple and ensure it is free from surface defects.

Skill Sequence

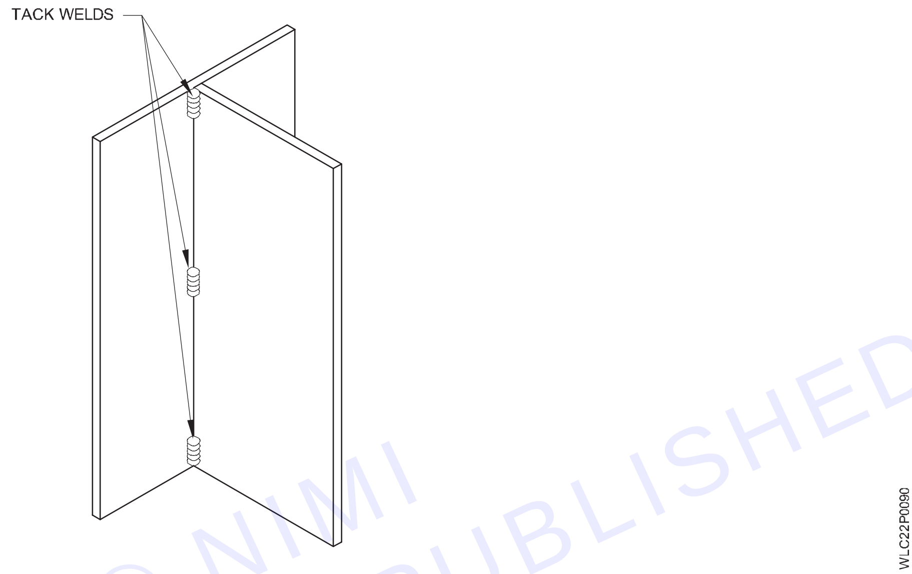
Fillet 'T' weld in MS sheet 2mm in vertical position

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

- prepare and weld fillet 'T' weld in MS sheet 2mm in vertical position.

Keep one of the sheets vertically at 90° to the bottom sheet (Fig 1) and tack weld using neutral flame at the ends of the joint in proper alignment and at the centre.

Fig 1



Maintain the angle of the blowpipe at 75-80° and filler rod at 40° respectively to the line of weld in vertical upward direction. (Fig 2) Also maintain a blowpipe angle of 45° between the sheet surfaces. (Fig 3)

Control the molten pool steadily and weld the fillet joint on the root by melting both the surfaces to be joined equally.

Dip the end of the filler rod continuously in the molten pool and proceed welding upward.

The above-mentioned procedure will help to fuse the root and both the sheet surfaces of the joint uniformly as well as control sagging of molten metal deposited into the joint.

Ensure uniform speed of torch travel against the gravitation pull of the hand due to the weight of blowpipe, hose etc.

Fig 2

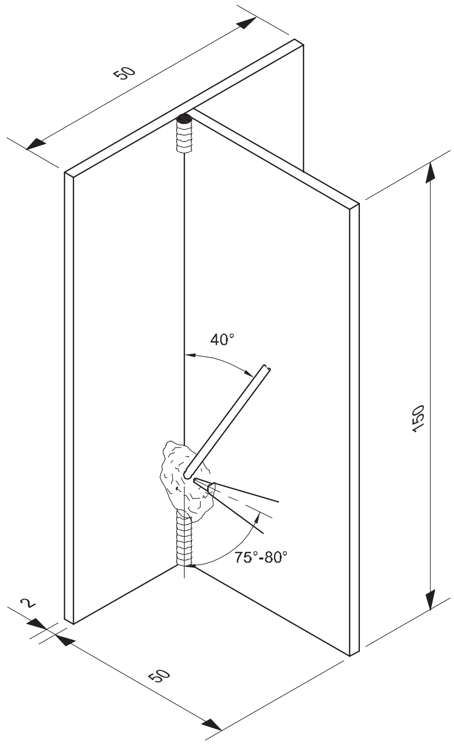
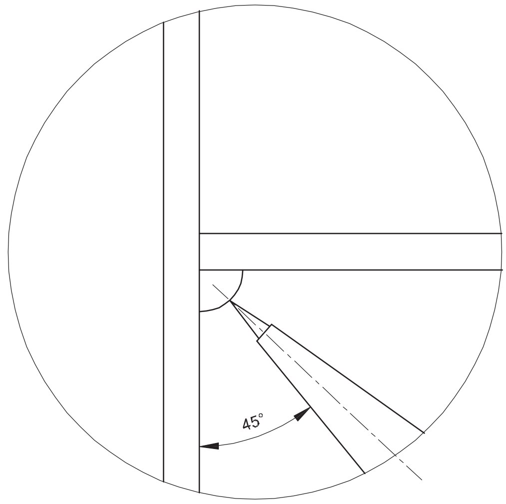


Fig 3



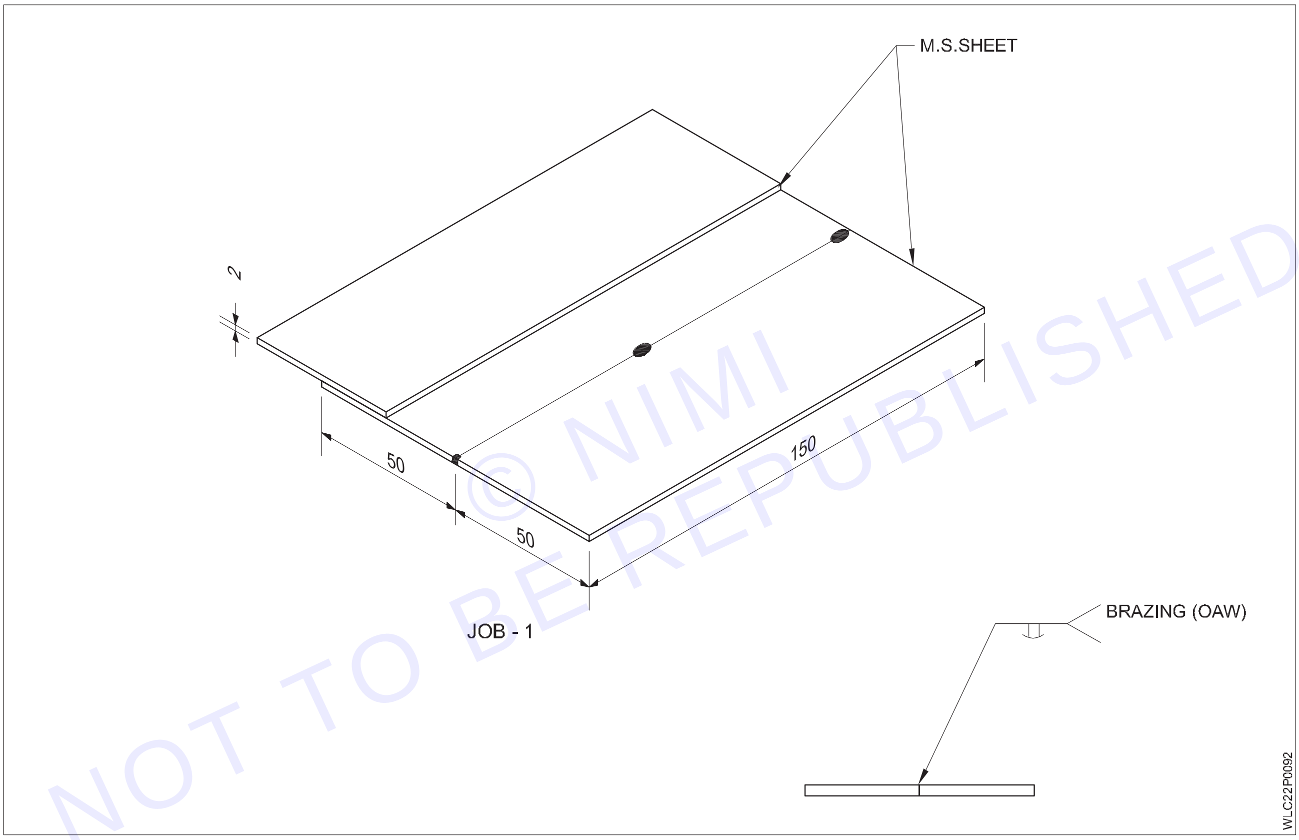
WLC22P0091

EXERCISE 20 : Square butt and lap joint on M.S. sheet 2mm thick by brazing in flat position (OAW)

Objectives

At the end of this exercise you shall be able to

- braze an M.S. square butt joint using oxidizing flame and brazing filler rod and flux
- remove the surface oxide and other impurities with wire wool
- select nozzle, filler rod, flux and flame for brazing
- clean the joint and inspect for surface defects.



Job Sequence

- Cut the sheets as per drawing and file the edges to be joined square.
- Clean the joint area.
- Set the sheets as a square butt joint without root gap
- Select nozzle, filler rod, gas pressures, flux.
- Set oxidizing flame.
- Use leftward technique.
- Preheat the sheets and joint area to about 800°C.
- Dip the hot filler rod in flux and melt the filler rod into the joint ensuring proper wetting conditions.
- Avoid application of too much heat into the joint.
- Finish the joint in one run only.

- Clean the joint and inspect for weld defects like porosity etc, and for slight root penetration and proper bonding.
- Prepare a copper and a brass tube as per dimension.
- Clean and remove the surface oxides by wire wool.
- Select the nozzle No. 5 and 1.6mmø silicon bronze filler rod.
- Apply flux to the filler rod.
- Set the oxidizing flame.
- Manipulate the blowpipe and filler rod with flux applied on it using proper angles to fill the bell mouthed groove.
- Clean and remove the flux residue.
- Inspect for external weld defects.

Skill Sequence

Brazing of square and lap joint on MS sheet of 2mm thick

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

- prepare and brazing of square and lap joint on MS sheet of 2mm thick.

Brazing of MS sheet (Job-1)

Oxidizing flame is used to avoid evaporation of zinc while brazing. Fig 1

The blow pipe and filler rod is held at angles as shown in Fig 1.

A No. 3 size nozzle with 0.15 kg/cm2 pressure for both gases are used as the base metal is not melted, but heated to around 800°C.

A 1.6mmø silicon bronze filler rod is used which helps free flow of molten filler metal.

Direct the flame to the joint edges and tack weld at the ends and centre of the joint. Fig 1.

Preheating the sheets to the correct temperature helps in proper wetting/spreading of the filler metal into the joint to get good bonding. Fig 1

Fig 1

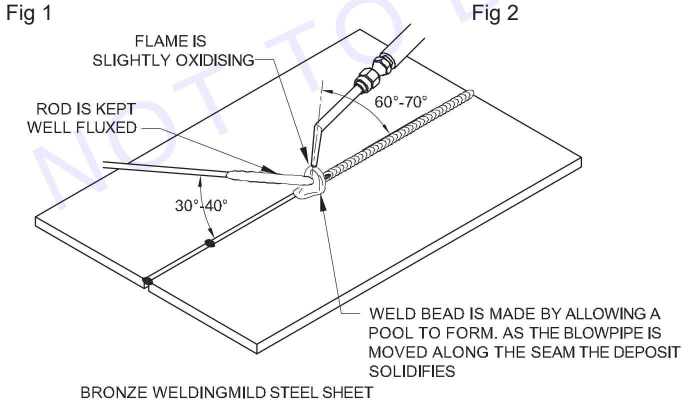
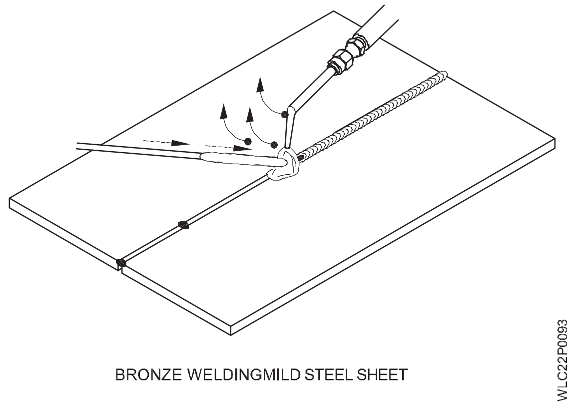


Fig 2



The flame has to be directed only on the melting filler rod or the weld deposit in order to prevent oxidation or overheating of MS sheet.

After establishing the molten pool, the flame is withdrawn slightly (Fig 2) to permit the deposited metal freeze partially. Again, reintroduce the filler rod to melt further deposit. Observe the brazed area carefully to ensure proper bonding is obtained and a uniform weld size is achieved.

To avoid crater at the end of the weld the filler rod is continued to be added into the molten pool at the finishing point and the flame is withdrawn.

It is essential to remove any unused and residual flux on the finished weld to avoid corrosion later on.

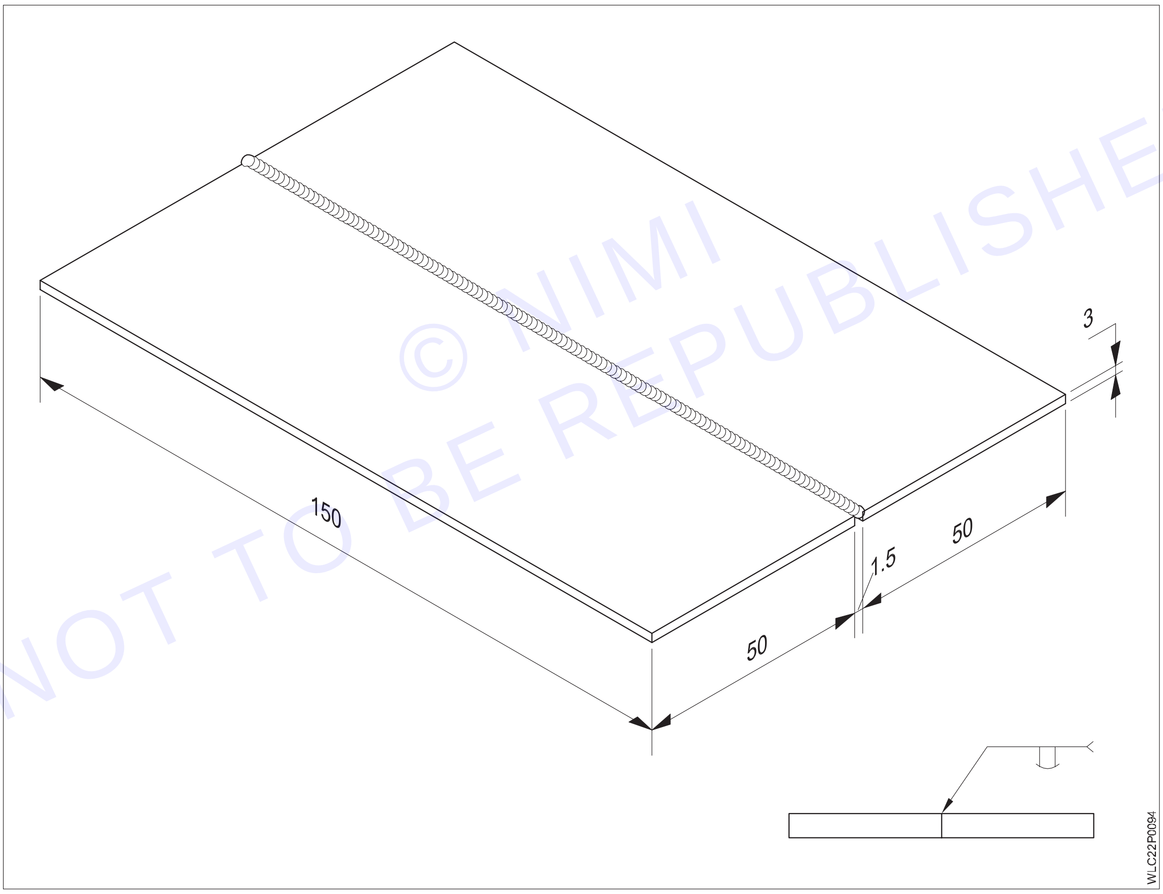
Check the joint for proper bonding of filler metal with the base metal and proper root penetration by the filler metal. Check for weld defects like surface porosity, etc.

EXERCISE 21 : Square butt joint on aluminium sheet 3mm thick in flat position (OAW)

Objectives

At the end of this exercise you shall be able to

- set the sheets with sufficient root gap after cleaning the edges
- set proper flame, select filler rod, gas nozzle, gas, pressures and flux
- preheat the job to the required temperature
- weld aluminium butt joint
- ensure fusion of edges without making holes at the joint
- remove flux residues from the weldment by chemical cleaning
- inspect for weld defects.



Job Sequence

- Prepare aluminium sheet as per dimension with square edges.
- Clean the surface and edges of the sheets to remove the surface oxide and other impurities using stainless steel wire brush/solvent.
- Don't grind aluminium sheets in a grinding machine.
- Apply the pasty flux on the butting edges.
- Set the sheets with 1.5 mm - 2 mm root gap. (Fig 1) As the thermal expansion of aluminium is more, the root gap can be set such that it increases at about 1mm per 100mm length of the joint for butt welds.

- Fix nozzle No. 5 on the blow pipe and adjust gas pressure of 0.15 kg/sq.cm2 for both gases.
- Adjust a strict neutral flame. (Fig 2)

Fig 1

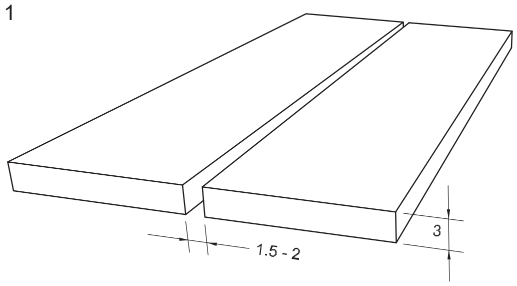
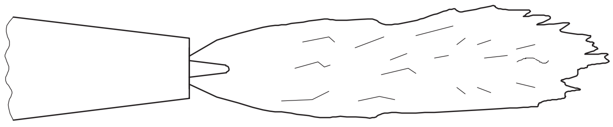
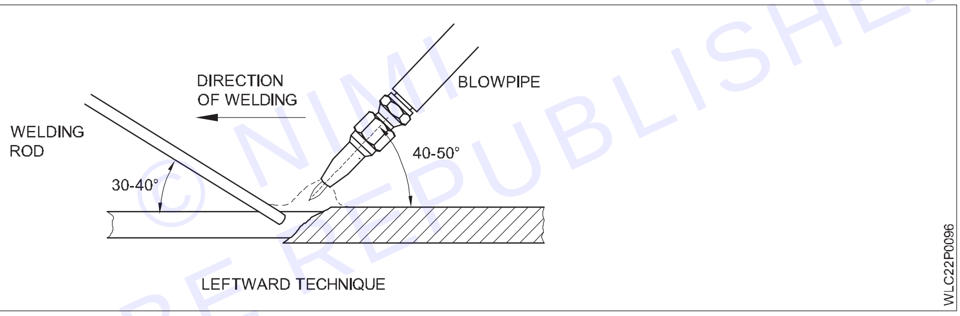


Fig 2



- Use silicon aluminium filler rod 3 mm ø and apply the pasty flux on the filler rod.
- Tack-weld at both ends of the joint and at the centre.
- Preheat the job to a temperature of 150° - 180°C to reduce the effect of expansion during welding using the blow pipe flame itself.
- Start welding by the leftward technique by holding the blowpipe at an angle of 40° to 50° and the filler rod at an angle of 30° - 40°. (Fig 3)

Fig 3



- Do not remove the filler rod end from the outer envelope of the flame till the welding is over.
- Clean the weld by washing in a 10% sulphuric acid solution.
- Again, wash the weld by rinsing in hot or cold water.
- No traces of flux should remain on the weld. It will cause corrosion, after completion of the weld.
- Inspect for weld defects.
- As the end of the joint is approached, reduce the blow pipe and filler rod angle and raise the inner cone. This is done to avoid burn through of the joint.

Skill Sequence

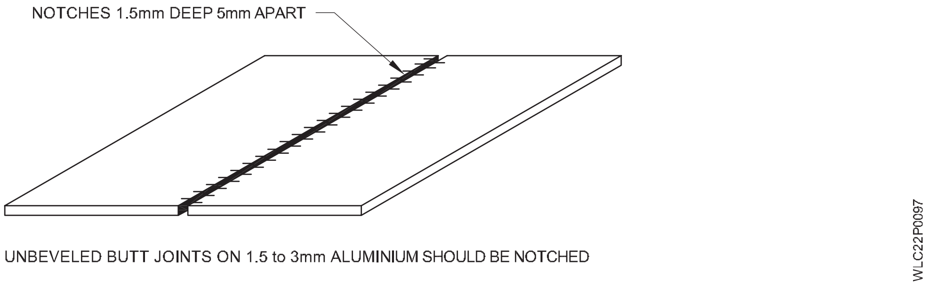
Square butt joint on aluminium sheet of 3mm thick

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

- prepare and weld square butt joint on aluminium sheet of 3mm thick.

While preparing square edges make notches on the edges to be joined. Fig 1

Fig 1

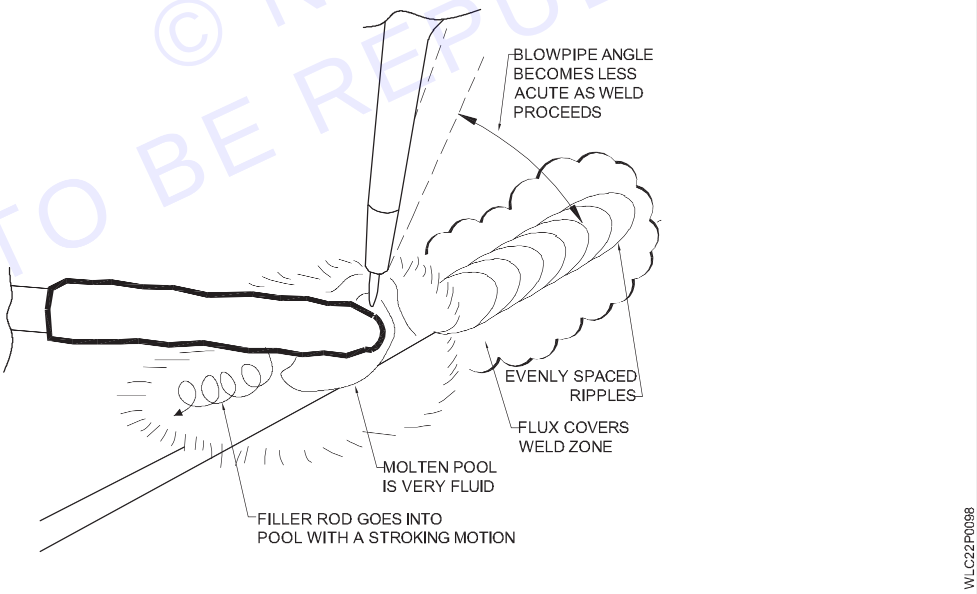


Since setting a strict neutral flame is difficult a very slight carburizing flame is set for welding aluminium.

While using leftward technique, the blow pipe angle will be reduced gradually as the welding progresses. Fig 2.

As there is no colour change when aluminium melts, watch carefully for any shrinking of oxide film on the surfaces of the base metal which indicates the starting of base metal melting.

Fig 2

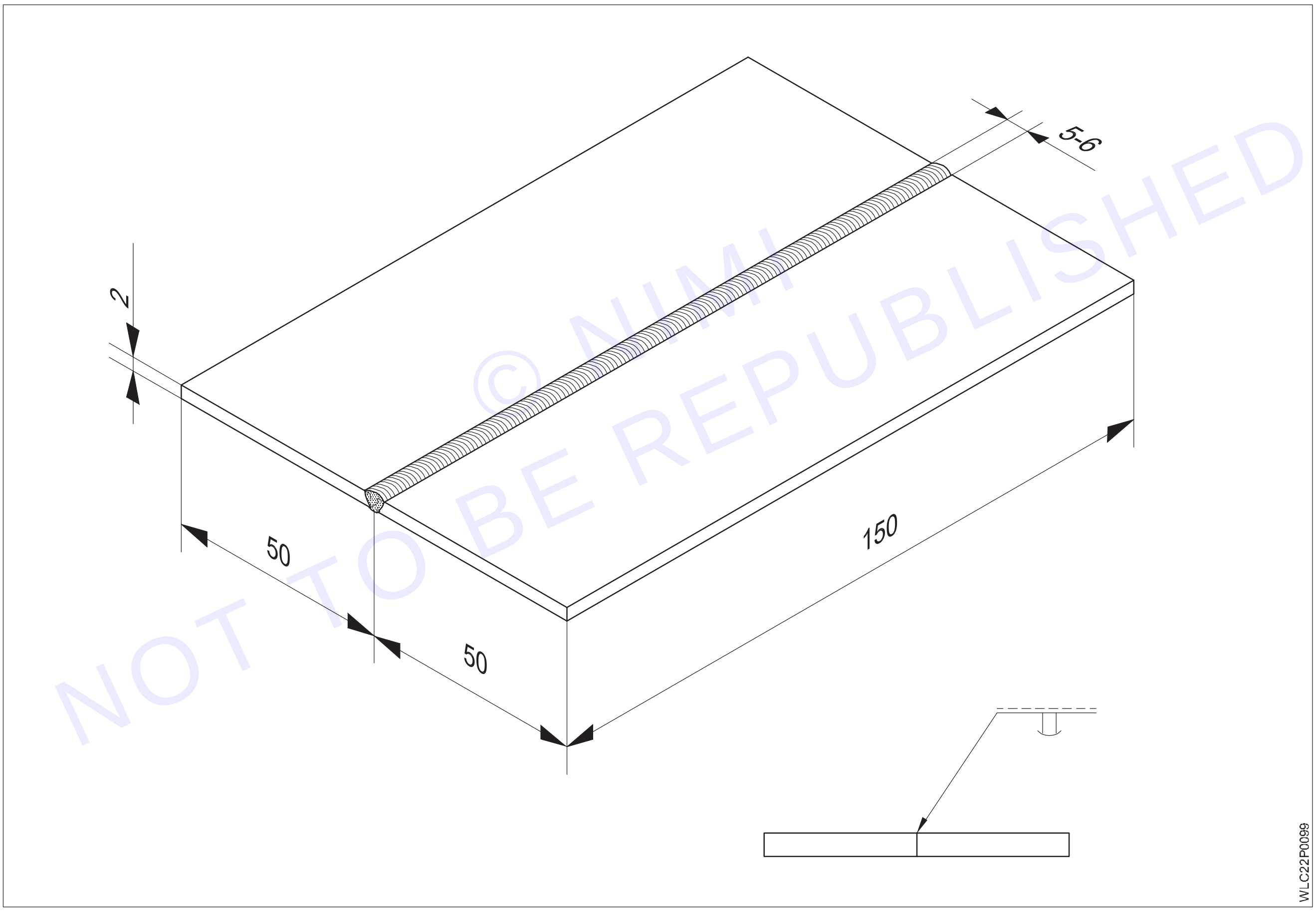


EXERCISE 22 : Square butt joint on copper sheet 2mm thick in flat position (1 G)

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.



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 thoroughly wash and dry the joint before tack welding.

4 Prepare square edges of the pieces by filing.

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

5 Select the nozzle No.10 and 0.15kg/cm2 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.

Note : 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)

Select nozzle No.5-7.

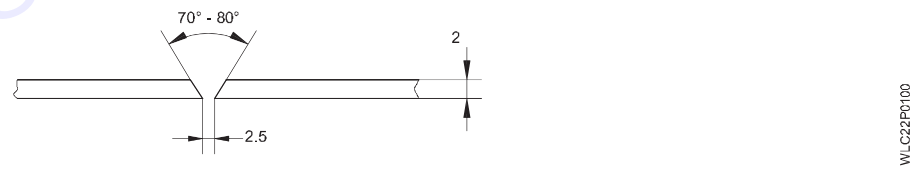
Note : A nozzle one size larger should be used as compared with the M.S. sheet welding because of high conductivity and quick dissipation of heat.

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.

Fig 1



Note : 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.

Set a strictly neutral flame.

Preheat the base metal up to 'peacock neck' colour (3500C) 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 600 - 800 and the filler rod angle 250 - 300 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.

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.

Fig 2

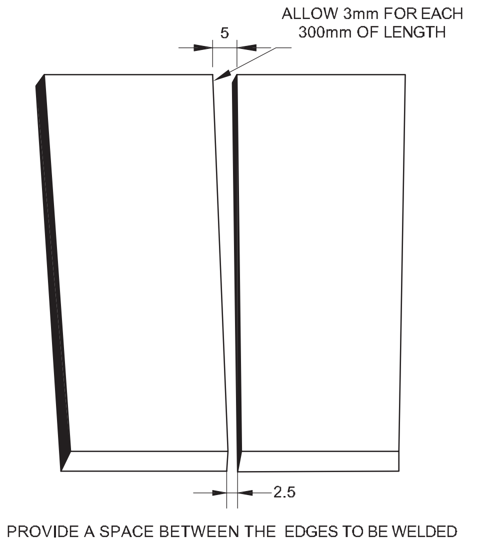
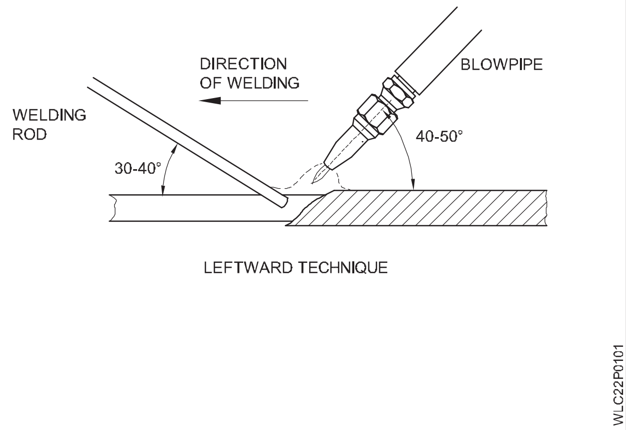


Fig 3



Post-heat the job to 3000C and allow to cool slowly. Clean the bead and remove the flux residue on both sides of the joint.

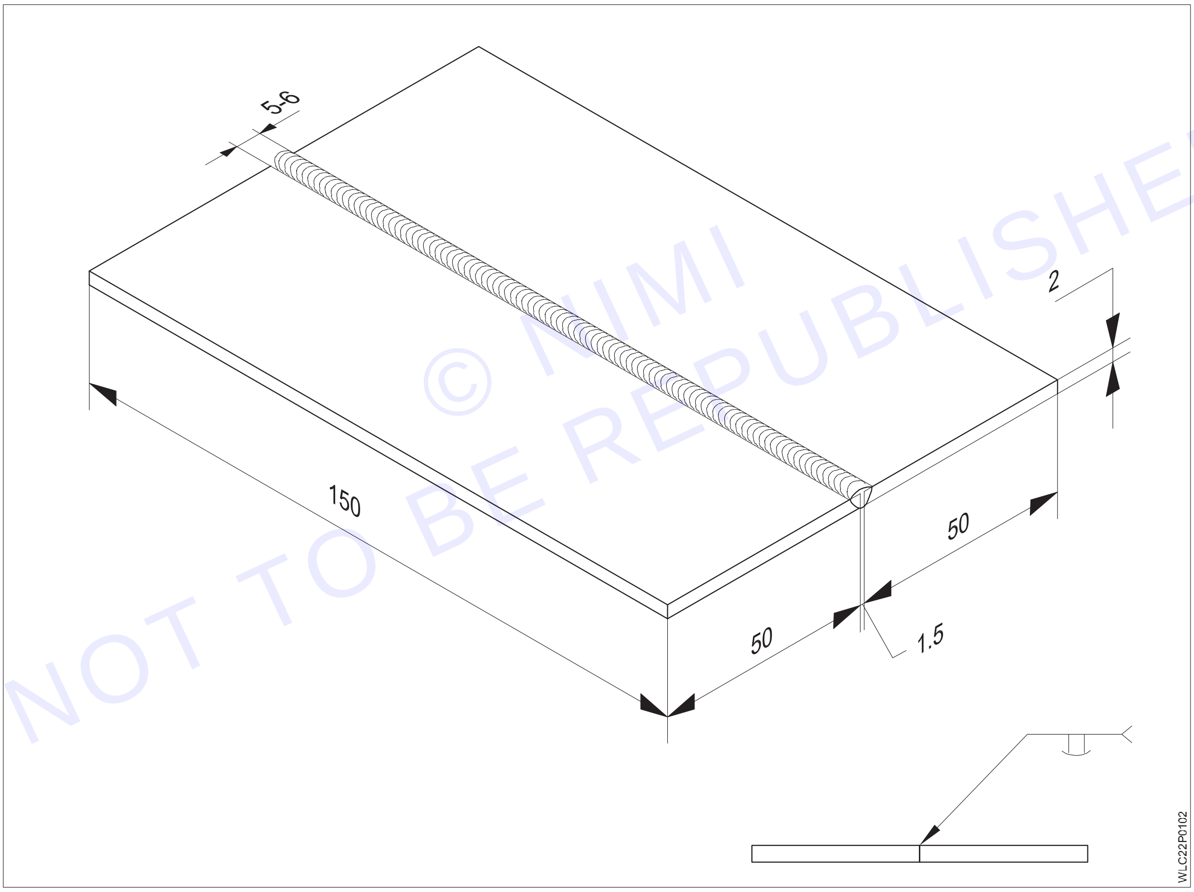
Inspect the joint for external defects and bead size and profile.

EXERCISE 23 : Square butt joint on brass sheet 2mm thick in flat position (OAW)

Objectives

At the end of this exercise you shall be able to

- remove oxides and other impurities from the surface of the base metal
- prepare a square edge and set the sheets as a butt joint
- select the correct size of nozzle and filler rod, gas pressure and flux
- set a soft oxidizing flame and tack-weld the butt joint
- manipulate the filler rod and blowpipe with appropriate angles and weld the joint
- clean and check the penetration and inspect the weld for weld defects.

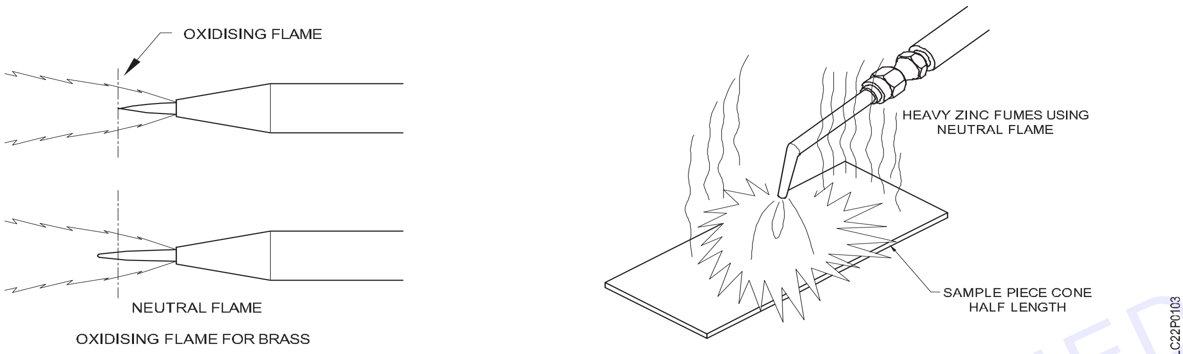


Job Sequence

- Prepare the brass sheets as per dimension given in the sketch.
- Deburr the edges of the sheet.
- Clean the surfaces of the sheet and remove oxides if any.
- Select nozzle No. 5 and set 0.15 kg/cm2 pressure for both the gases.
- Select a silicon-bronze rod of 1.5 mm ø.
- Select brass flux (borax type). Apply the flux by dipping the hot end of the filler rod in the powdered flux from time to time.

- Set and align the plates with a root gap of 1.5 mm.
- Set a soft oxidizing flame. (Fig 1)
- Slightly preheat the plates before tacking and tack weld using 1.5mmø filler rod. The pitch of tacks should be 50mm.
- Adopt leftward technique.
- Add the filler rod more rapidly as welding approaches the end of the seam. Fill the crater.
- Ensure complete removal of all flux residue.
- Clean the weld bead and inspect.
- Avoid inhaling zinc oxide fumes using a respirator.

Fig 1



Skill Sequence

Square butt joint on brass plate 2mm thick in flat position

Objectives: At the end of this exercise you shall be able to
- prepare and weld square butt joint on brass plate 2mm thick in flat position.

Set a neutral flame and play over the sample brass piece.

White zinc fumes will be seen. Then reduce the acetylene gas by operating the acetylene control valve in the blowpipe until the white fumes disappears. This is the required oxidizing flame for the particular brass sheet to be welded.

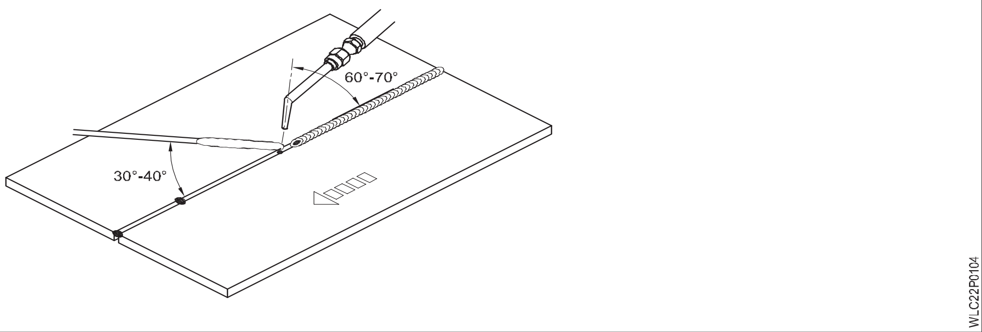
Commence welding at right side end and continue until the joint is completed. The filler rod is fed into the pool as the surface sinks, indicating that penetration is being achieved.

The inner cone of the flame is held fairly close to the surface of the weld. Keep the angle of the blowpipe at 60°-70° and filler rod at 30°- 40°. (Fig 1)

Reduce the blowpipe angle or withdraw entirely to reduce heat input at the crater.

A respirator is to be used to avoid inhaling of toxic zinc fume coming out of the brass sheet.

Fig 1

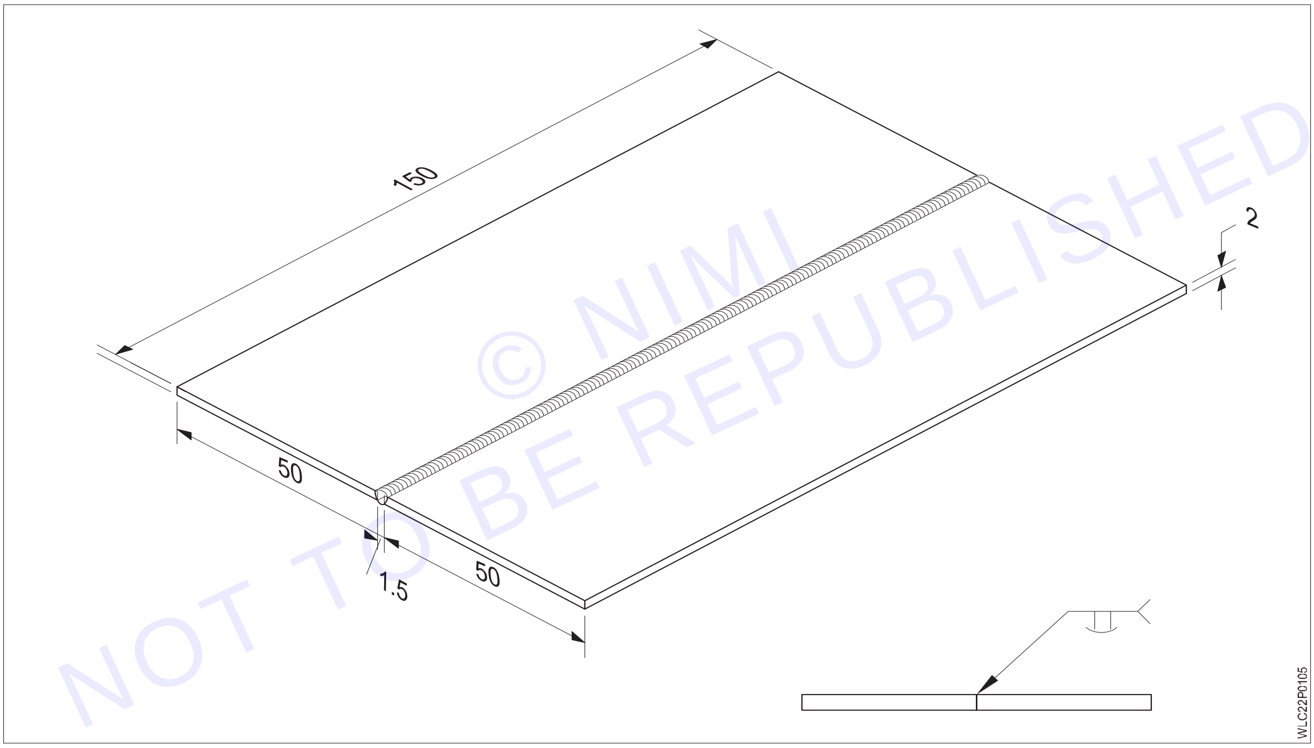


EXERCISE 24 : Square butt joint on stainless steel sheet 2mm thick in flat position (OAW)

Objectives

At the end of this exercise you shall be able to

- clean the chromium oxides and other impurities that exist on the surface of the stainless-steel sheet
- prepare square edges on stainless steel sheets
- apply stainless steel flux on the edges of the sheet to be welded
- select suitable stainless steel filler rod, nozzle, gas pressure
- set a perfect neutral flame
- weld the square butt joint with uniform root penetration using leftward technique
- clean the joint and inspect for weld defects.



Job Sequence

- Prepare the stainless-steel sheet as per dimensions.
- Clean the edges of the sheets.
- Select the nozzle No. 5 for 3.15 mm thickness.
- Select the stainless-steel flux and apply on both sides of the edges of the joint by using a 12mm paint brush and apply on filler rod.
- Set and align the stainless-steel sheet as square butt joint.
- Set perfect neutral flame.
- Tack-weld at every 50mm length of the butt joint.
- Weld the joint using leftward technique.
- Clean the joint and inspect the weld for defects.

Skill Sequence

Square butt joint on stainless steel sheet 2mm thick in flat position

Objectives: At the end of this exercise you shall be able to
- prepare and weld square butt joint on stainless steel sheet 2mm thick in flat position.

Prepare the stainless-steel sheet as per dimensions given in the sketch.

Use a stainless-steel wire brush to clean the edges of the sheets and remove any chromium oxide and other impurities from the edges.

Select nozzle No. 5 and fix on the blowpipe.

Select a 1.6 mm ø specially treated columbium bearing 18/8 type stainless steel filler rod, or cut strips from the base metal to use as filler rod. 18/8 stainless steel means the alloy steel contains 18% chromium, 8% nickel and the balance % is iron, carbon % etc.

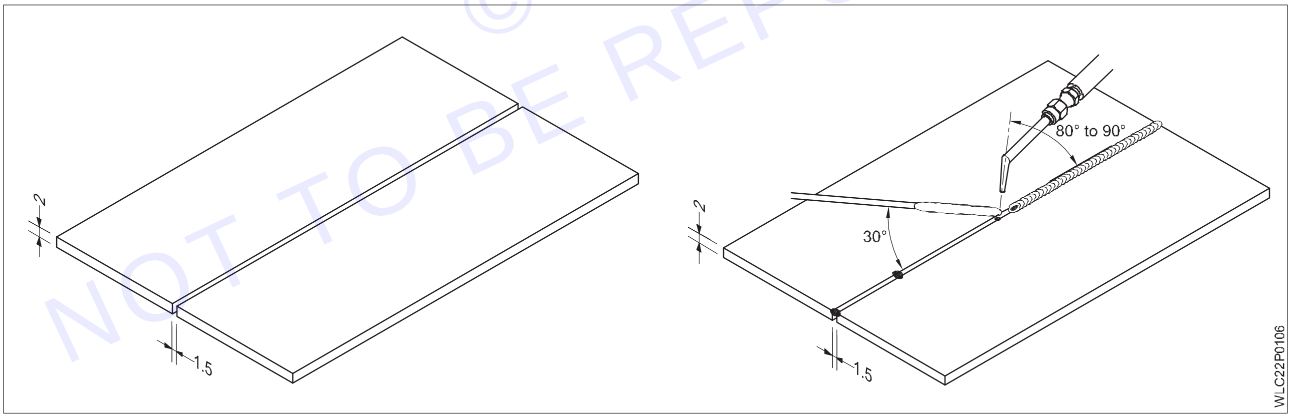
Select good quality flux which contains zinc chloride and potassium dichromate; make powdered flux in a pasty form by adding water. Apply the flux on both sides of the plate and filler rod.

Set the sheets as butt joint on a thick metal plate with 1.5 mm gap as shown in Fig 1.

Set a strict neutral flame or slightly carburizing flame so as to prevent the formation of oxidizing flame which is harmful.

Tack-weld on both ends of the joints and for every 50 mm in between them.

Start welding from the right-hand side by holding the blowpipe at an angle of 80° to 90° and the filler rod at 20° to 30°. (Fig 2)



Note : Ensure uniform penetration at the root of the joint.

Finish the weld by filling up the crater at the end of the bead.

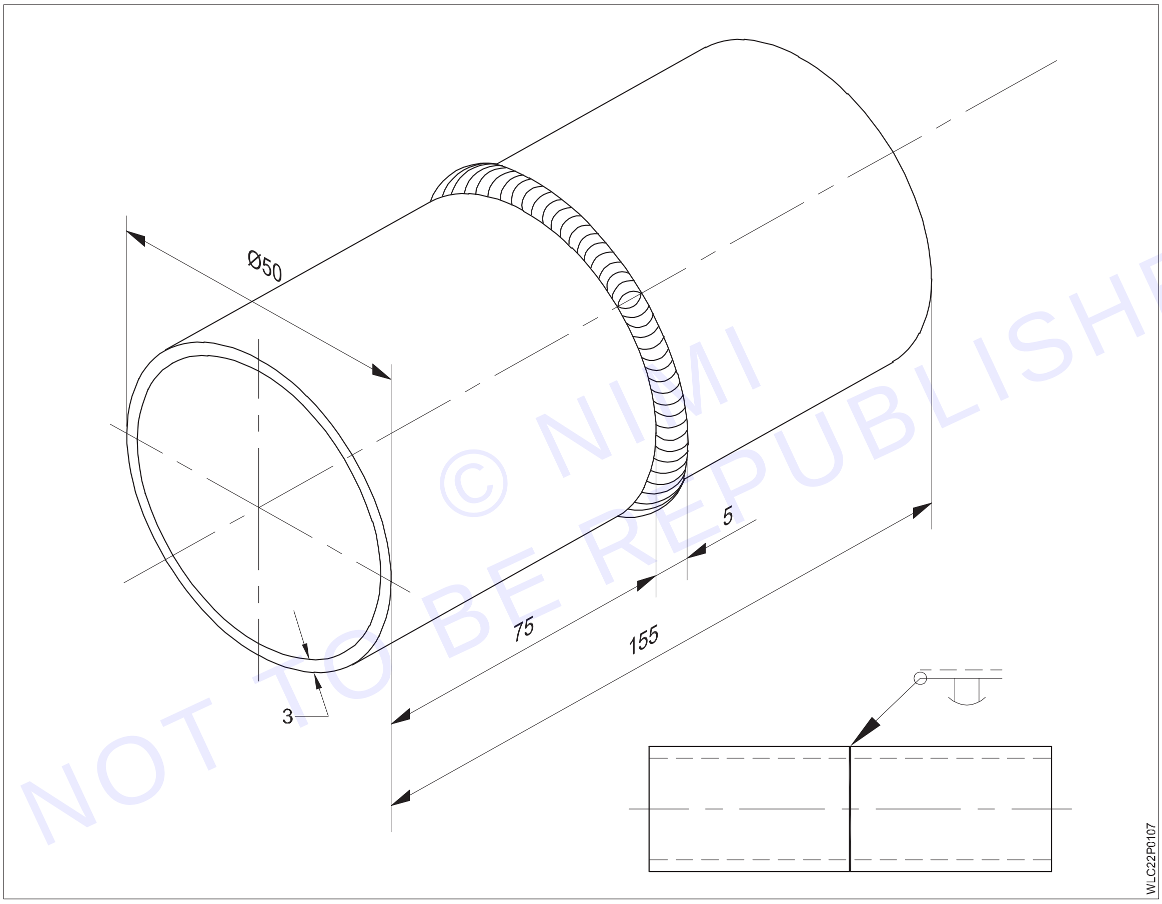
Clean the weld bead and inspect.

Note : Ensure the complete removal of the flux residues.

Pipe welding butt joint on MS pipe ø50mm × 3mm wall thickness in flat position (OAW)

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

- cut and prepare the MS pipe as per the dimension given in the drawing
- align the axis of the pipes in flat position as a pipe butt joint
- select nozzle, filler rod sizes, gas pressures and flame
- set the root gap and tack weld the pipes
- set the tack welded pipes with their axes horizontal
- weld the butt joint in segments ensuring proper root penetration, bead size, profile and reinforcement
- clean and inspect for surface defects.



Job Sequence

- Cut the pipes to 77mm length by hacksaw and file its end square to 75mm length. Chamfer the outside edge of the pipe to 30 - 35° angle leaving a root face/land of 1.5mm at the bottom edge of the pipe.
- Clean the inside and outside surfaces of the cut pipes after deburring.
- Fix No. 5 size nozzle, select 1.6mmø CCMS filler rod and set 0.15 kg/cm2 pressure for both gases.
- Set the 2 pipes on an angle or channel fixture to form a coaxial pipe butt joint with proper root gap.
- Follow necessary safety precautions.
- Set neutral flame.
- Tack weld in 3 places (120° apart) keeping 1.5mm root gap between the pipes.
- Divide the pipe circumference into four segments. Keep the pipe horizontally on the fixture.

- Deposit the root run starting from 3 o'clock position to 12 o'clock position using proper blowpipe and filler rod angles. (I segment)
- Turn the pipe joint in the clockwise direction so that the end of the root run already made in I segment comes to the 3 o'clock position.
- Continue to weld the root run for the second quarter segment as done for the first segment.
- Similarly, complete root run of 3rd and 4th segments.
- Ensure the root penetration by maintaining a keyhole at the root throughout the root run.
- Clean the root run by steel wire brush.
- Fix No. 7 size nozzle, select 3mmø CCMS filler rod and set 0.15 kg/cm2 gas pressure.
- Set neutral flame and fill the V groove by depositing the 2nd run using slight weaving to the blowpipe so that both the faces of the V and the root run will fuse properly.
- Ensure proper bead size, profile and weld reinforcement as well as avoid undercut and other weld defects.
- Clean the joint and inspect for external defects.

Fig 1

Skill Sequence

Structural pipe welding butt joint on MS plate ø 50 × 3 mm wall thickness in flat position

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

- prepare and weld structural pipe welding butt joint on MS plate ø 50 × 3 mm wall thickness in flat position.

Pipe welding is a highly skilled welding operation, which involves correct alignment and good penetration by equally melted edges of the pipes. As the welding is to be done on a curved surface, the position of the blow pipe and filler rod will continuously change as the welding progresses along the joint. To do this you have to put some extra efforts to get the special skill of welding a pipe joint.

Preparation and setting: Check and ensure correct size of pipes. Prepare two M.S. pipes 50 mm ø and 75 mm long by hacksaw cutting. As the end faces of a pipe cut by a hacksaw may not be at 90° to the pipe axis, file the end faces of the pipe to get the 90° angle. Bevel the ends of the pipes by filing.

Clean the pipes and remove burrs, if any. Align the pipes in flat position as shown in Fig 1. Tack the weld joint by inserting 1.5 mm wire to maintain a uniform root gap. (Fig 2a and 2b) Ensure the tack welded pipes are coaxial. (i.e., the axis of both the pipes are the same.)

Select the angle iron or channel fixture according to the diameter of the pipe.

Place the tacked pipes on the fixture.

To ensure proper root penetration select nozzle No. 5 and a 1.6 mm C.C.M.S. rod for the root run.

Start welding as shown in the figure and complete the first segment. (Figs 3 and 4) The blowpipe and the filler rod angles are as shown in Fig 4 at the "start of the weld" and have to be changed to those angles shown at the "stop weld" continuously and gradually. i.e. weld from 3 o'clock position to 12 o'clock position.

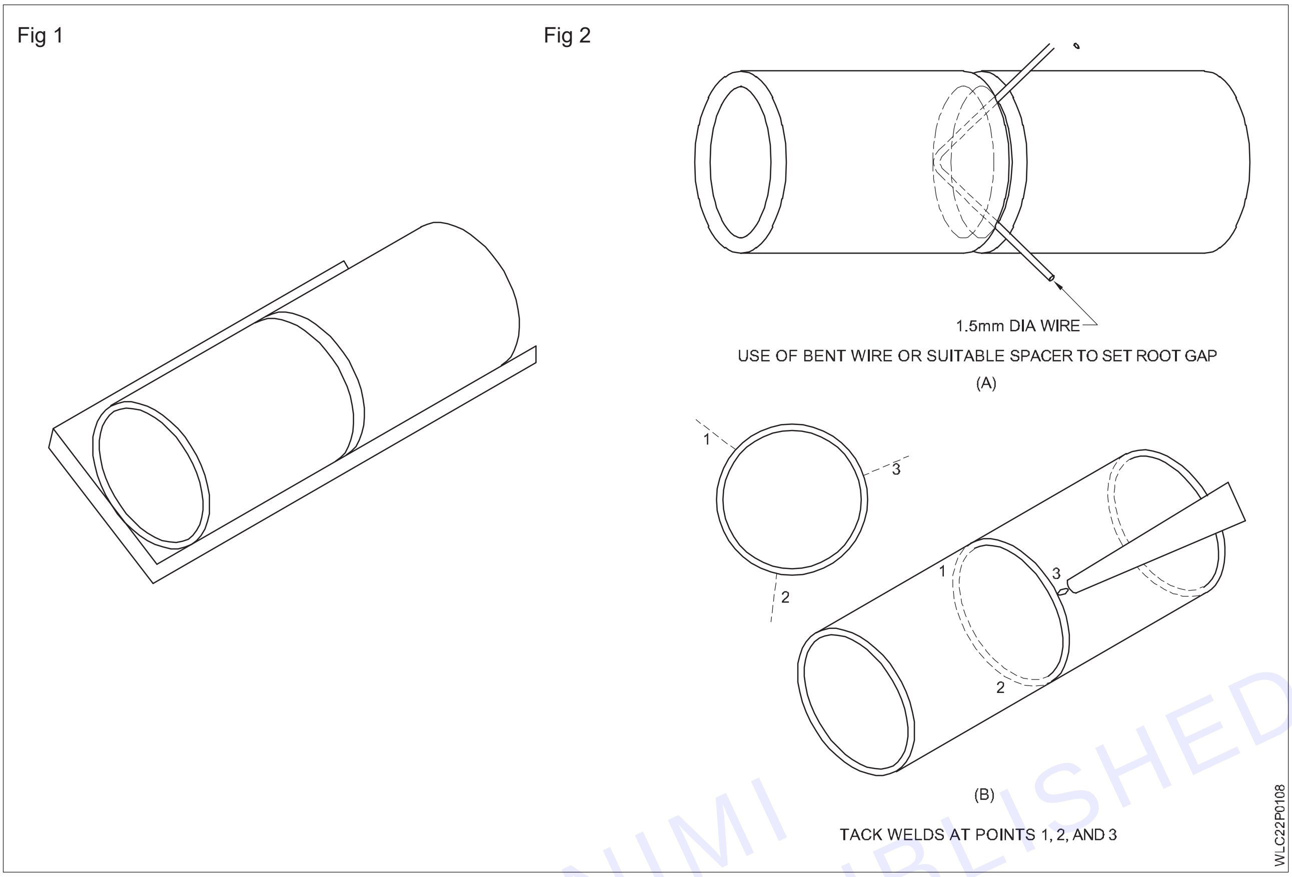
After completion of I segment welded, rotate the pipe joint in clockwise direction until the II segment will come to the position of I segment.

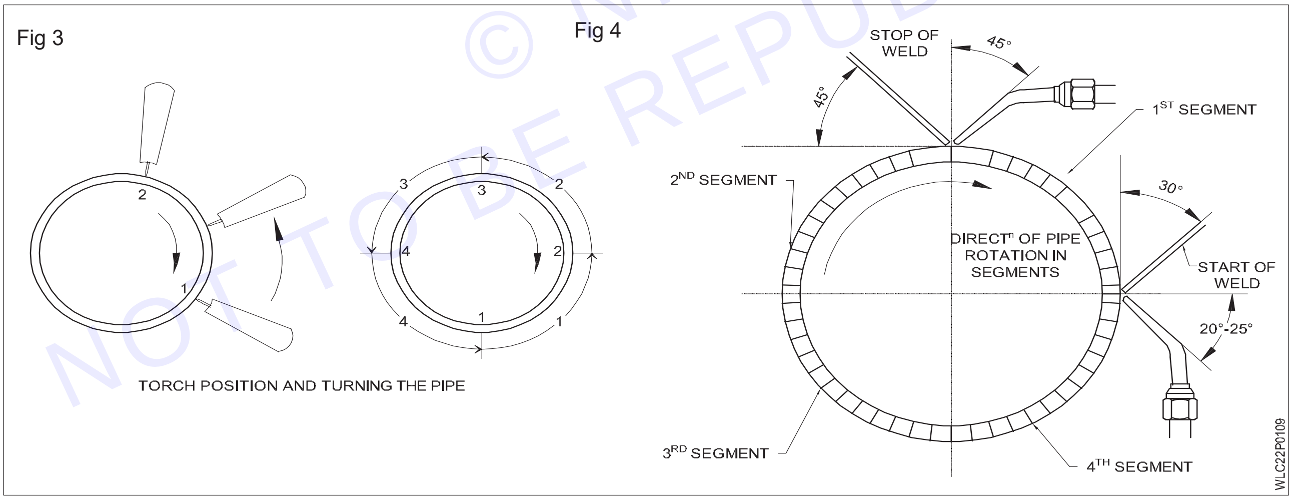
Deposit the root run on the II segment similar to the I segment.

Further welding is done by rotating the pipe to the III and IV segment.

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

It is very important to maintain a keyhole ahead of the molten pool at the root of the joint which will ensure root penetration.





Remove the work piece from the rotating fixture.

Clean the weld bead and inspect the root run for root penetration and weld defects.

Keep the pipe joint on the rotating fixture and fix no. 7 nozzle, set 0.15 kg/cm2 pressure for the gases and use 3mmø CCMS filler rod.

Deposit the final run over the root run using neutral flame.

Follow the same welding technique used for the root run except maintaining a keyhole. Ensure proper fusion of the root run and the side walls of the V groove by proper movement of blow pipe and filler rod.

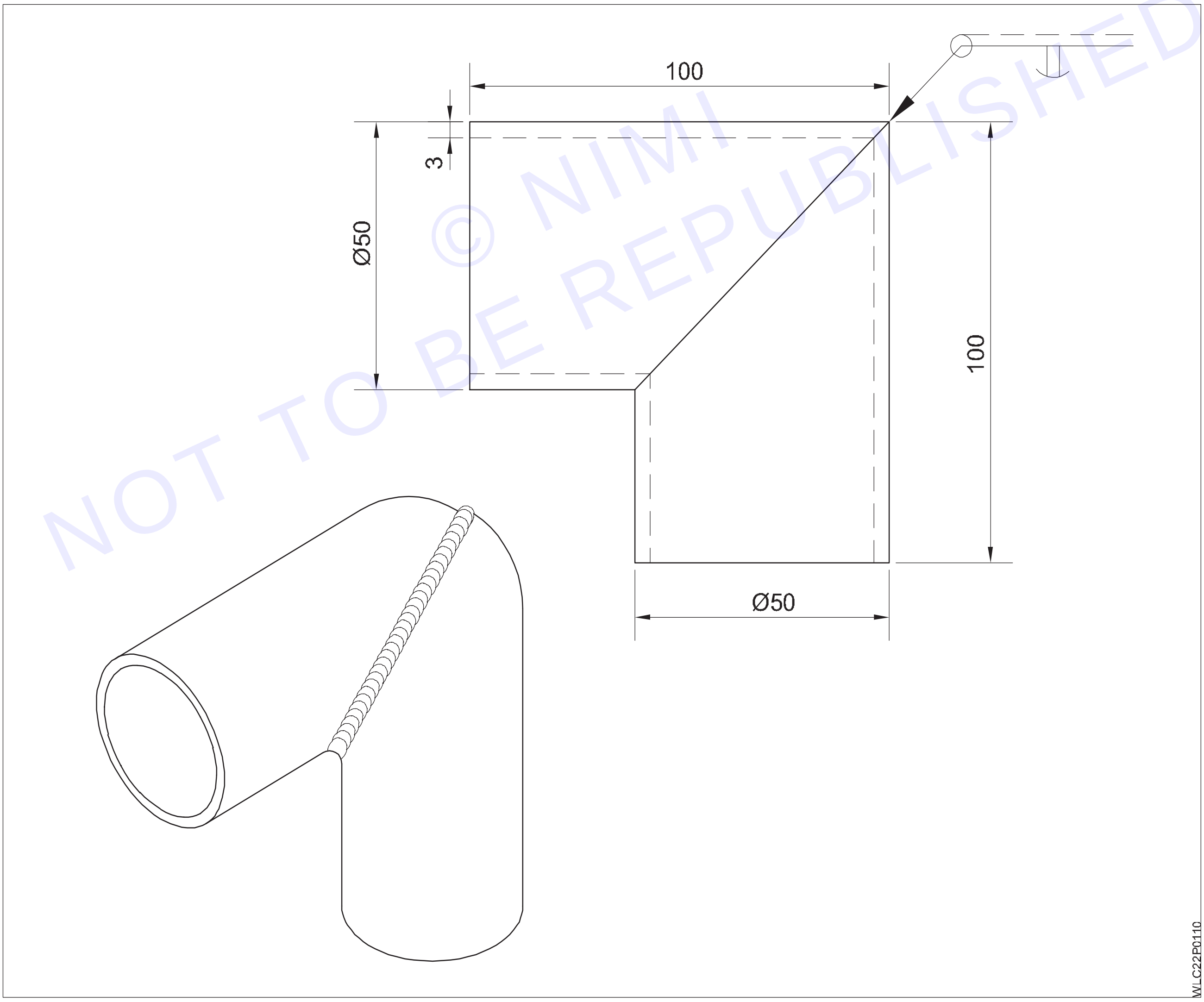
Ensure undercuts are avoided and proper bead profile, size and reinforcement is maintained. Clean the joint and inspect for weld defects.

EXERCISE 25 : Pipe welding - Elbow joint on MS pipe ø50mm and 3mm wall thickness in flat position (OAW)

Objectives

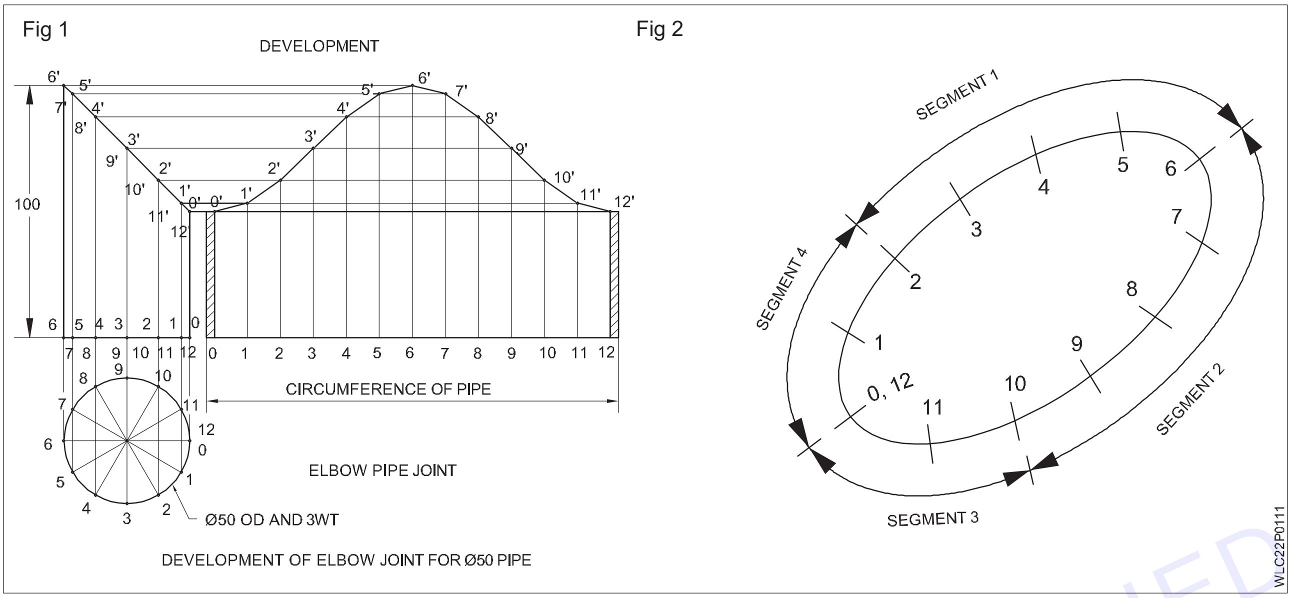
At the end of this exercise you shall be able to

- draw the development for "ELBOW" pipe joint
- cut and prepare the pipe as per the dimensions
- clean the oxides and burrs from the welding surfaces
- set the pipes to form a 90° pipe elbow joint
- tack weld the pipe with a root gap of 1.6mm
- start the weld and complete it in two halves
- clean and inspect for weld defects.



Job Sequence

- Ensure the correct size of the pipes are used.
- Draw development for an “elbow” joint. Fig 1 on a drawing sheet scale full size.



- Cut the development of the pipe elbow from the drawing sheet and paste it on one end of both the 100mm long pipes.
- Make punch marks along the profile of the development on the pipes and cut the pipe along the punch marks using a hacksaw.
- Deburr the cut edges and file it to correct any irregularity on the cut edges.
- Clean the surface of the pipe of any oxide and other contaminants.
- Set and align the pipe to on angle of 90°.
- Select nozzle No. 7 and ø3mm CCMS filler rod with 0.15 kg/cm2 pressure for both gases.
- Set neutral flame.
- Follow necessary safety precautions.
- Tack welds the joints at 4 places with 1.6mm root gap and keep the joint in alignment. Check the 90° angle between the pipe axes using try square.
- Use leftward and vertical welding technique.
- Weld the joints by manipulating the blowpipe and filler rod in one run using 3mmø CCMS rod dividing the weld into 4 segments.
- The joint which will be in the form of an ellipse has to be welded in 4 segments. Fig 2 The order of sequence of welding is 2 to 6 (segment 1). 10 to 12 (segment 3) 10 to 6 (segment 2) and 2 to 0 (segment 4). This order of welding sequence will help to keep the tacked joint such that the welding is partially done in vertically upwards and partially in flat position.
- Ensure maintaining keyhole and ending the weld of each segment properly to get the root penetration without fail.
- Avoid excessive penetration.
- Clean the welded joint and inspect for weld defects.

Skill Sequence

(ELBOW) Joint on MS pipe ø50×3mm wall thickness in flat position

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

- prepare and weld (ELBOW) joint on MS pipe ø50×3mm wall thickness in flat position.

nozzle to the blowpipe to help in fusing both the edges of the joint (which is 3mm thick) to the full depth and get good root penetration.

Also, the joint which is elliptical in shape can be welded properly with good fusion and root penetration only if the tack welded pipes are welded in 4 segments.

The segments are divided on the tacked pipe elbow joint as shown in Fig 2 under job sequence.

This division into 4 segments will help to keep the job in the required position so that the welding is done partially by vertical welding technique and partially by flat position.

In addition, the distortion in the pipe joint due to welding can be controlled by welding the segment in the sequence 1,3,2 and 4.

Maintaining a continuous keyhole as done in pipe square butt joint will help in getting good root penetration.

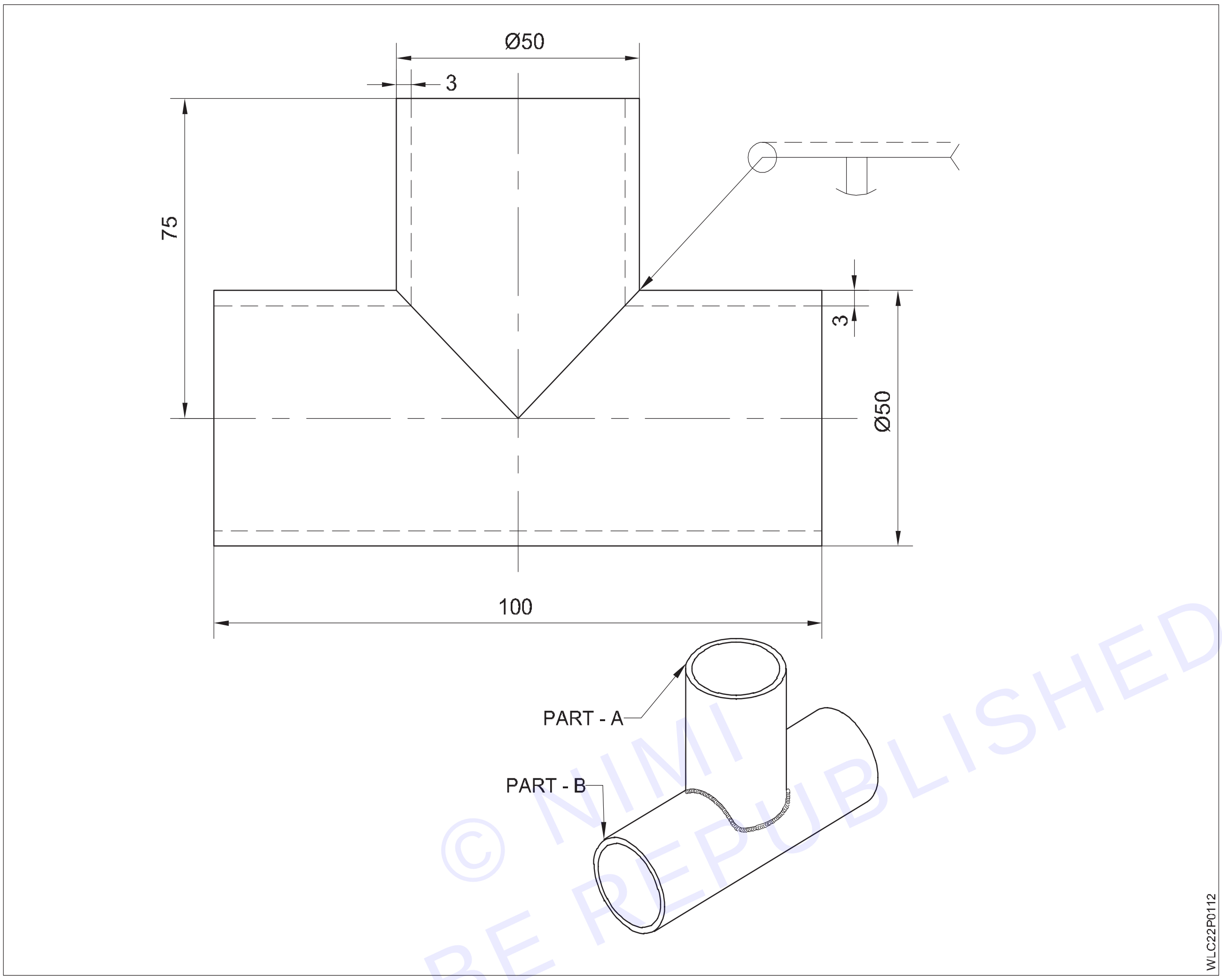
During welding fuse, the tacks fully and also ensure proper fusion of edges and root of the joint of each segment.

Use the blow pipe and filler rod angles of 60 - 70° and 30 - 40° to the tangent at the point of welding. Give a very slight side to side motion to the blowpipe.

Pipe welding 'T' joint on MS pipe ø50mm and 3mm wall thickness in flat position (OAW)

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

- draw the development for 90° T branch
- cut and prepare the pipes as per dimensions
- set 90° angle of the branch pipe using try square
- tack weld the pipe and recheck the angle
- start and complete the weld in two halves
- manipulate the blowpipe and filler rod holding them at the required angles during welding
- clean and inspect for external weld defects.



Job Sequence

- Ensure the correct size of pipes are used.
- Prepare development for 90° branch. (Fig 1) on a drawing sheet.
- Cut and paste it on the pipes.
- Punch marks the profile of the development on both pipes. Cut the branch pipe along the punch marked profile and file it. Cut the profile marked on the main pipe by gas cutting and file it.
- Deburr the gas cut edges and file the edges.
- Clean the surface of the pipe to remove any oxide and other contaminants.
- Set and align the branch pipe with the main pipe at an angle of 90°. (Fig 2)
- Select no. 7 nozzle, ø3mm CCMS rod and use neutral flame with 0.15 kg/cm2 pressure for both gases.
- Follow necessary safety precautions.
- Tack-weld the joint at 4 places with 90° intervals and with a 2 mm root gap to ensure root penetration.
- Ensure the tacked pipe "T" joint is positioned properly to make it convenient to manipulate the blow pipe and filler rod without any obstruction.
- Weld the joint by manipulating the blow pipe and filler rod without rotation of the pipe.

- Maintain keyhole throughout the welding and give side to side motion to the blow pipe to ensure good root penetration and fusion of both the edges of the joint.
- Take care to properly fuse the crater of the previous sector welded with the starting of the new sector.
- Complete the weld in 4 sectors 1, 2, 3 and 4 along the curved joint using leftward technique. Fig 2

Note : Avoid excess penetration.

- Clean the weld and inspect the weldment for defects.

Fig 1

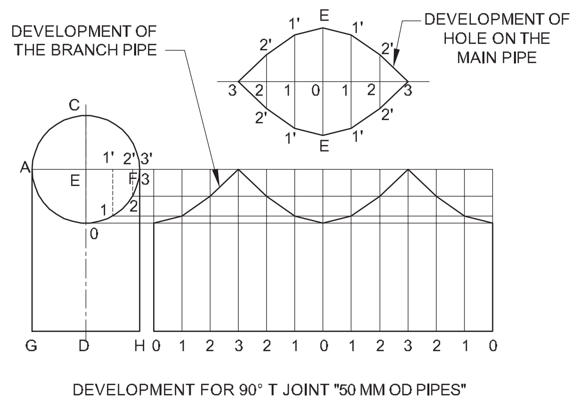
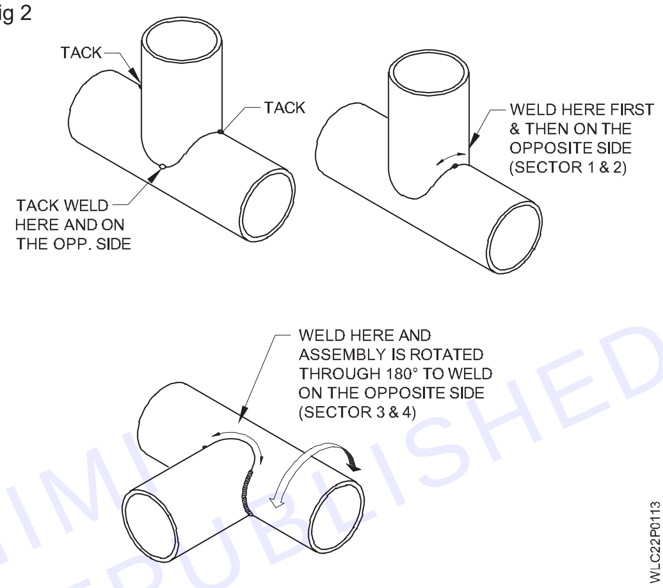


Fig 2

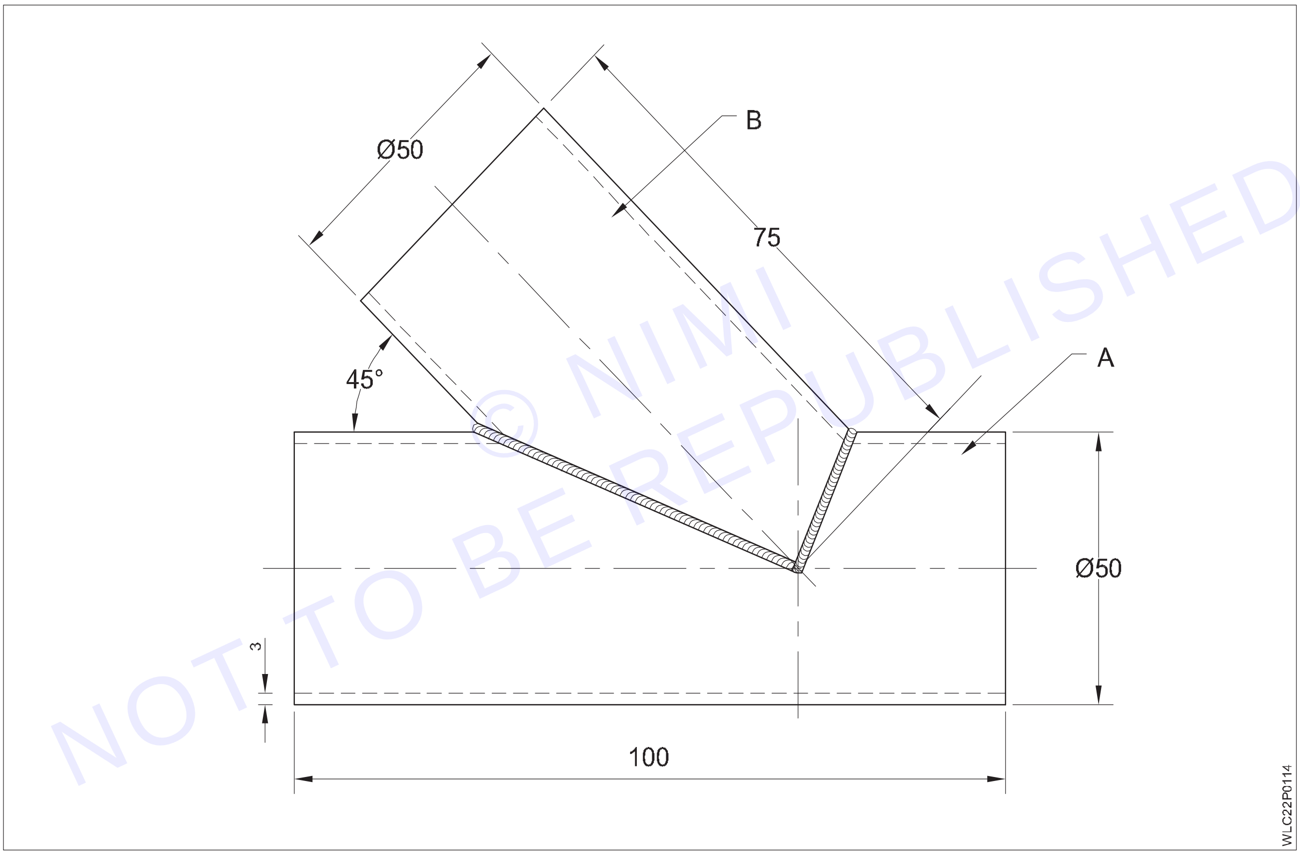


EXERCISE 26 : Pipe welding - 45° branch joint MS pipe ø50mm and 3mm wall thickness in flat position (OAW)

Objectives

At the end of this exercise you shall be able to

- prepare the development of pipe for 45° branch joint
- cut and prepare the pipes as per dimensions
- tack and complete the welding by manipulating the torch and filler rod.

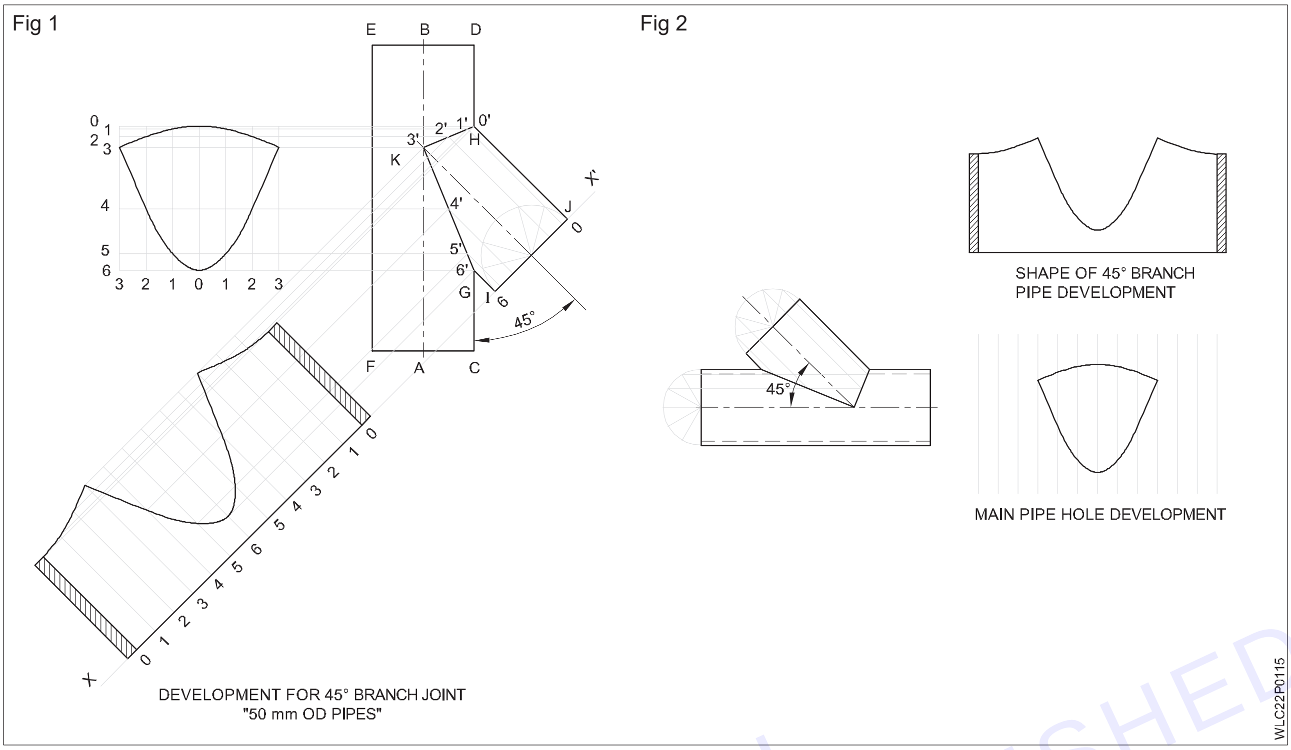


Procedure for development of 45° branch pipe: Refer Fig 1. Draw a centre line AB.

Mark the points C, D, E and F taking the radius and the length of the given pipe with the centre line AB as reference line.

On the line “CD” locate the position of the 45° branch pipe. This will be “G”.

Draw a 45° angle at the point “G”.



Choose a suitable height and mark the height of the branch pipe (GI) in 45° line from point G.

From I, draw a horizontal line on both sides (XX'). This XX' will be the base line for drawing development.

From I, plot the outside diameter of the branch pipe IJ on the line XX'.

Draw a centre line for the branch pipe. This line will cut the main pipe's centre line AB at K.

Join GK. Draw a perpendicular line to GK at K which meets

CD at H. Join KH. Now IGKHJ will be the shape (outline) of the branch pipe.

Draw a semicircle equal to the branch pipe outside diameter.

Divide the semicircle into 6 equal parts as 0-1; 1-2; 2-3; 3-4; 4-5 & 5-6.

Draw vertical lines from these points 1,2,3,4,5. Already

there will be two vertical lines IG from the point 6 and JH

from point 0. These vertical lines will cut the branch pipe

lines 'GK' and 'KH' at points 6', 5', 4', 3', 2', 1' & 0'. Note that points 6' and gas well as points 0' and H are the same points. In the base line XX' plot 13 points equal to the distance of '0-1' as 0, 1,2,3,4,5,6,5,4,3,2,1,0.

Draw vertical lines to XX' from these 13 points.

Draw horizontal lines parallel to XX' from points 6', 5', 4', 3', 2', 1', 0'. These 7 horizontal lines will cut the 13 verticals lines from the base line at 13 points.

Join the 13 cutting points with a regular smooth curve.

Now the required development for the 45° branch pipe will be ready. Give allowance of 3 to 5mm at the edges of the development. (Fig 1)

For developing a hole in the base pipe: Above the main pipe, draw 7 lines parallel to AB namely 3,2,1,0,1,2,3 equal to the distance of 0-1 on the semi-circle.

Draw vertical lines from 0', 1', 2', 3', 4', 5', 6'. These vertical lines will intercept the 7 horizontal lines. Join the intercepting points with a smooth curve. The required development for hole is now ready.

Job Sequence

- Ensure the correct size of pipes are used.
- Prepare development for 45° branch on a drawing sheet.
- Cut and paste it on the pipes.
- Punch marks the profile of the development on both pipes. Cut the branch pipe along the punch marked profile and file it. Cut the profile marked on the main pipe by gas cutting and file it.
- Deburr the gas cut edges and file the edges.
- Clean the surface of the pipe to remove any oxide and other contaminants.
- Set and align the branch pipe with the main pipe at an angle of 45°. (Fig 2)
- Select no. 7 nozzle, ø3mm CCMS rod and use neutral flame with 0.15 kg/cm2 pressure for both gases.
- Follow necessary safety precautions.
- Tack-weld the joint at 4 places with 45° intervals and with a 2 mm root gap to ensure root penetration.
- Ensure the tacked pipe “Branch” joint is positioned properly to make it convenient to manipulate the blow pipe and filler rod without any obstruction.
- Weld the joint by manipulating the blow pipe and filler rod without rotation of the pipe.
- Maintain keyhole throughout the welding and give side to side motion to the blow pipe to ensure good root penetration and fusion of both the edges of the joint.
- Complete the weld in 4 sectors 1, 2, 3 and 4 along the curved joint using leftward technique.
- Take care to properly fuse the crater of the previous sector welded with the starting of the new sector.

Note : Avoid excess penetration.

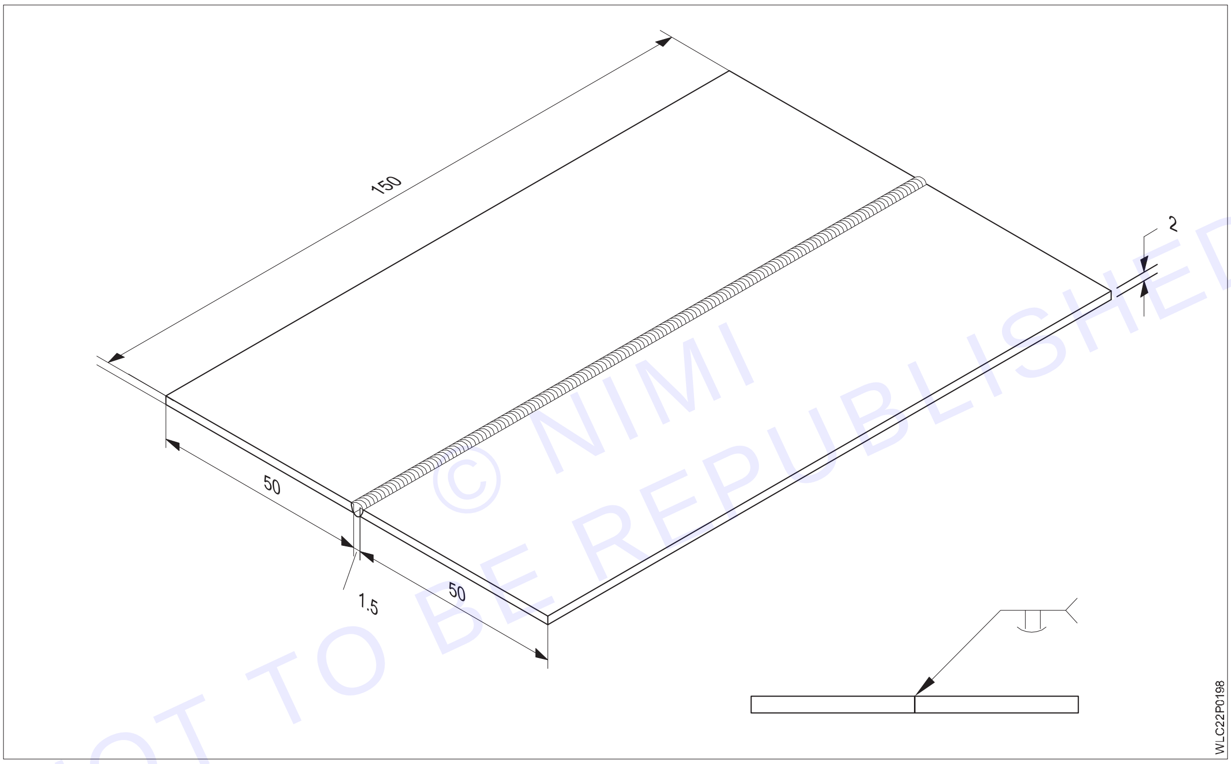
- Clean the weld and inspect the weldment for defects.

EXERCISE 27: Square butt joint on stainless steel sheet 3mm thick in flat position (OAW)

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.



Job Sequence

- Prepare the stainless-steel sheet as per dimensions.
- Clean the edges of the sheets.
- Select the nozzle No. 5 for 3.15 mm thickness.
- Select the stainless-steel flux and apply on both sides of the edges of the joint by using a 12mm paint brush and apply on filler rod.
- Set and align the stainless-steel sheet as square butt joint.
- Set perfect neutral flame.
- Tack-weld at every 50mm length of the butt joint.
- Weld the joint using leftward technique.
- Clean the joint and inspect the weld for defects.

Skill Sequence

Square butt joint on stainless steel sheet 3mm thick in flat position

Objectives: At the end of this exercise you shall be able to
- prepare and weld square butt joint on stainless steel sheet 3mm thick in flat position.

Prepare the stainless-steel sheet as per dimensions given in the sketch.

Use a stainless-steel wire brush to clean the edges of the sheets and remove any chromium oxide and other impurities from the edges.

Select nozzle No. 5 and fix on the blowpipe.

Select a 1.6 mm ø specially treated columbium bearing 18/8 type stainless steel filler rod, or cut strips from the base metal to use as filler rod. 18/8 stainless steel means the alloy steel contains 18% chromium, 8% nickel and the balance % is iron, carbon % etc.

Select good quality flux which contains zinc chloride and potassium dichromate; make powdered flux in a pasty form by adding water. Apply the flux on both sides of the plate and filler rod.

Set the sheets as butt joint on a thick metal plate with 1.5 mm gap as shown in Fig 1.

Set a strict neutral flame or slightly carburizing flame so as to prevent the formation of oxidizing flame which is harmful.

Tack-weld on both ends of the joints and for every 50 mm in between them.

Start welding from the right-hand side by holding the blowpipe at an angle of 80° to 90° and the filler rod at 20° to 30°. (Fig 2)

Note : Ensure uniform penetration at the root of the joint.

Finish the weld by filling up the crater at the end of the bead.

Clean the weld bead and inspect.

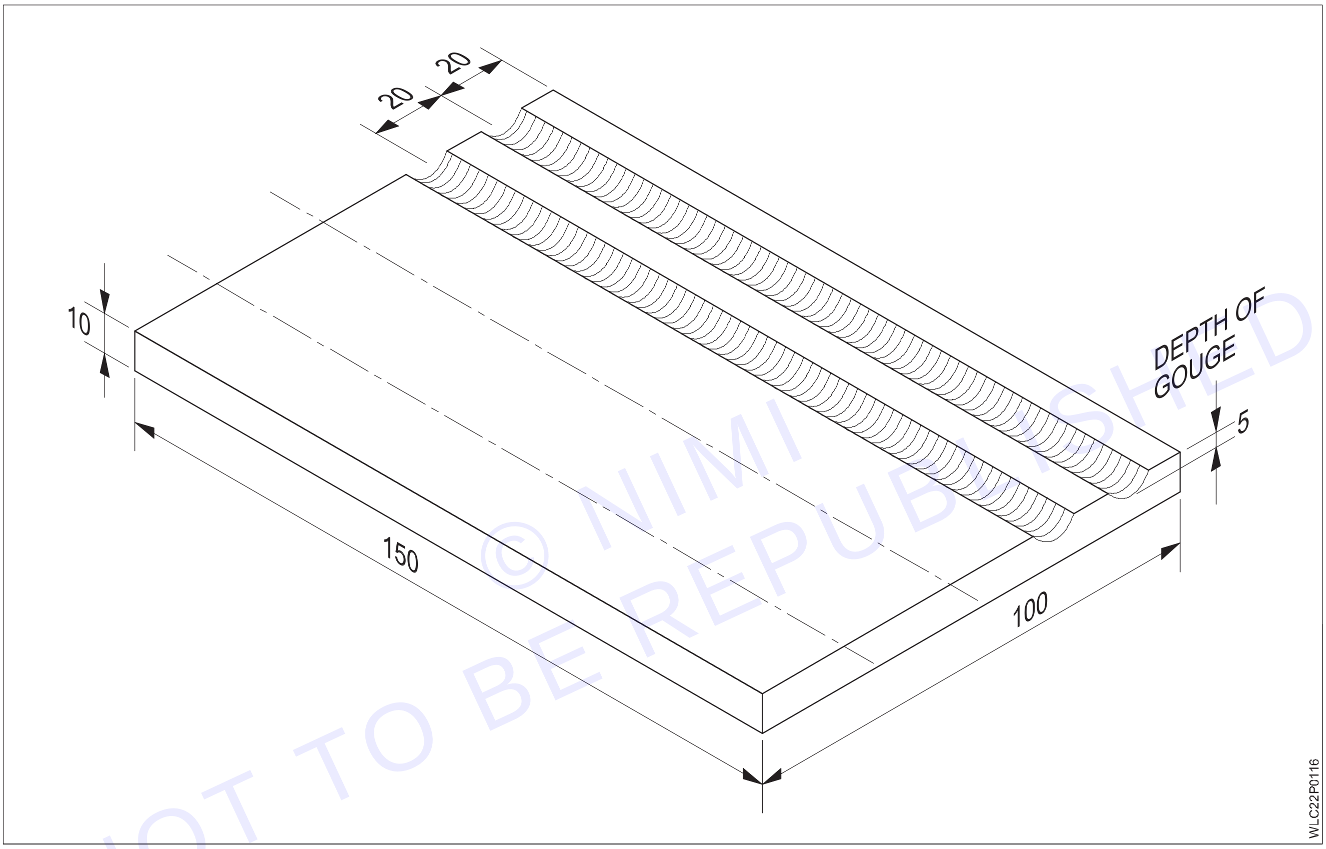
Note : Ensure the complete removal of the flux residues.

EXERCISE 28: Arc gouging on MS plate 10mm thick (AG-01)

Objectives

At the end of this exercise you shall be able to

- select the electrode and set the current as per requirements
- start and maintain gouging action
- clean and inspect the gouging.



Job Sequence

- Mark and cut the pieces as per the given size.
- Mark and punch the straight line.
- Keep the plate in down hand position.
- Use 4mm dia electrode for 10mm thick plate and select DC electrode negative (DCEN).
- Set 300 amps current for both AC or DC machines and select DCEN if DC is used.
- Start from edge of the plate keeping a slant angle.
- When molten metal is established reduce the angle further to gouge and remove surface metal.
- While gouging is in progress remove molten metal and slag away from the arc and gouged groove.
- Move the electrode fast and control the gouging action.
- Complete the operation and clean the gouging surface.
- Inspect the groove for smoothness, even depth and uniformity.

Skill Sequence

Arc gouging on MS plate 10mm thick in flat position

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

- prepare and do the arc gouging on MS plate 10mm thick in flat position.

Prepare the pieces: Mark and cut the pieces as per given sizes by gas cutting. Clean the surfaces. Mark and punch a straight line.

Position the plate down hand or flat.

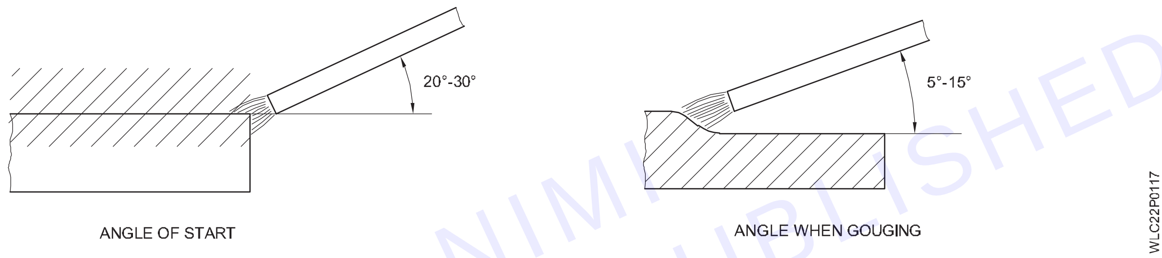
Select the electrode and set the current.

Select a 4 mm dia. gouging electrode for a 10 mm thick plate.

Set 300 amps current in AC or DC m/c and if DC is used set the (straight polarity) electrode negative (DCEN).

Gouging the plate: Point the electrode towards one end of the edge with an angle of 20°-30° and 90° to the rear surface of the plate. (Fig 1)

Fig 1



Strike the arc.

Note : Wear a respirator while gouging.

As the molten pool is established, lower the electrode holder and reduce the angle between 5°-15° from 20°-30°.

Move the electrode along the line of marking from the right to the left side of the plate without side movement.

While gouging is in progress push the molten pool and slag away from the arc and the gouged groove.

Due to rapid fusion because of the arc, heat, move the electrode fast and control the gouging operation.

Note : Ensure that the angle of slope is not too steep, and avoid grooving too deeply.

Note : Use safety boots and leg guards to protect the legs.

Maintain the angle and travel of electrode constant so as to obtain a groove of uniform width and depth.

Clean the gouging surfaces.

Note : Inspect the gouging.

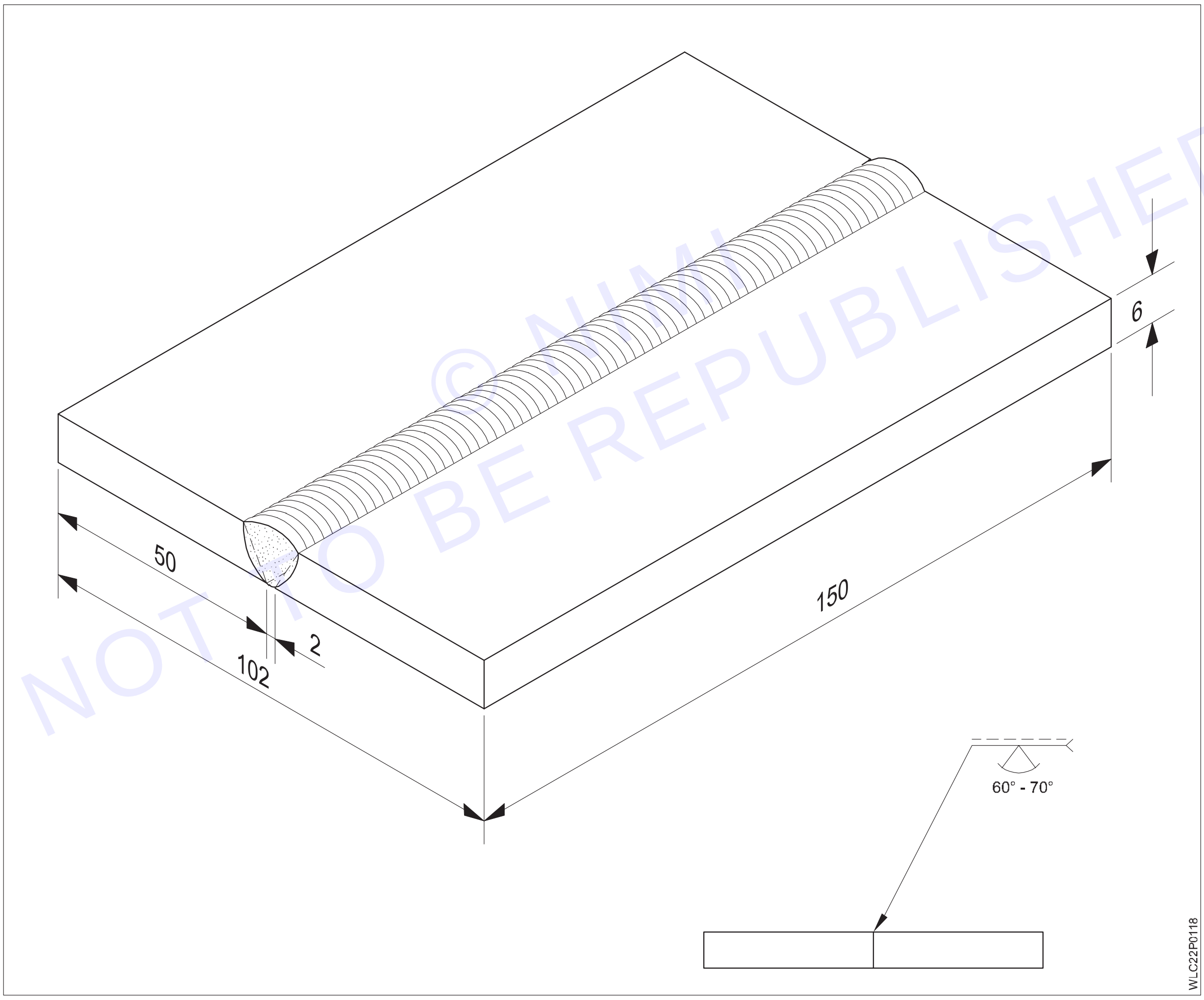
Check the smoothness, depth and uniformity of gouging.

EXERCISE 29 : Single "V" butt joint on cast iron plate 6mm thick in flat position (SMAW)

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.



Job Sequence

- Bevel the edges to 30° angle by grinding (or) filing maintain root face to 1.5mm.
- Keep the plates in alignment in flat position maintain a root gap of 2.50mm.
- Select low hydrogen type E7016 (or) E7018 electrode 3.15mm size and use DCEP polarity i.e., connect the electrode cable to the +ve terminal of the machine.
- Follow necessary safety precautions.
- Preheat the job to 300°C using a oxy-acetylene torch and check the temperature using a thermo chalk and tack weld on both ends using low hydrogen electrode.
- Keep the tack welded joint in flat position.
- Deposit the root run using ø3.15mm low hydrogen M.S. electrode ensuring root penetration.
- Clean the root run. Deposit 2nd and 3rd run using slight weaving and digging motion.
- Maintain minimum interpass temp 200°C throughout and also peen the weld bead by ball pein hammer to remove internal stress concentration for every run.
- Post heat the job if required and cover it in dry sand or ash to allow to cool slowly.
- Clean the weld and inspect it for cracks, proper fusion and other surface defects.

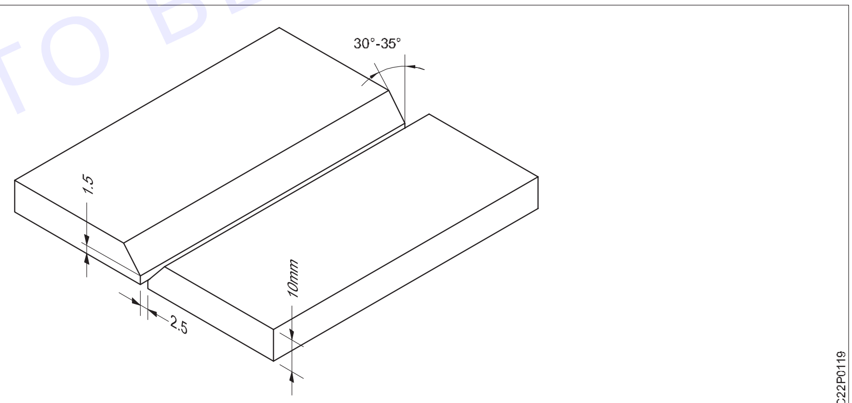
Skill Sequence

Single 'V' butt joint on cast iron plate

Objectives: At the end of this exercise you shall be able to
- prepare and weld single 'V' butt joint on cast iron plate.

Bevel the edges: Bevel the edges to 30° angle by machining or filling. Maintain the root face 1.5 mm (Fig 1) avoid sharp edges as it may get chipped off if not handled properly.

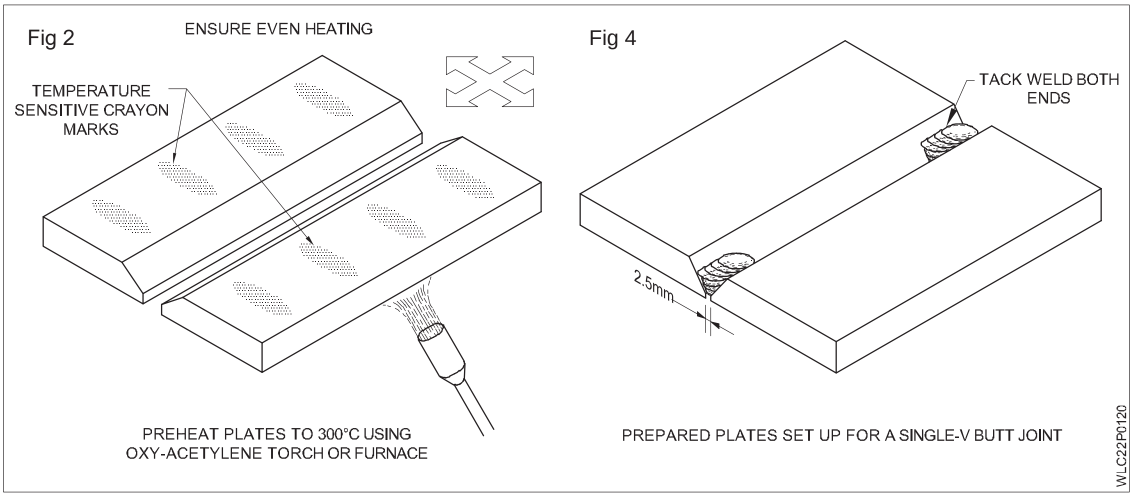
Fig 1

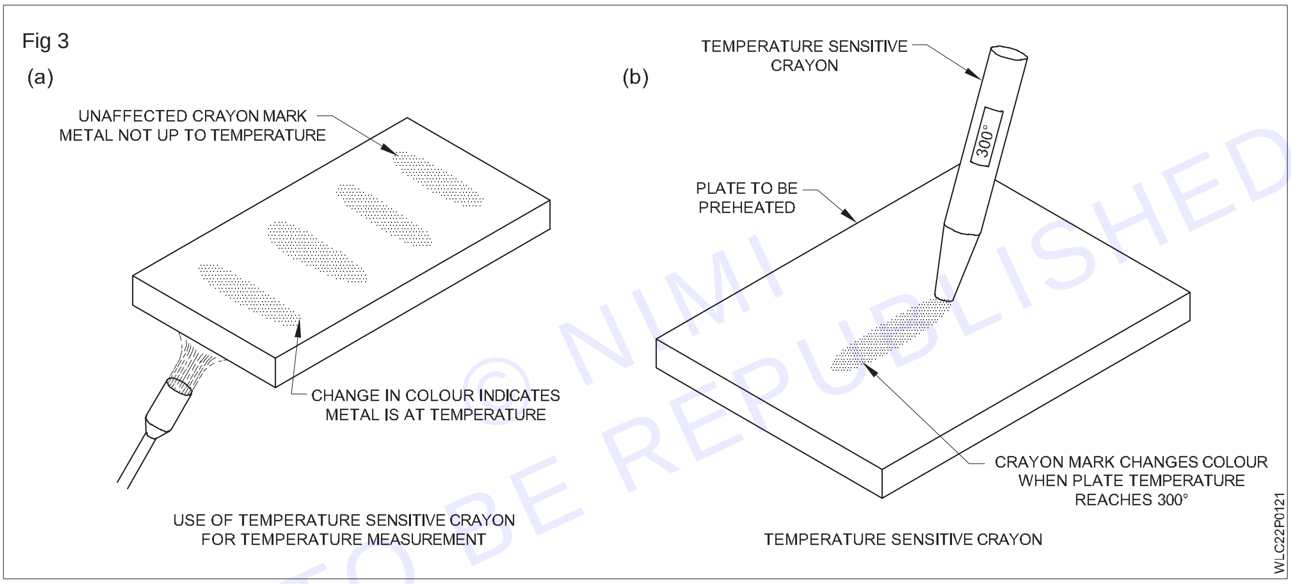


PREPARE EDGES BY FILING, GRINDING OR MACHINING AND SET PARALLEL 2.5mm APART

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 thermo chalk. (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 130-140 amps with DCEP. (Electrode +ve) Deposit root run with electrode angle of 80° to the line of weld with medium arc length. AVOID SHORT ARC.

Clean the root run by a wire brush. Deposit the second the 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.

Deposit the third run by using a 3.15 mm dia. Electrode with a slight weaving motion. Keep the electrode angle at 80° to the line of weld. 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.

The use of low hydrogen electrode and the preheating, post heating, peening and slow cooling are essential to avoid cracks in the cast iron joint.

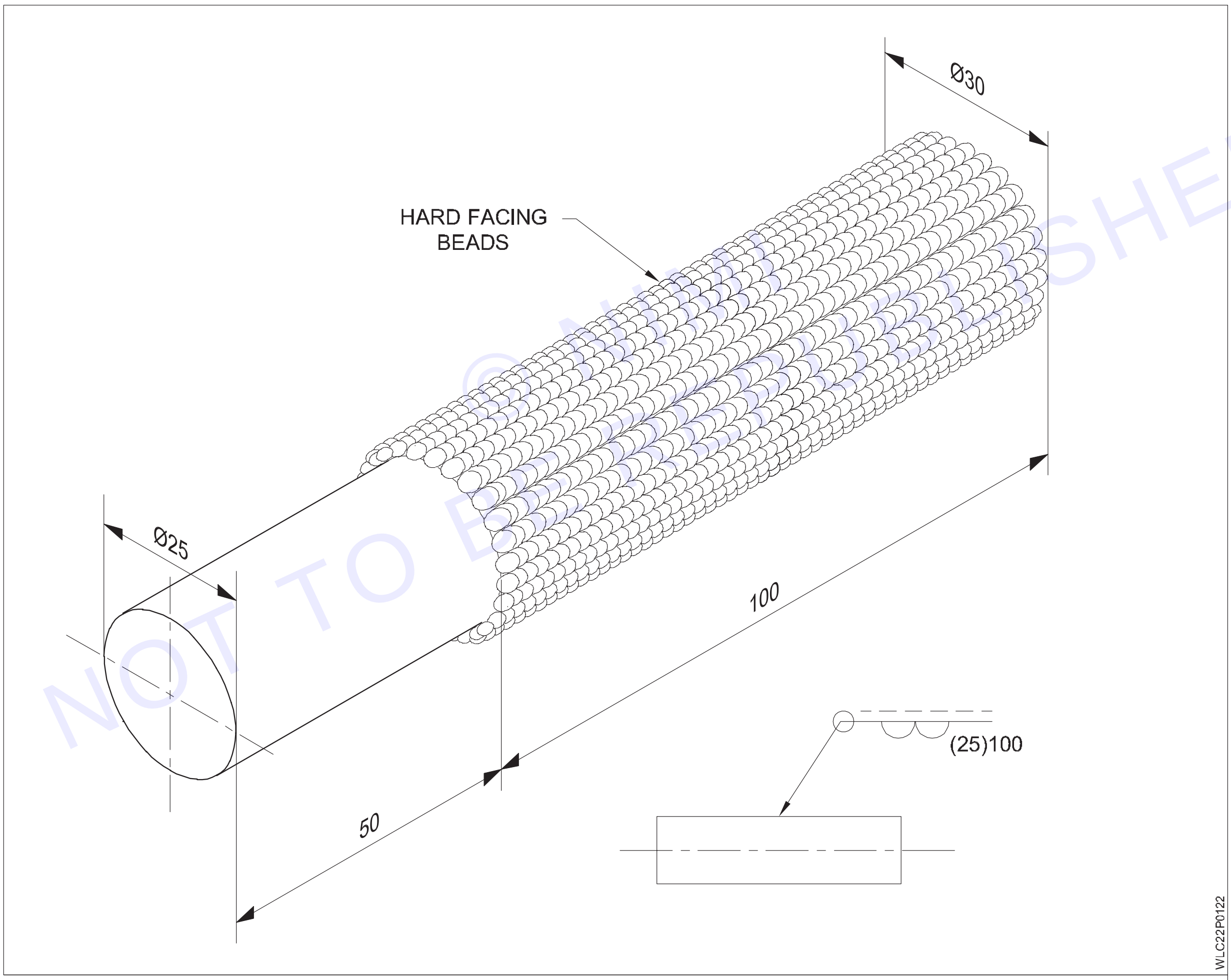
Inspect the welds: Inspect the welds for proper fusion, cracks and other surface defects.

EXERCISE 30 : Hard facing practice on MS round rod 25mm - by using hard facing

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.



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

Single 'V' butt joint on cast iron plate

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

- prepare and weld single 'V' butt joint on cast iron plate.

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)

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.

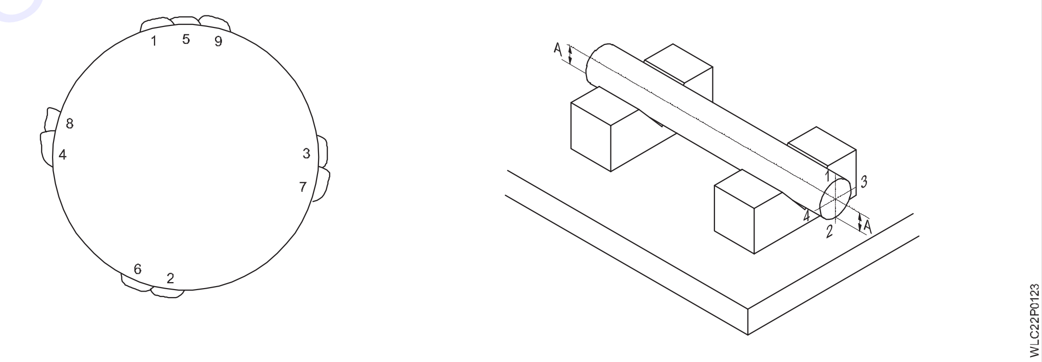
Welding: Deposit 100mm long beads along one side parallel to the axis.

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.

Fig 1



Complete the job by depositing symmetrically as shown in 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 2

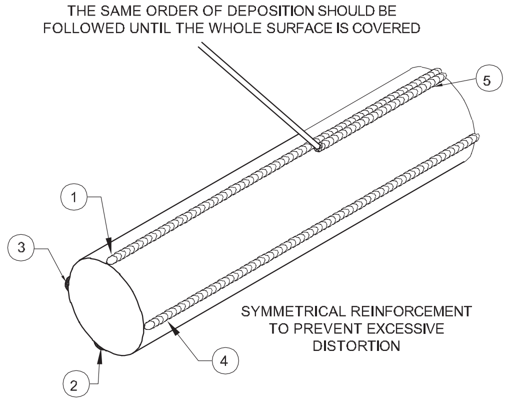
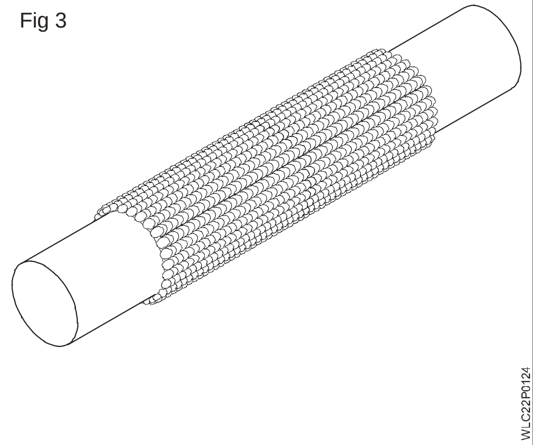


Fig 3



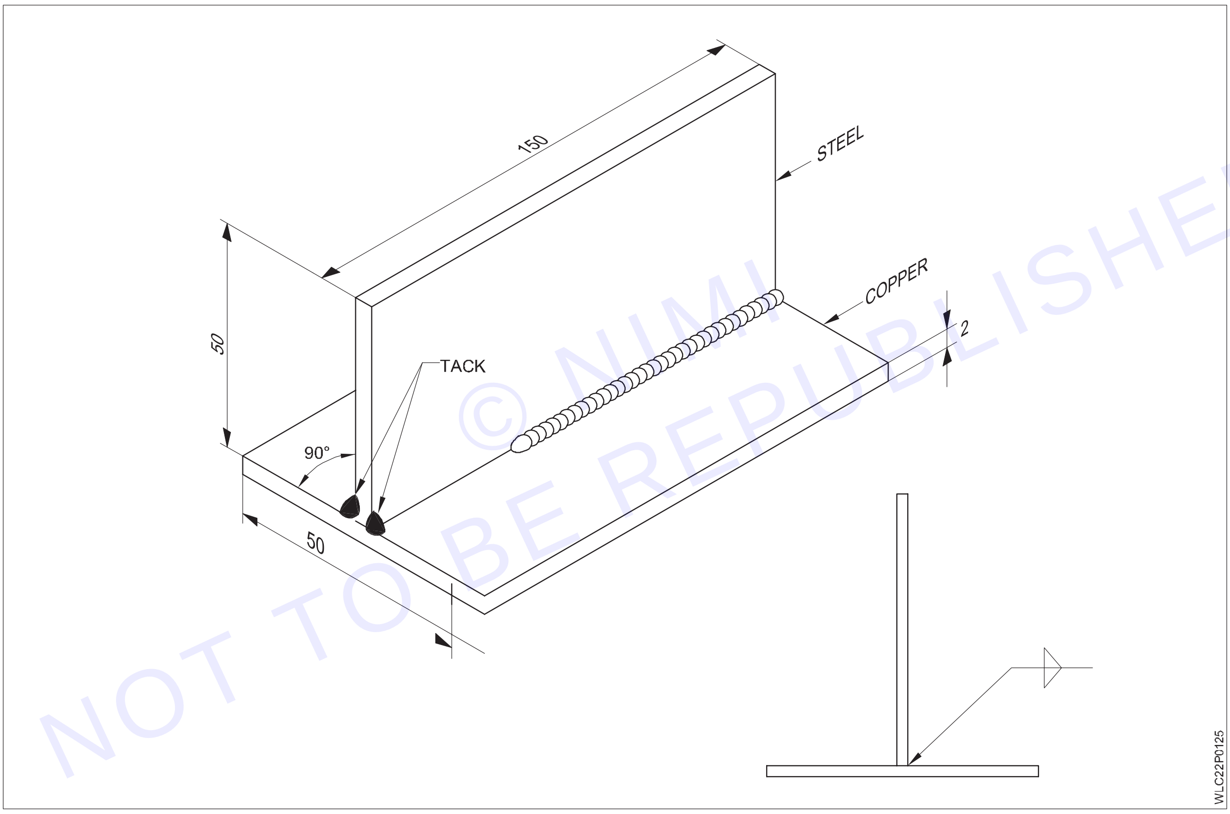
After treatment: Cooling of the job after hard facing should be slow and uniform.

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.

EXERCISE 31 : 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.



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 O2 and C2H2) slowly and let the working pressure.

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

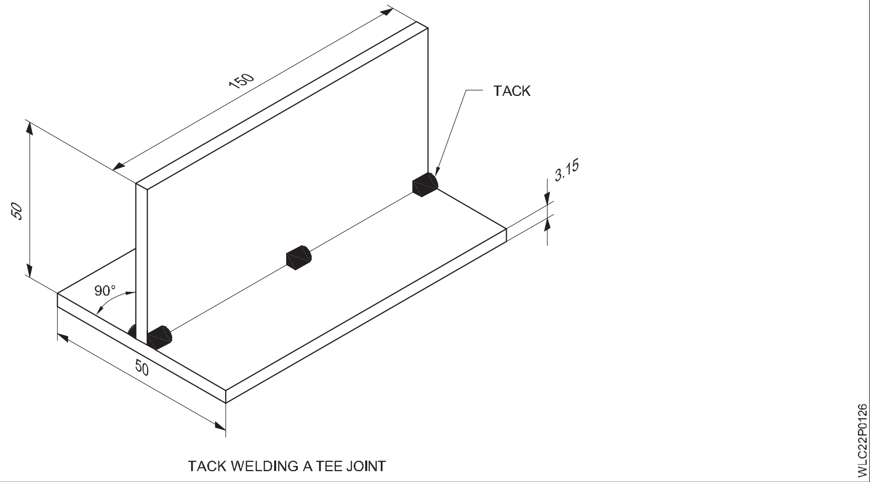
7 Select 1.6mm ø filler rod with 40 to 50% silver and 25- 15% zinc remaining copper.

8 Ignite the flame by spark lighter.

9 Set slightly oxidising flame.

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

Fig 1



TACK WELDING A TEE JOINT

11 Complete the 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 450 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.

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 2

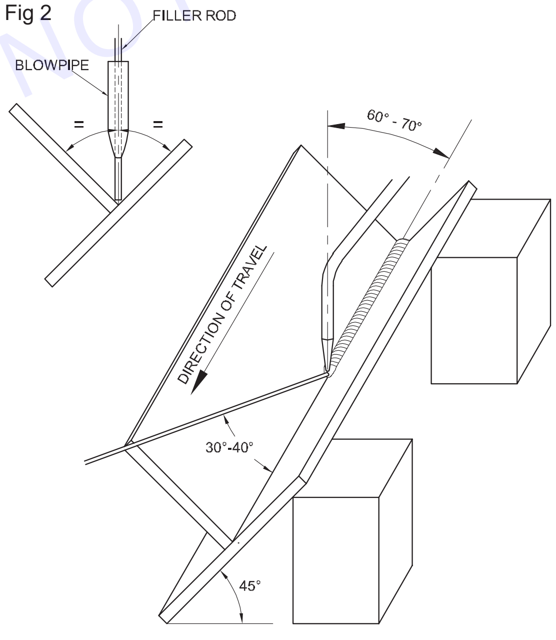
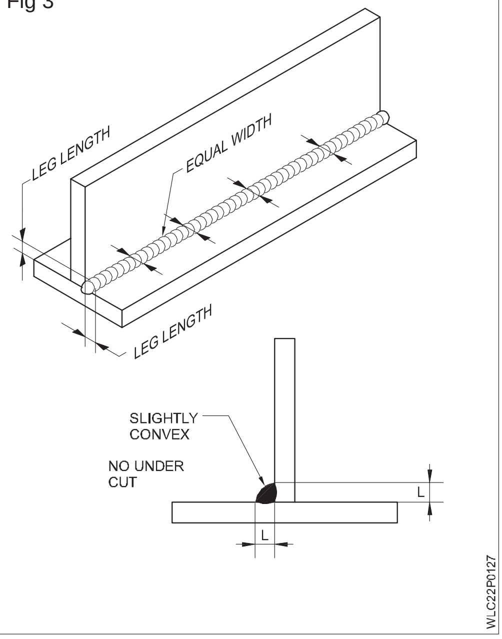


Fig 3

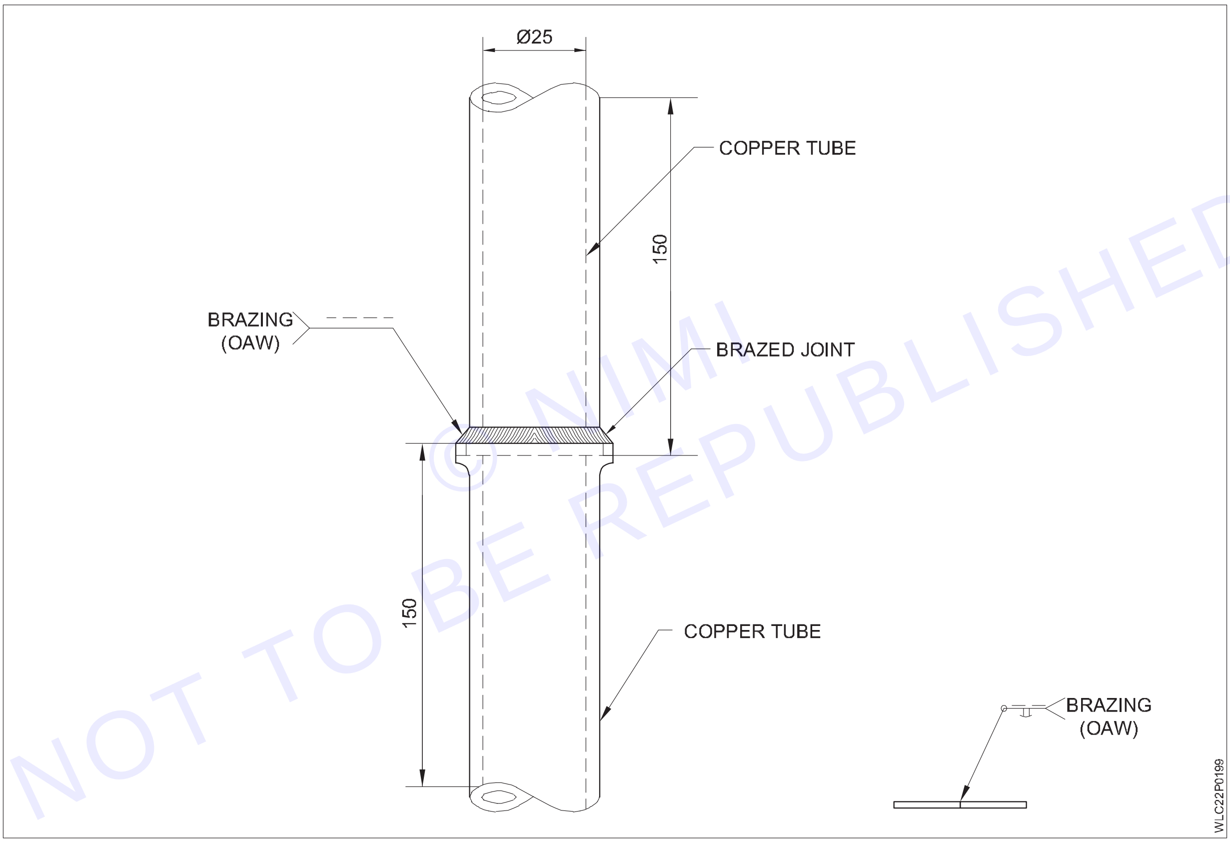


EXERCISE 32 : Silver brazing on copper tube to tube (OAW-04)

Objectives

At the end of this exercise you shall be able to

- prepare a bell mouth by heating the tip of the pipe
- select nozzle, filler rod, flux and flame for brazing
- tack the bell mouth joint and braze the joint using pipe welding technique
- clean the joint and inspect for surface defects.



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 1.6mme phosphorus bronze or 27-35% 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 be and tack at 3 places

8 Keep the tack welded pipes with their axes vertical

9 Surt Brazing at the mid point of two tack welds and and 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.

Skill Sequence

Silver brazing on copper tube to tube

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

- prepare the brazing of copper to copper tube

Brazing of copper to copper tube

Shen the and of copper tube to be bell-mouthed by seating. (Fig 1)

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

Fig 1

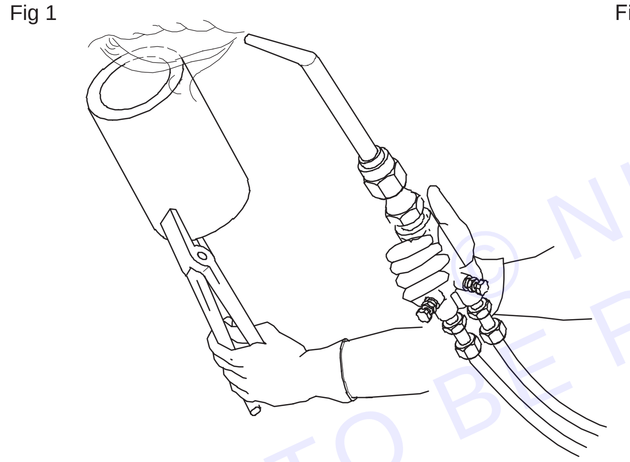
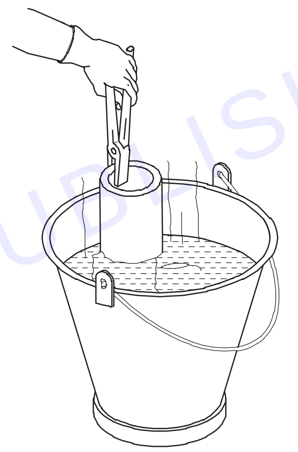


Fig 2



WLC22P0200

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

insert the mandrel and drive into the softened end of the be by hammering. (Fig 3)

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

Fig 3

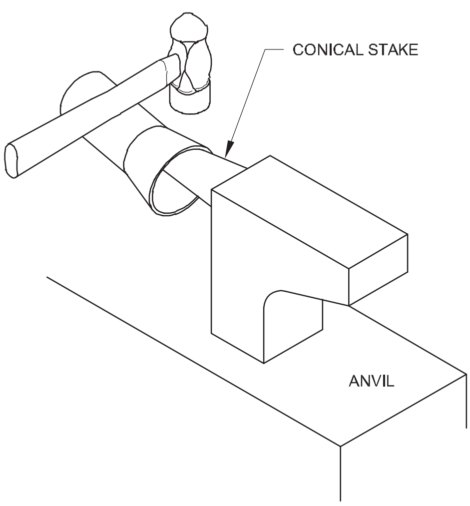
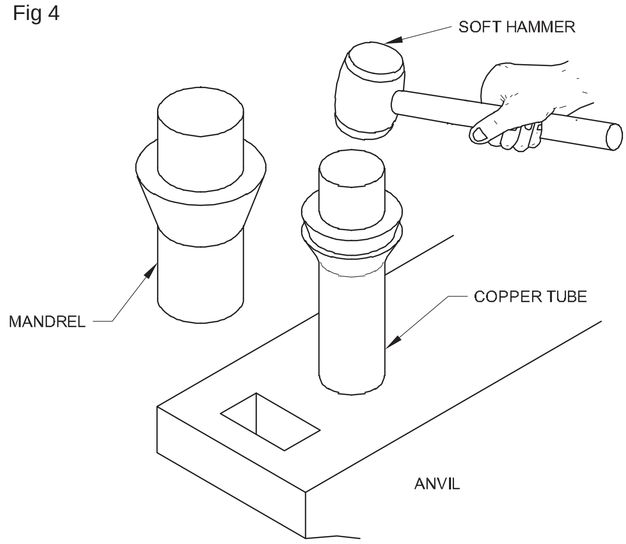


Fig 4



WLC22P0201

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

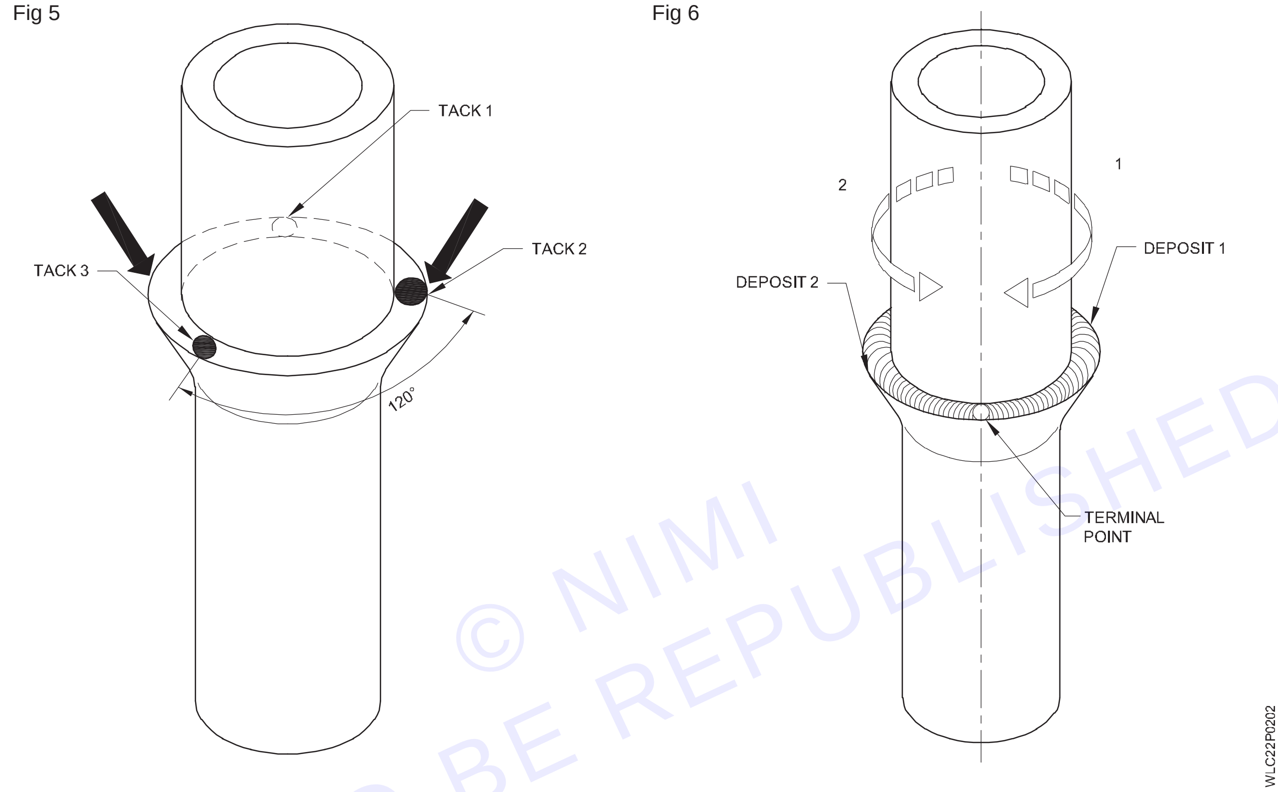
Keep the tack welded pipe assembly vertically and heat it until the colour of the tube starts changing.

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)

Fig 5

Fig 6



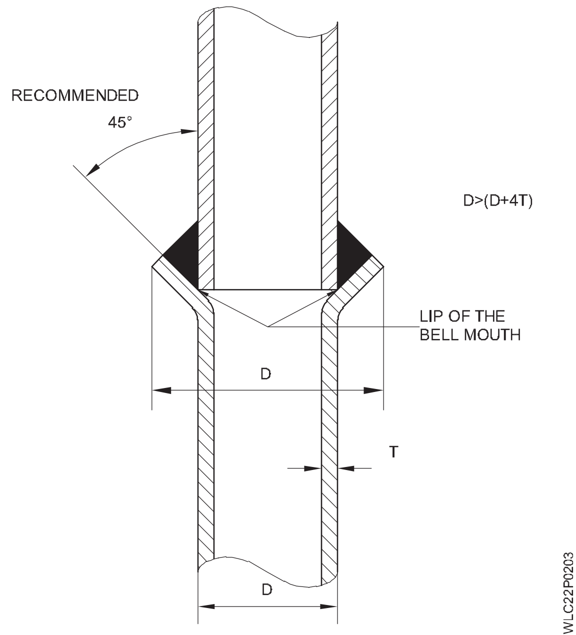
Clean the deposit.

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)

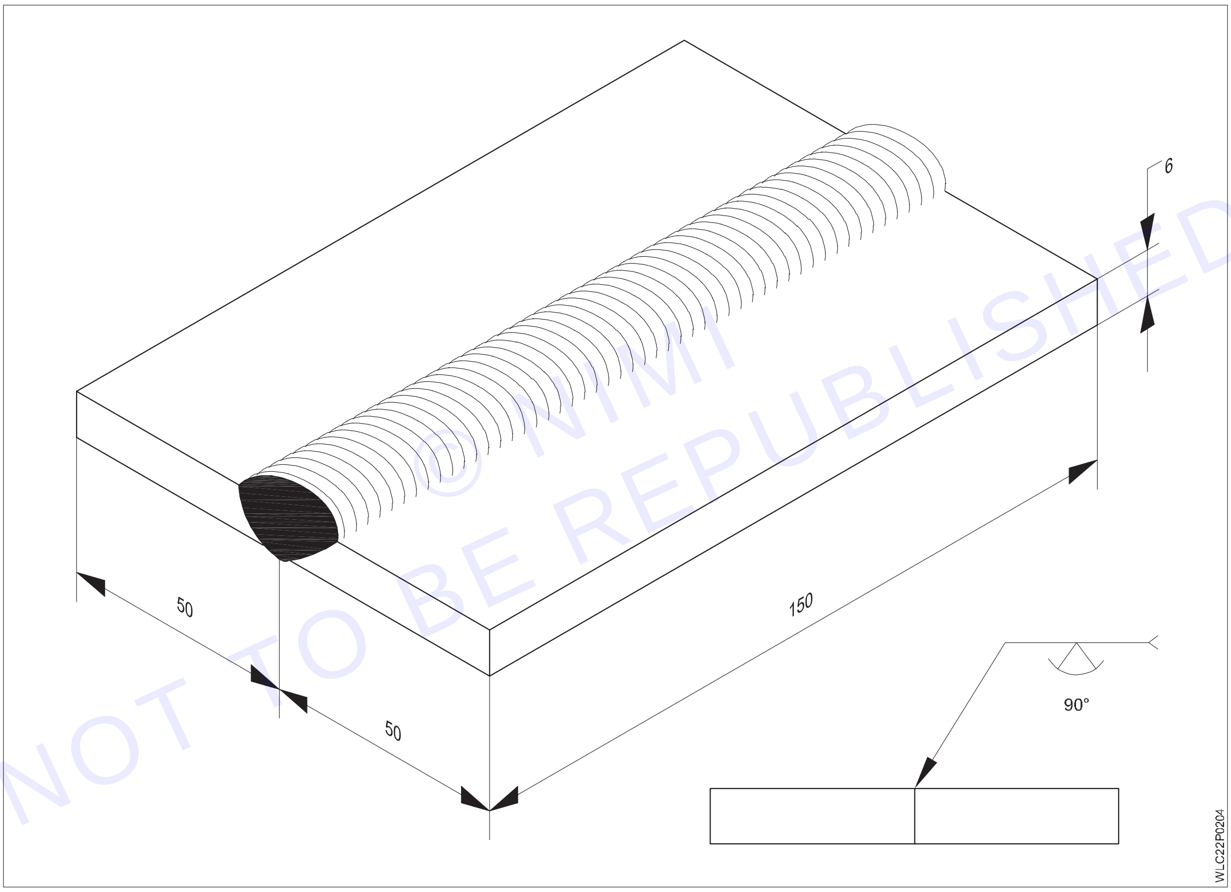
Fig 7



Bronze welding of single "V" butt joint on cast iron plate 6mm thick plate (OAW)

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 oxidized 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.



Job Sequence

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.

- Clean the surface of the work piece 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 V of included angle of 90°. 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 kg/cm2 pressure for both gases.
- Ensure all safety precautions before lighting the torch.
- Set a soft oxidizing 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° slope.
- Ensure wetting of weld faces by the filler metal before building up the bead.
- Heat the weld faces only to dull red color 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

Bronze welding of single ‘V’ butt joint on cast iron plate of 6mm thick

Objectives: At the end of this exercise you shall be able to
- prepare and bronze welding of single ‘V’ butt joint on cast iron plate of 6mm thick.

Set the job with 30° inclinations. Keep the angle of the filler rod at 30° to 40° and give a rubbing action to the filler rod on the V.

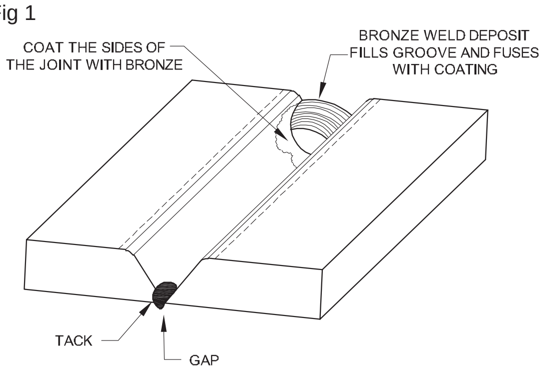
Maintain the angle of the blowpipe at 60° to 70° and give a circular motion to the blowpipe. (Fig 2)

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°C 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.

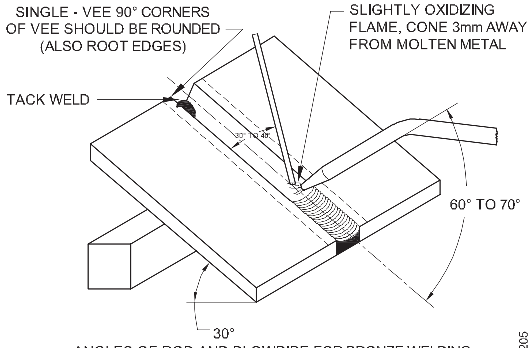
Then return to the starting point and add sufficient filler metal to produce a satisfactory weld. This method is repeated continuously until the root run is completed. Fig 2 Ensure root penetration by the filler metal and fusion between consecutive bronze filler metal deposits.

Fig 1



BRONZE WELDING CAST IRON
MAKING THE COATING AND DEPOSIT

Fig 2

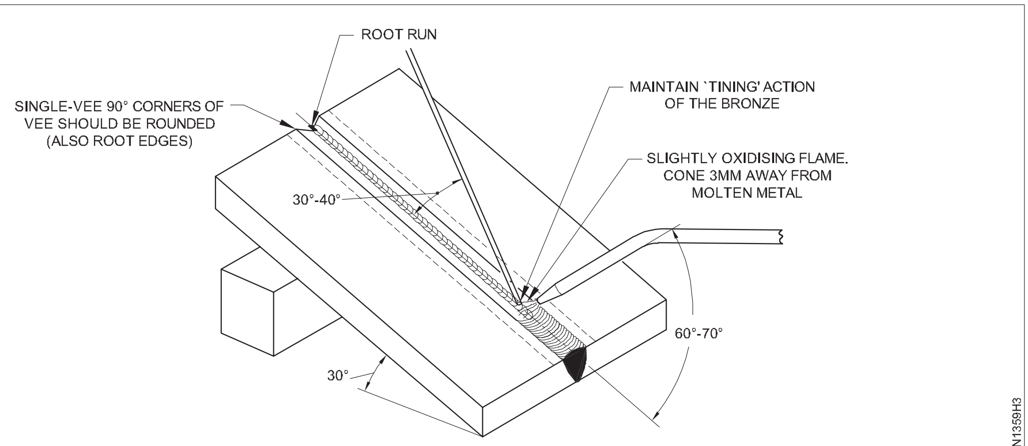


ANGLES OF ROD AND BLOWPIPE FOR BRONZE WELDING
BRONZE WELDING CAST IRON (ROOT RUN)

WLC22P0205

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

Fig 3



BRONZE WELDING CAST IRON DEPOSITING SECOND RUN

Set the job with 30° inclinations. Keep the angle of the filler rod at 30° to 40° and give a rubbing action to the filler rod on the V.

EXERCISE 44 : Fusion welding of cast iron butt weld, cast iron block 150 x 50 x 10mm- position flat

Objectives

At the end of this exercise you shall be able to

- prepare the edges of the plate to be welded
- set the job as per sketch
- select the nozzle and filler rod, set the gas pressures and flame for cast iron welding
- preheat the job by a blowpipe
- identify and use the flux
- manipulate the blowpipe and filler rod to get proper root penetration and fusion weld face
- take steps for post heating and slow cooling
- clean the joint and inspect for external weld defects.

Job Sequence

Maintain the angle of the blowpipe at 60° to 70° and give a circular motion to the blowpipe.

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°C 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.

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. Ensure root penetration by the filler metal and fusion between consecutive bronze filler metal deposits.

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

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.

- Clean the surfaces of the job piece thoroughly by a wire brush and remove the skin of the plate near the joining surfaces by grinding
- Bevel the edges for butt welding at an angle of 45” by grinding
- Deburr the edges by filing and round the comers.
- Set the job pieces with a 2-3 mm root gap and keep it on the fire-brick
- Select nozzle No. 10 and fix in the blowpipe
- Set the neutral flame and preheat the surfaces of both plates to a dull red colour
- Select 6mme super silicon cast iron filler rod and cast iron flux
- Dip the hot end of the filler rod into the powdered flux and keep it ready for use at the time of tacking and welding

Skill Sequence

- Tack-weld both ends of the job by applying cast iron flux and using a C.I. filler rod with 2 mm root gap.
- Keep the inner cone of the flame at about 3 to 4 mm away from the molten metal.
- Give a slight weaving motion to the blowpipe but not to the filler rod.
- Weld the root run ensuring penetration and fill the crater
- Clean the root run thoroughly
- Play the flame again on the job and preheat to dull red colour
- Deposit a second layer over the root run by manipulate in the blowpipe and filler rod in the same manner as done earlier.
- Stop at the finishing point at the left, fill the crater and complete the weld.
- Heat the job again and cover the job by ash or dry sand and allow it to cool slowly
- Clean the joint and inspect for weld defects like cracks, undercut, poor weld profile, weld reinforcement, blow-hole, porosity etc.

Check and ensure the correct size of the cast iron pieces.

Clean the surfaces of the job pieces thoroughly before welding.

Bevel the edges at an angle of 45” by grinding or by machining with about 2 mm root face as shown in the figure 2. Avoid feather edges and round off the sharp edges.

Keep the job pieces on the fire-brick and set a root gap of 2 mm to 3 mm.

Select nozzle No. 10 and adjust a perfect neutral flame. Preheat the job to a dull red colour (about 540°C) by playing the flame over the entire plate surfaces.

Use the temperature sticks to check the temperature.

Tack-weld at both ends of the joint by using a 6 mm super silicon cast iron rod with cast iron flux

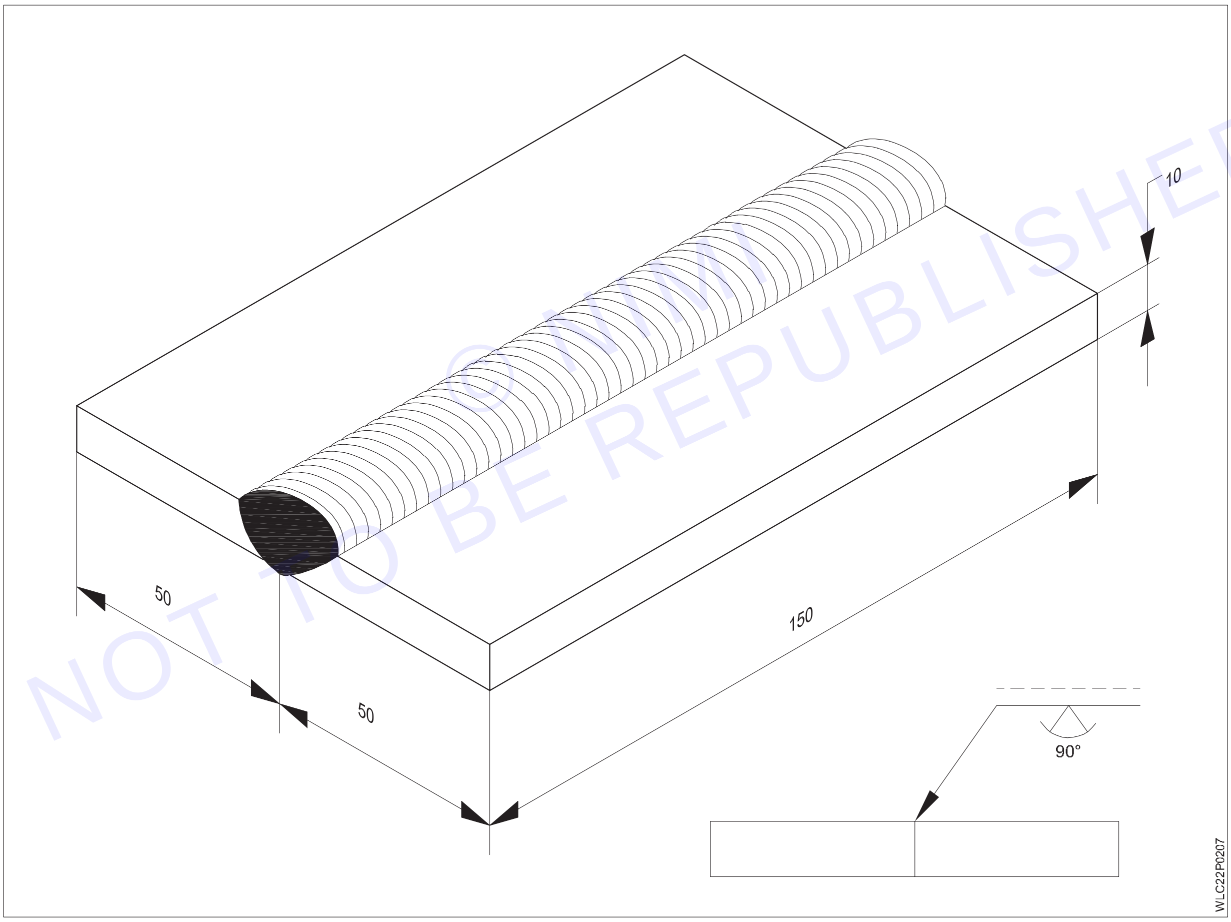
Weld the root run (first layer) by holding the blowpipe at an angle of 60° to 70° and the filler rod 40° to 50” in leftward technique (forehand technique).

EXERCISE 45 : Bronze welding of single "V" butt joint on cast iron plate 6mm thick plate (OAW)

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 oxidized 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.



Job Sequence

Dip the hot end of the rod into the powdered flux at intervals. Use only enough flux to remove the oxides as excessive use of flux causes blow holes and weakens the weld.

Check up the uniform penetration at the root.

Play the flame again on the job to maintain uniform preheat

Weld a second layer using the same techniques as were used for the first layer. Give a slight weaving motion to the blowpipe during welding.

Keep the inner cone of the flame at about 3 to 4 mm away from the molten metal. If it touches the molten metal, hard spots will occur.

Finish the weld by filling up the crater.

Post heat the job to dull red colour

Allow the job to cool slowly by covering the job with a heap of lime or ash or dry sand.

After cooling, clean the welded job with a wire brush and inspect for weld defects like porosity, cracks, slag inclu sions, undercut, lack of penetration etc.

- Clean the surface of the work piece 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 V of included angle of 90°. 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 kg/cm² pressure for both gases.

Skill Sequence

Bronze welding of single 'V' butt joint on cast iron plate of 6mm thick

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

- prepare and bronze welding of single 'V' butt joint on cast iron plate of 6mm thick.

Set the job with 30° inclinations. Keep the angle of the filler rod at 30° to 40° and give a rubbing action to the filler rod on the V.

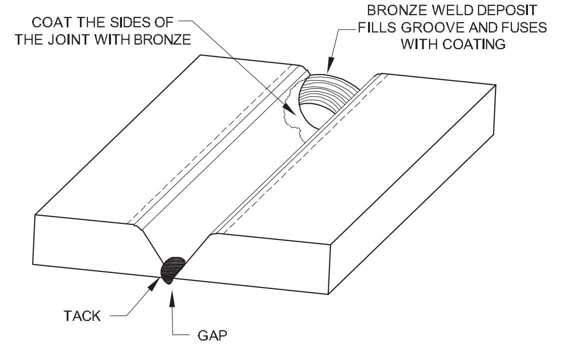
Maintain the angle of the blowpipe at 60° to 70° and give a circular motion to the blowpipe. (Fig 2)

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°C 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)

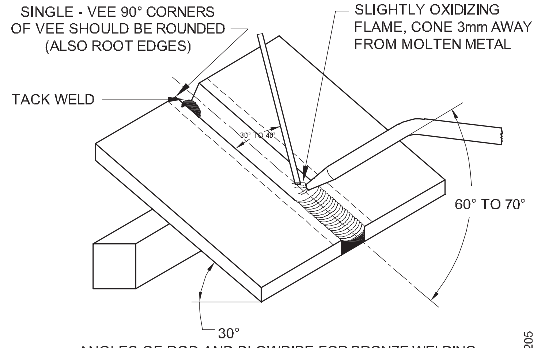
Then return to the starting point and add sufficient filler metal to produce a satisfactory weld. This method is repeated continuously until the root run is completed.(Fig 2) Ensure root penetration by the filler metal and fusion between consecutive bronze filler metal deposits.

Fig 1



BRONZE WELDING CAST IRON MAKING THE COATING AND DEPOSIT

Fig 2



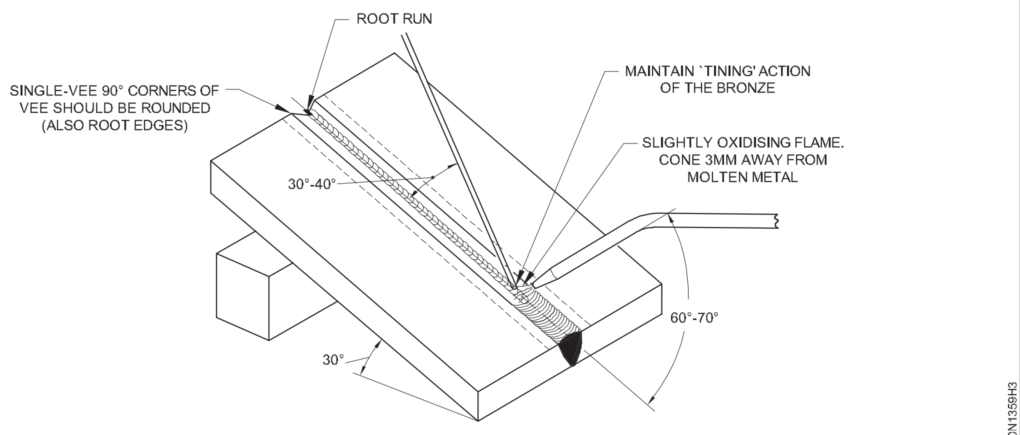
ANGLES OF ROD AND BLOWPIPE FOR BRONZE WELDING

BRONZE WELDING CAST IRON (ROOT RUN)

WLC22P0205

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

Fig 3



BRONZE WELDING CAST IRON DEPOSITING SECOND RUN

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

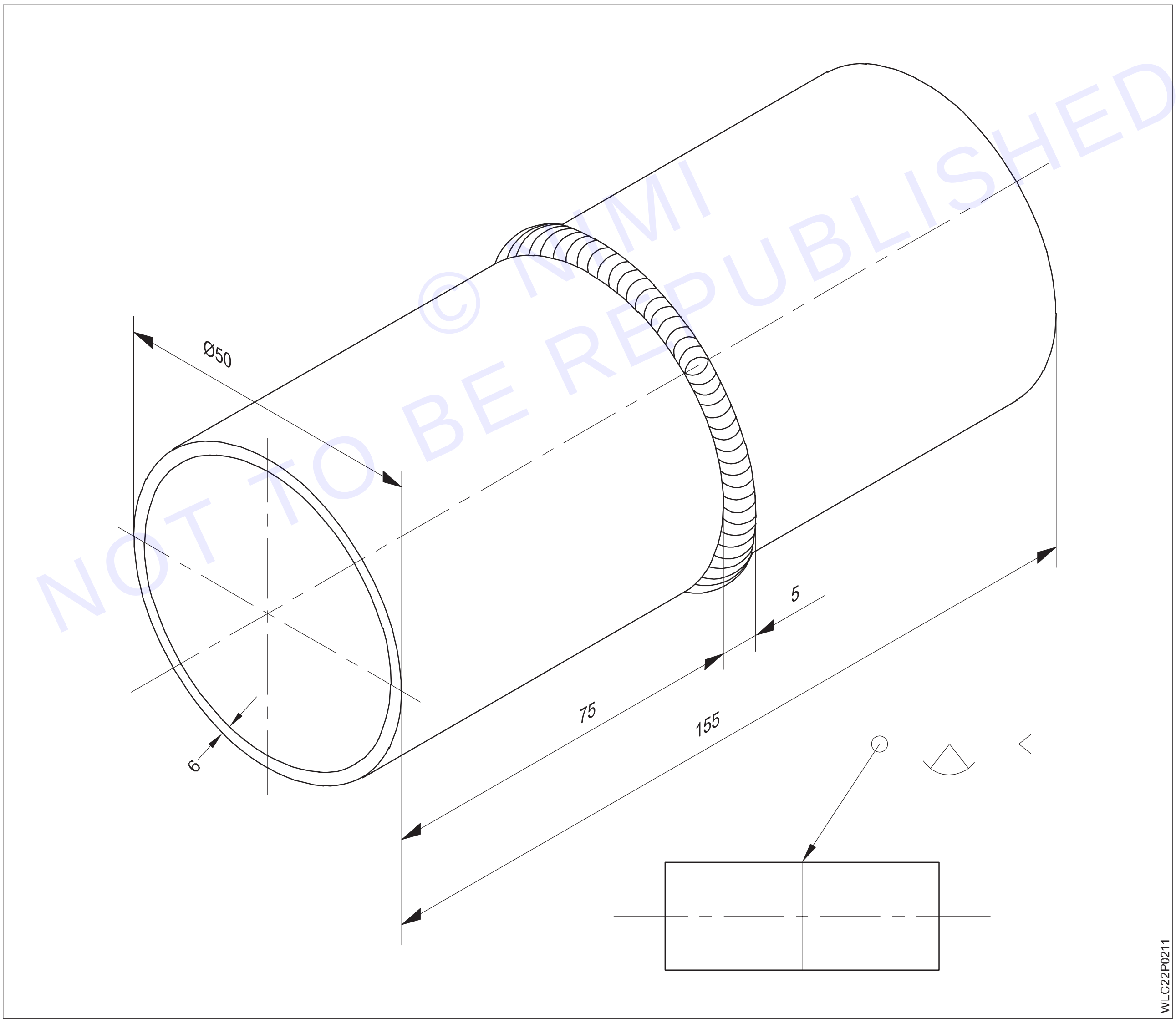
Inspect the joint for weld defects like porosity, incomplete penetration etc.

EXERCISE 33 : Pipe butt joint on MS pipe ø50mm wall thickness 6mm flat position (SMAW)

Objectives

At the end of this exercise you shall be able to

- cut and bevel the pipe for welding
- tack pipes for butt welding
- make root run by rotation method
- make filling run by rotation
- clean the job and inspect for defects.



Job Sequence

- Cut the pipes to the given size.
- File pipe ends to be at right angle to the pipe axis.
- Grind the edges to 30 to 35° bevel maintaining 1.5 to 1.75 mm root face.
- Remove the burrs and rust from the pipe ends.
- Arrange the 2 pipes to form as a butt joint.
- Use a fixture or V profile of an angle iron to align pipes.
- Switch ‘on’ the machine and select a 3.15 mm ø electrode for tacking and the root run and set an 100 amps current.
- Put 4 tacks at regular interval adjusting 2 mm root gap between the pipes using spacers.
- Ensure that each tack ends with a key hole.
- Check and ensure that the pipes are in line after tacking.
- Set 110 amp for a 3.15mmø electrode for root run.
- Deposit the root run in flat position by rotating the pipe.
- Welding using the keyhole technique ensures root penetration.
- Remove slag from the root thoroughly.
- Deposit the second and third run using a 3.15 mm ø electrodes i.e. the same as for the root run.
- Clean and inspect the joint.

Skill Sequence

Pipe joint on MS pipe ø50mm×6mm wall thick in overhead rolled position

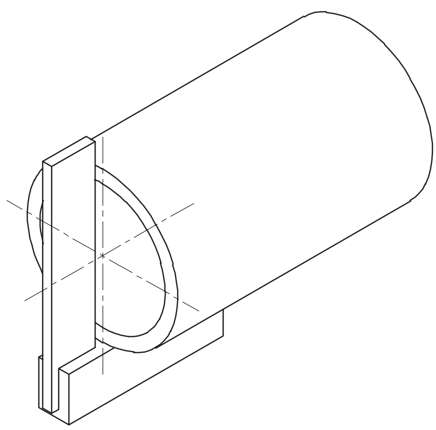
Objectives: At the end of this exercise you shall be able to

- prepare and weld pipe joint on MS pipe ø50mm×6mm wall thick in overhead rolled position.

Cut the pipes to the given size by a hacksaw.

Check the squares of the pipe end by using a try square. (Fig 1) and file the pipe end so that it is square with the pipe axis.

Fig 1



Prepare 30 to 35° bevel on one end of each pipe, leaving 1.5 to 1.75 mm root face by grinding or by filing. (Fig 2)

Switch 'on' the machine and adjust 110 amp current for 3.15 mm ø medium coated M.S. electrode (B.I.S code ER4211). Use DCEN polarity. (Fig 3)

Fig 2

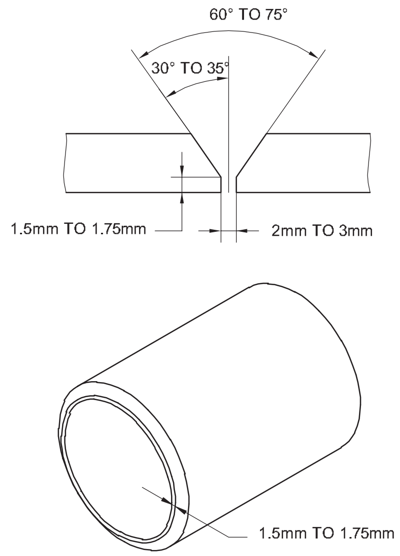
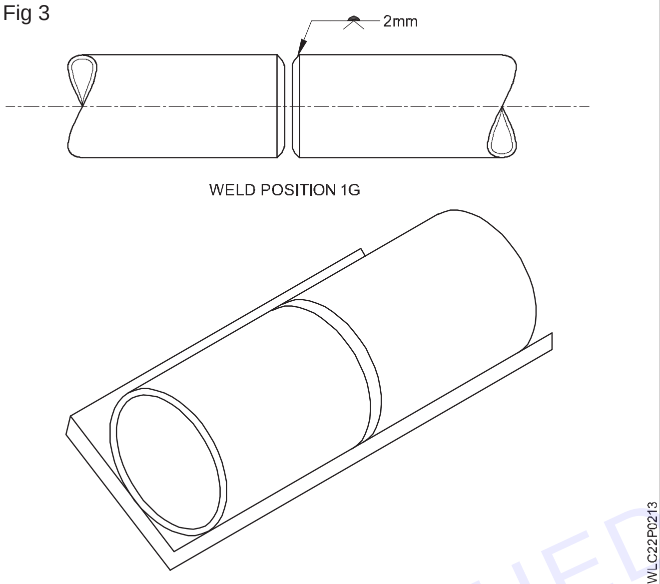


Fig 3



Before tacking, align the pipes on V profile of an angle iron with 2 mm root gap (Fig 3) and tack them as shown in Fig 4. Check the gap using a 2 mm rod.

Place the electrode in the holder, as in Fig 6. Use a 90 degree angle or a 45 degree angle away from the end of the holder.

Position yourself so that you are at a 90 degree angle to the pipe. Be sure you are comfortable.

Strike the arc, on the bevel, at approximately 3 o'clock. Carry it down to 4 o'clock. Pause long enough for the root faces to melt away and for a keyhole to form (Fig 5). Then reverse your electrode direction.

Fig 4

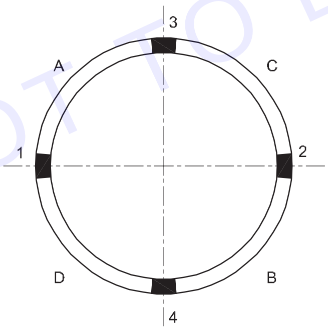
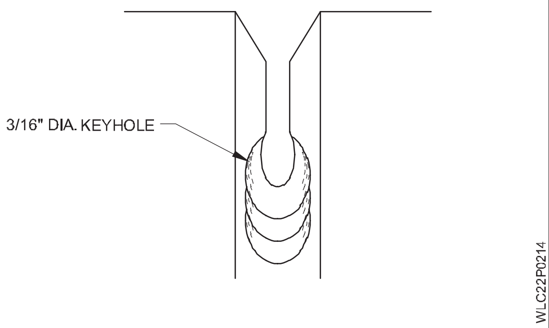


Fig 5



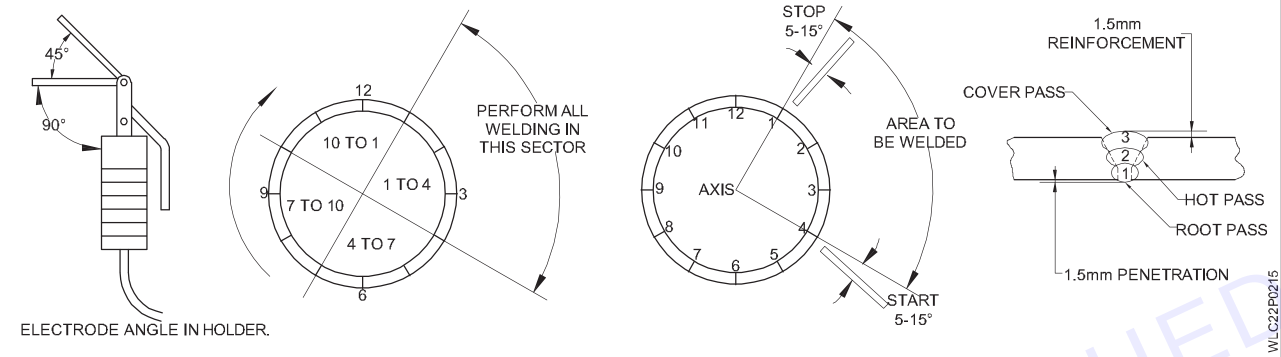
To run the first pass uphill, utilize the whipping method, as in welding plate in the vertical position. Use an electrode at a push angle of 5 to 15 degrees upward, as in Fig 6. Whip upward, taking care not to damage the surface of the pipe on either side of the V groove. Stop when you reach 1 o'clock, as shown in Fig 6. Clean thoroughly.

Turn the pipe toward you one quarter of a turn. Then proceed in the same manner until the first pass is completed. Be sure to start the next electrode slightly below the crater.

The second pass (hot pass) and third pass (cover pass) can be welded using 3.15mm electrode with either the triangle motion or the alternate weave, as in vertical plate welding. Take care to pause at the sides of the joint. Burn out any entrapped slag and fill in any undesirable undercut.

The sequence of beads is shown in Fig 6. Adhere to the maximum root and face reinforcement shown.

Fig 6



When you make the connection on completing the pass, be sure to overlap slightly. Break the arc by slowly drawing it away from the puddle.

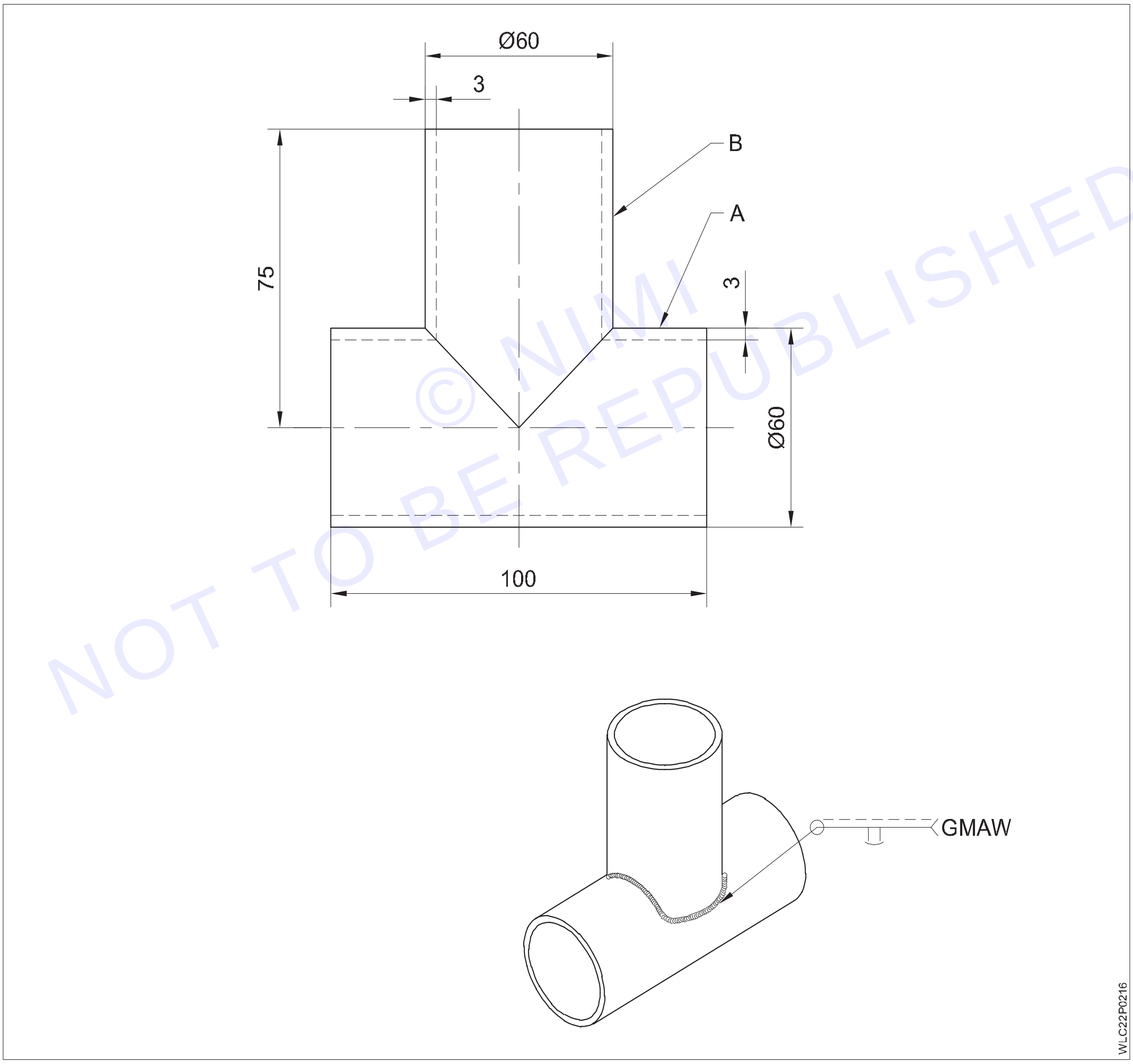
Clean and inspect the joint for surface defects

EXERCISE 34 : Pipe tee joint on M.S. pipe (flat position)

Objectives

At the end of this exercise you shall be able to

- prepare the development for pipe Tee fillet joint and cut the template
- mark the pipes by using a template
- cut the marked area by using an oxy-acetylene cutting blowpipe or a hand hacksaw
- set and tack weld the 90° pipe Tee joint with 1.6 mm root gap
- deposit the root and second runs of weld beads
- inspect the welds.



Job Sequence

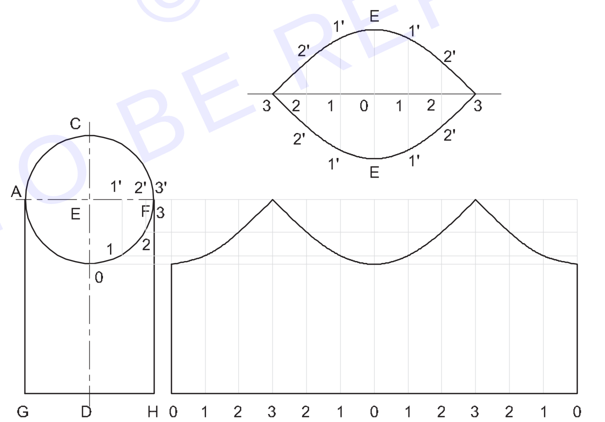
- Keep the template firmly on the vertical and horizontal pipes
- Mark the pipe by using a template.
- Mark and punch it.
- Cut the marked pipe with an oxy-acetylene cutting blowpipe or a hand hacksaw.
- Grind the cutting edges and set for tack-welding the pipe Tee joint with the 1.6 mm root gap.
- Round off the cutting edges.
- Set and tack weld the 90 pipe Tee joint with the 1.6 mm root gap and in correct alignment by using a try square.

Deposition of weld beads

- Divide the pipe welding into 4 segments and mark them 1, 2, 3, and 4.
- Start the root run with a 3.15 mm electrode and use 130 amps current. Complete the welding on side number 1. Then start on side number 2 and complete it. Then start on side number 3 and complete it. Finally start on side number 4 and complete. This will minimize distortion.
- Use the keyhole method and keep the welding electrode position slightly uphill so as to obtain uniform penetration.
- After cleaning the root run, weld the final run with a 3.15 mm o electrode and use 130 amps current.
- Complete the welds with slight sideways movement of the electrode and clean it with a chipping hammer and wire brush.

Inspect the welds

- Check root penetration, undercut, reinforcement height and bead appearance.



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

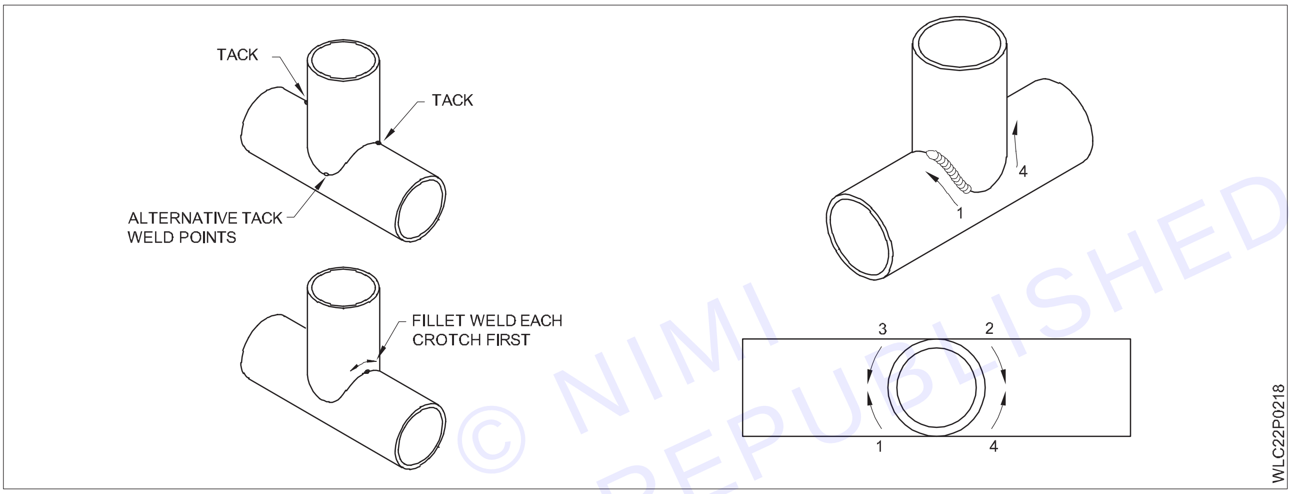
Skill Sequence

Tee joints on M.S pipe ϕ 60 mm OD x 3mm WT 1G position (ARC constant rolling) GMAW-17

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

- prepare and make pipe Tee joint.

For welding the joints in 1G position it is convenient to use the pipe lines. Maintain a uniform travel speed for the torch to get the required bead reinforcement, use the and spatter spray as and when the torch nozzle gets clogged with weld spatters.

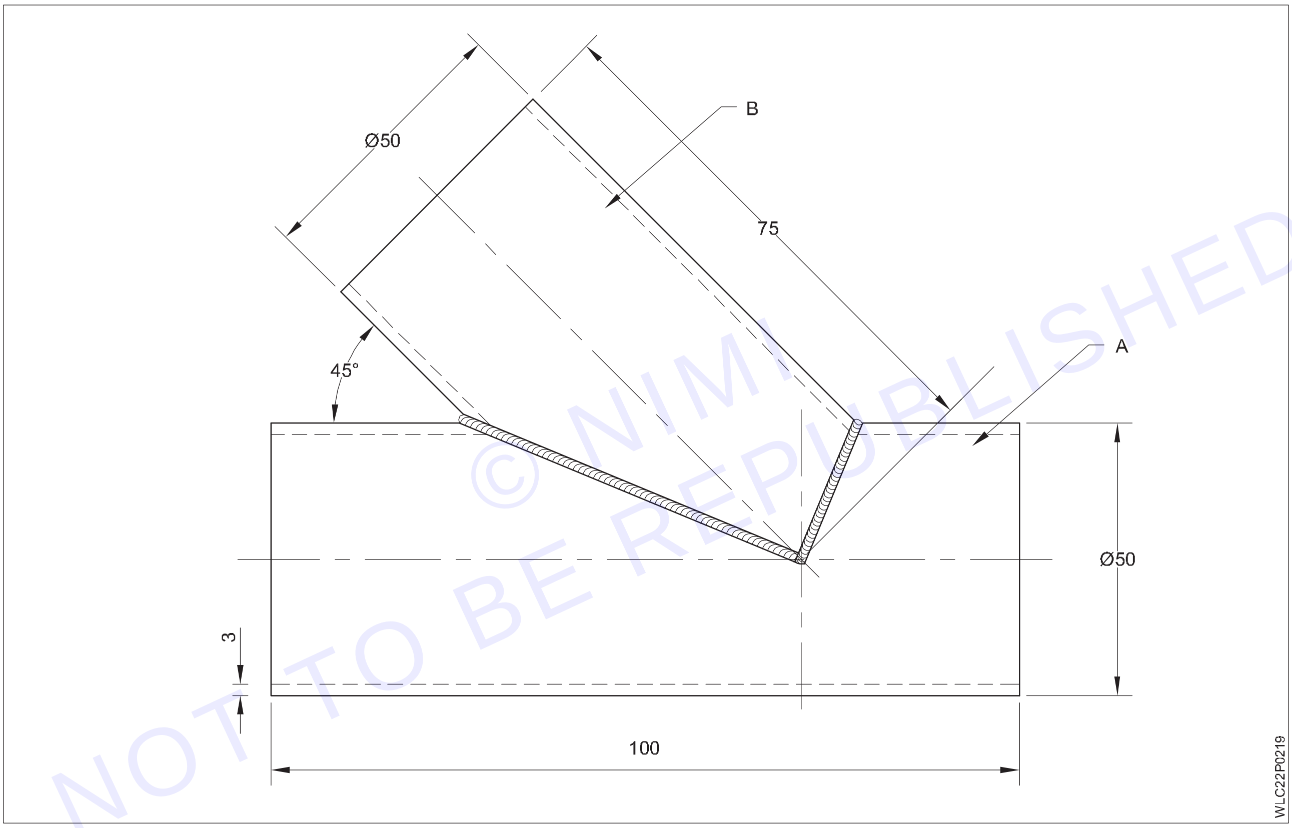


EXERCISE 35 : Pipe welding 45° angle joint on M.S. pipe ø 50mm and 3mm wall thickness (SMAW)

Objectives

At the end of this exercise you shall be able to

- prepare the development of pipe for 45° branch joint
- cut and prepare the pipes as per dimensions
- tack and complete the welding by manipulating the torch and filler rod.



Procedure for development of 45° branch pipe: Refer Fig 1. Draw a centre line AB.

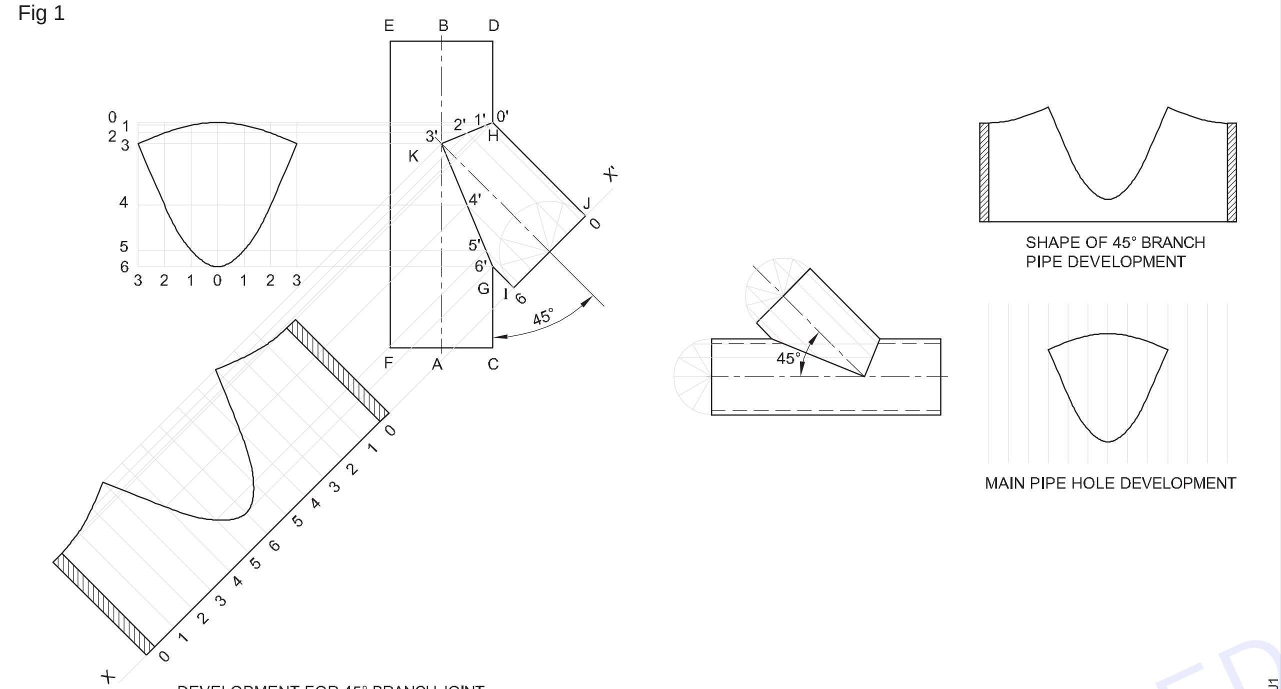
Mark the points C, D, E and F taking the radius and the length of the given pipe with the centre line AB as reference line.

On the line "CD" locate the position of the 45° branch pipe. This will be "G".

Draw a 45° angle at the point "G".

Choose a suitable height and mark the height of the branch pipe (GI) in 45° line from point G.

Fig 1



DEVELOPMENT FOR 45° BRANCH JOINT
"50 mm OD PIPES"

From I, draw a horizontal line on both sides (XX'). This XX' will be the base line for drawing development.

From I, plot the outside diameter of the branch pipe IJ on the line XX'.

Draw a centre line for the branch pipe. This line will cut the main pipe's centre line AB at K.

Join GK. Draw a perpendicular line to GK at K which meets CD at H. Join KH. Now IGKHJ will be the shape (outline) of the branch pipe.

Draw a semicircle equal to the branch pipe outside diameter.

Divide the semicircle into 6 equal parts as 0-1; 1-2; 2-3; 3- 4; 4-5 & 5-6.

Draw vertical lines from these points 1,2,3,4,5. Already there will be two vertical lines IG from the point 6 and JH from point 0. These vertical lines will cut the branch pipe lines 'GK' and 'KH' at points 6', 5', 4', 3', 2', 1' & 0'. Note that points 6' and gas well as points 0' and H are the same points. In the base line XX' plot 13 points equal to the distance of '0-1' as 0, 1,2,3,4,5,6,5,4,3,2,1,0.

Draw vertical lines to XX' from these 13 points.

Draw horizontal lines parallel to XX' from points 6', 5', 4', 3', 2', 1', 0'. These 7 horizontal lines will cut the 13 verticals lines from the base line at 13 points.

Join the 13 cutting points with a regular smooth curve.

Now the required development for the 45° branch pipe will be ready. Give allowance of 3 to 5mm at the edges of the development. (Fig 1)

For developing a hole in the base pipe: Above the main pipe, draw 7 lines parallel to AB namely 3,2,1,0,1,2,3 equal to the distance of 0-1 on the semi-circle.

Draw vertical lines from 0', 1', 2', 3', 4', 5', 6'. These vertical lines will intercept the 7 horizontal lines. Join the intercepting points with a smooth curve. The required development for hole is now ready.

Job Sequence

- Ensure the correct size of pipes are used.
- Prepare development for 45° branch on a drawing sheet.
- Cut and paste it on the pipes.
- Punch marks the profile of the development on both pipes. Cut the branch pipe along the punch marked profile and file it. Cut the profile marked on the main pipe by gas cutting and file it.
- Deburr the gas cut edges and file the edges.
- Clean the surface of the pipe to remove any oxide and other contaminants.
- Set and align the branch pipe with the main pipe at an angle of 45°.
- Select no. 7 nozzle, ø3mm CCMS rod and use neutral flame with 0.15 kg/cm² pressure for both gases.
- Follow necessary safety precautions.
- Tack-weld the joint at 4 places with 45° intervals and with a 2 mm root gap to ensure root penetration.
- Ensure the tacked pipe “Branch” joint is positioned properly to make it convenient to manipulate the blow pipe and filler rod without any obstruction.
- Weld the joint by manipulating the blow pipe and filler rod without rotation of the pipe.
- Maintain keyhole throughout the welding and give side to side motion to the blow pipe to ensure good root penetration and fusion of both the edges of the joint.
- Complete the weld in 4 sectors 1, 2, 3 and 4 along the curved joint using leftward technique.
- Take care to properly fuse the crater of the previous sector welded with the starting of the new sector.

Note: Avoid excess penetration.

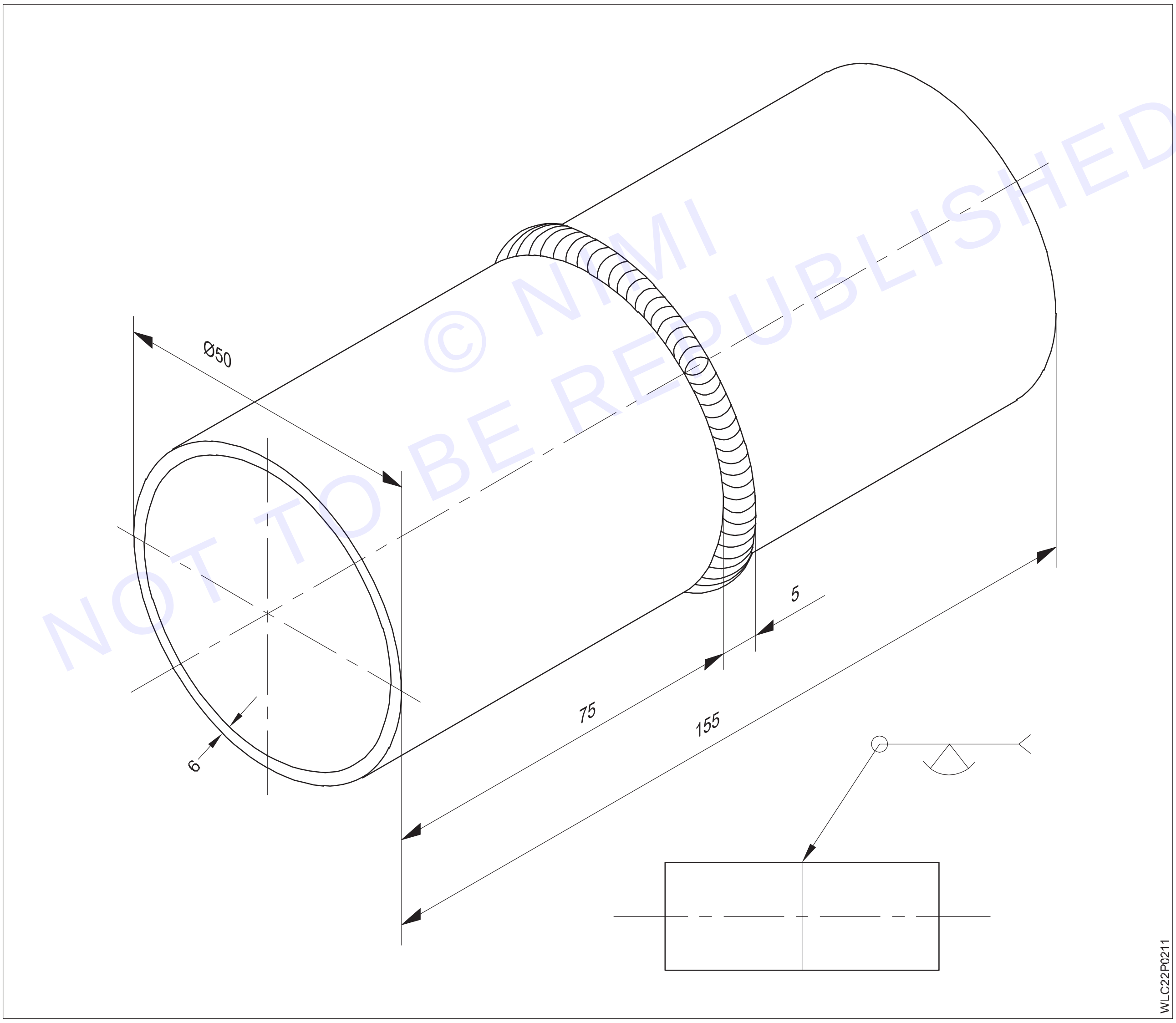
- Clean the weld and inspect the weldment for defects.

EXERCISE 36 : Pipe butt joint on MS pipe ø 50mm wall thickness 6mm (1G Rolled) position (SMAW-23)

Objectives

At the end of this exercise you shall be able to
- cut and bevel the pipe as per drawing
- tack weld for butt welding
- make root 2nd and 3rd weaving run by rotation method
- clean the job and inspect for defects.

Job Sequence



- Cut the pipes to the given size
- File pipe ends to be at right angle to the pipe axis.
- Grind the edges to 30 to 35° bevel maintaining 1.5 to 2.9mm root face.
- Remove the burrs and rust from the pipe ends

- Arrange the 2 pipes to form as a butt joint.
- Use a fixture or V profile of an angle iron to align pipes

Wear protective clothing

- Switch 'on' the machine and select a 3.15 mm electrode for tacking and the root run and set a 110 amps current
- Put 4 tacks at regular intervals adjusting 3 mm root gap between the pipes using spacers.
- Ensure that each tack ends with a key hole
- Check and ensure that the pipes are in line after tacking
- Set 110 amp for a 3 15mmø electrode for root run.
- Deposit the root run in flat position by without rotating the pipe
- Welding using the keyhole technique ensures root penetration.
- Remove slag from the root thoroughly.
- Deposit the second and third run using a 3.15 mm a electrodes ie the same as for the root run.
- Clean and inspect the joint

Skill Sequence

Pipe welding butt joint on MS pipe ø50mm and 5mm wall thickness in 1G position

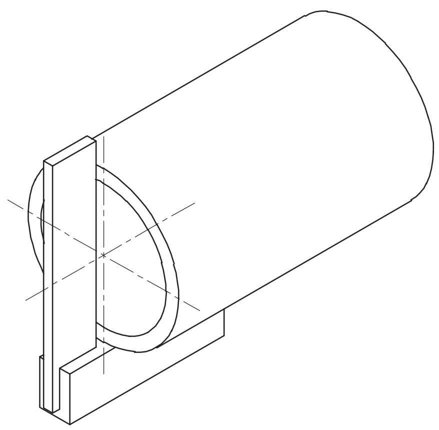
Objectives: At the end of this exercise you shall be able to

- prepare and weld butt joint on MS pipe in (IG) position.

Cut the pipes to the given size by a hacksaw.

Check the squares of the pipe end by using a try square (Fig 1) and file the pipe end so that it is square with the pipe axis

Fig 1



Prepare 30 to 35 bevel on one end of each pipe, leaving 1.5 to 1.75 mm root face by grinding or by filing (Fig 2)

Switch 'on' the machine and adjust 110amp current for 3.15 mm medium coated M.S. electrode (B.I.S code ER4211). Use DCEN polarity

Before tacking, align the pipes on V profile of an angle iron with 2 mm root gap (Fig 3) and tack them as shown in Fig 4. Check the gap using a 2 mm rod.

Fig 2

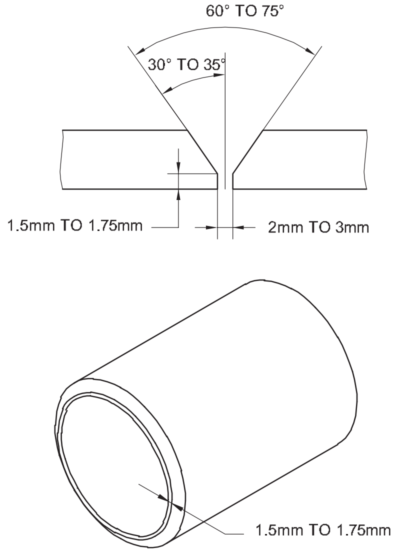
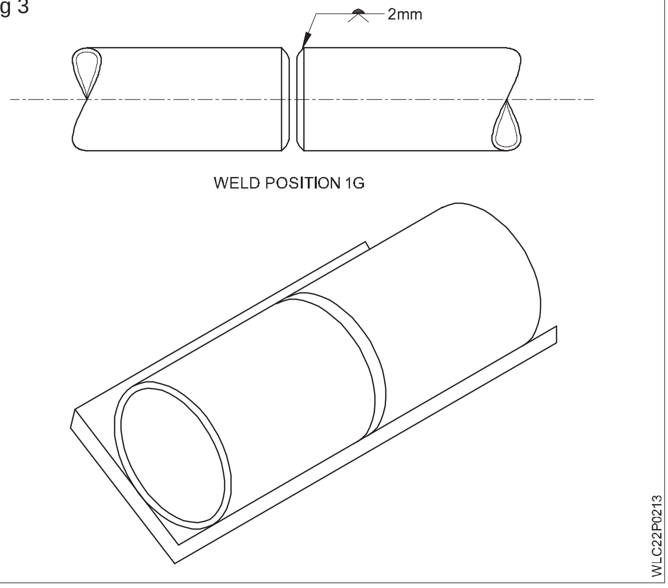


Fig 3



Place the electrode in the holder as in Fig 6. Use a 90degree angle or a 45degree angle away from the end of the holder.

Position yourself so that you are at a 90degree angle to the pipe. Be sure you are comfortable.

Strike the arc, on the bevel, at approximately 3 o'clock. Carry it down to 4 o'clock Pause long enough for the root faces to melt away and for a keyhole to form Fig 5. Then reverse your electrode direction.

Fig 4

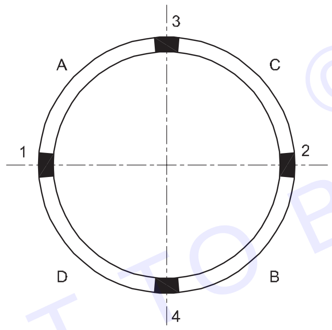
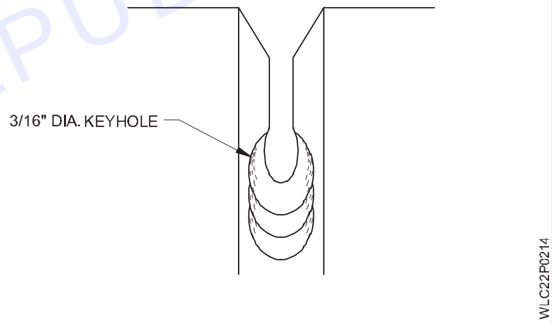
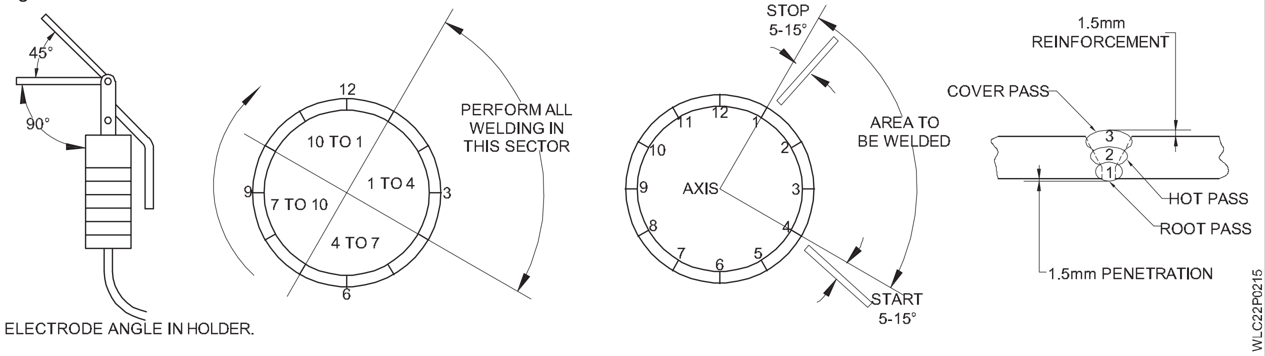


Fig 5



To run the first pass uphill, utilize the whipping method, as in welding plate in the vertical position. Use an electrode at a push angle of 5 to 15 degrees upward, as in Fig 6. Whip upward, taking care not to damage the surface of the pipe on either side of the V groove. Stop when you reach 1 o'clock, as shown in Fig 6. Clean thoroughly

Fig 6



Turn the pipe toward you one quarter of a tum. Then proceed in the same manner until the first pass is completed. Be sure to start the next electrode slightly below the crater.

The second pass (hot pass) and third pass (cover pass) can be welded using 3.15mm electrode with either the triangle motion or the alternate weave, as in vertical plate welding Take care to pause at the sides of the joint. Burn out any entrapped slag and fill in any undesirable under- cut

The sequence of beads is shown in Fig 6. Adhere to the maximum root and face reinforcement shown

When you make the connection on completing the pass, be sure to overlap slightly. Break the arc by slowly drawing it away from the puddle.

Clean and inspect the joint for surface defects

To run the first pass uphill, utilize the whipping method, as in welding plate in the vertical position. Use an electrode at a push angle of 5 to 15 degrees upward, as in Fig 6. Whip upward, taking care not to darnage the surface of the pipe on either side of the V groove. Stop when you reach 1 o'clock, as shown in Fig 6.

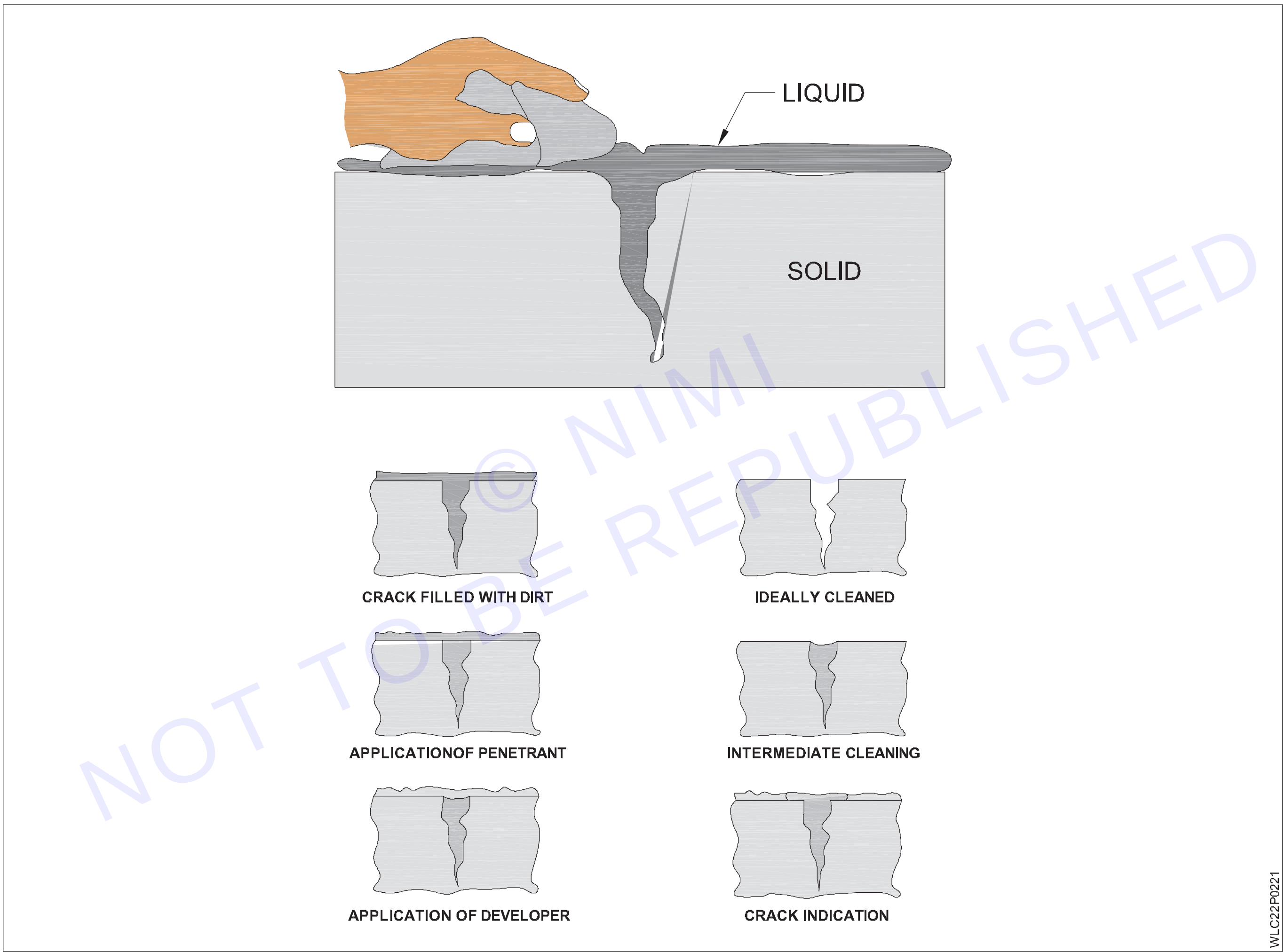
EXERCISE 37 : Dye penetrant test

Objectives

At the end of this exercise you shall be able to

- inspect welded component for surface defect using
- state the penetration test
- identify the defect.

Job Sequence



- Clean the surface of the test piece spray the colored dye on the surface
- Allow the dye to soak for about 2 to 3 minutes wash the surface with cleaner
- Dry the surface using a test cloth
- Spray the liquid developer on the surface
- Observe the colored due coming out in the shape of the defect in to the white liquid developer analyses the defect

Methods of non destructive tests

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

- explain the non-destructive testing methods
- explain the uses of the common non-destructive methods
- explain the uses of special non-destructive testing.

Non-destructive testing methods are classified as common testing and special testing methods.

Common non-destructive testing

– Visual inspection

– Leak or pressure test

– Stethoscopic test (Sound)

Special non-destructive tests

– Magnetic particle test

– Liquid penetrant test

– Radiography (X-ray) test

– Gamma ray test

– Ultrasonic test.

Liquid penetrant test: This test is based on the principle that coloured liquid dyes and fluorescent liquid penetrate into the cracks and are used to check for surface defects in metals, plastics, ceramics and glass. A solution of the coloured dye is sprayed on the clean welded joint and allowed to soak. Then the dye is washed off using a cleaner, and the surface dried with soft cloth.

A liquid developer (white in colour) is then sprayed on the weld. The coloured dye comes out in the shape of surface defects into the white developer coating. The defect can be seen in normal light with naked eyes.

EXERCISE 38 : Pipe butt weld butt joint on MS pipe 25mm o.d. 3mm w.t. position 2G vertical arc welding

Objectives

At the end of this exercise you shall be able to

- cut bevel the pipe for welding
- tack pipes for butt welding
- make root run by rotation method
- make filling run by rotation
- clean the job and inspect for defects.

Job Sequence

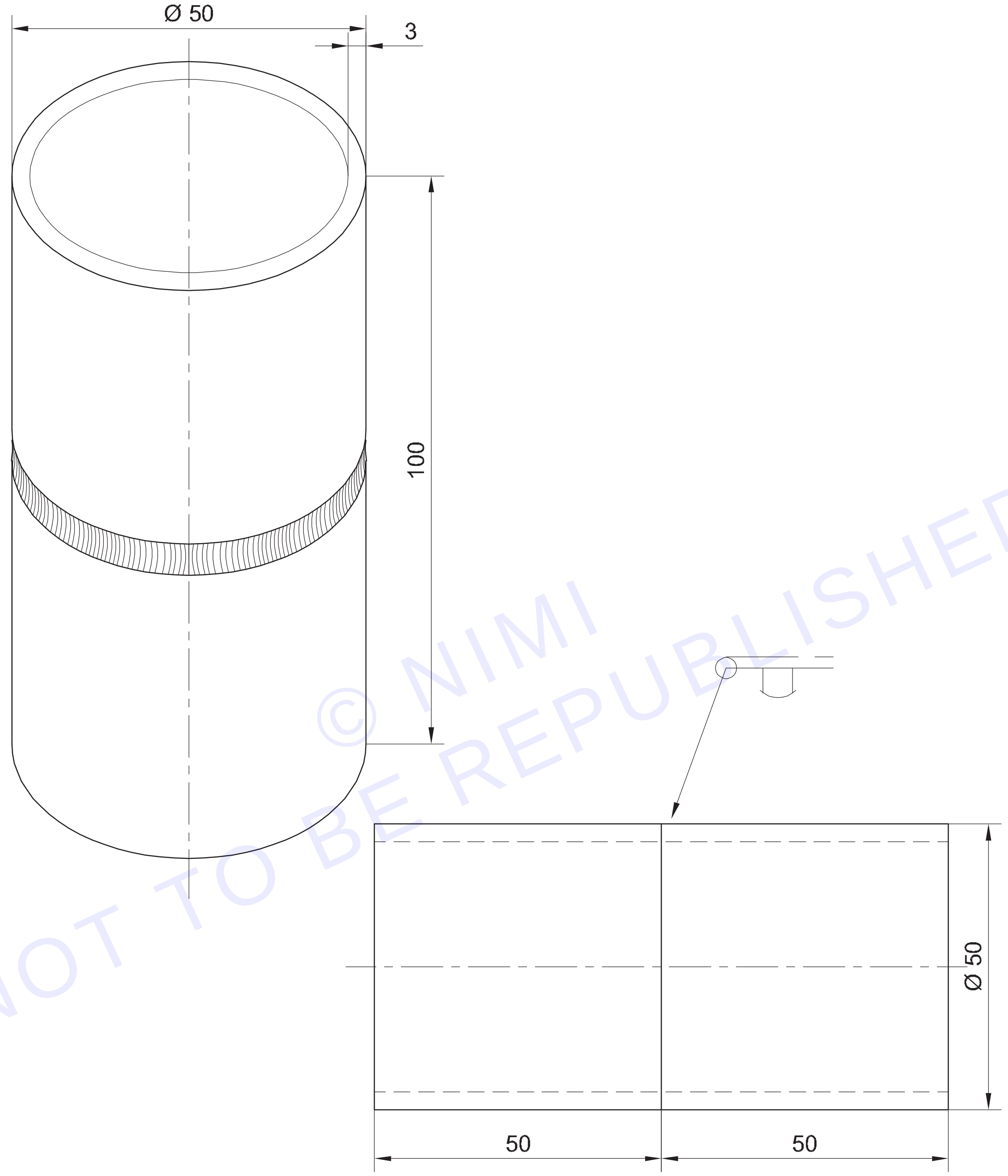
- Cut the pipes to the given size.
- File pipe ends to be at right angle to the pipe axis.
- Grind the edges to 30° to 35" bevel maintaining 1.5 to 1.75mm root face.
- Remove the burrs and rust from the pipe ends.
- Check the perpendicularly of the work piece using the try square.
- Arrange the 2 pipes to form as a butt joint.
- Use a fixture or V profile of an angle iron to align pipes in 6G position.

Note: Wear protective clothing (safety apparels)

- Switch on the machine and select a 3.15mm dia electrode for tacking and the root run and set 100 amps current.
- Put4 tacks at regular intervals adjusting 2mm root gap between the pipes using spacers.
- Ensure that each tack ends with a keyhole.
- Check and ensure that the pipes are in line after tacking.
- Set 110amps for a 3.15mm dia electrode for root run.
- Deposit the root run in flat position by rotating the pipe.
- Welding using the keyhole technique ensures root penetration.
- Remove slag from the root thoroughly.
- Deposit the second and third run using 3.15mm dia electrodes i.e. the same ad for the root run.
- Clean and inspect the joint.

  a To ensure uniform and correct reinforcement

  b To ensure that the weld face is free from porosity, slag inclusion, unfilled crater, overlap and edge of plate melted off/insufficient throat thickness


Ø 50
3
100
50
50
Ø 50
WLC22P0222

EXERCISE 39 : Inspect and clear using LPI testing during root pass and cover pass

Objectives

At the end of this exercise you shall be able to

- inspect welded component for surface defect using
- state the penetration test
- identify the defect.

Job Sequence

- Clean the surface of the test piece spray the colored dye on the surface
- Allow the dye to soak for about 2 to 3 minutes wash the surface with cleaner
- Dry the surface using a test cloth
- Spray the liquid developer on the surface
- Observe the colored due coming out in the shape of the defect in to the white liquid developer analyses the defect

Methods of non destructive tests

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

- explain the non-destructive testing methods
- explain the uses of the common non-destructive methods
- explain the uses of special non-destructive testing.

Non-destructive testing methods are classified as common testing and special testing methods.

Common non-destructive testing

– Visual inspection

– Leak or pressure test

– Stethoscopic test (Sound)

Special non-destructive tests

– Magnetic particle test

– Liquid penetrant test

– Radiography (X-ray) test

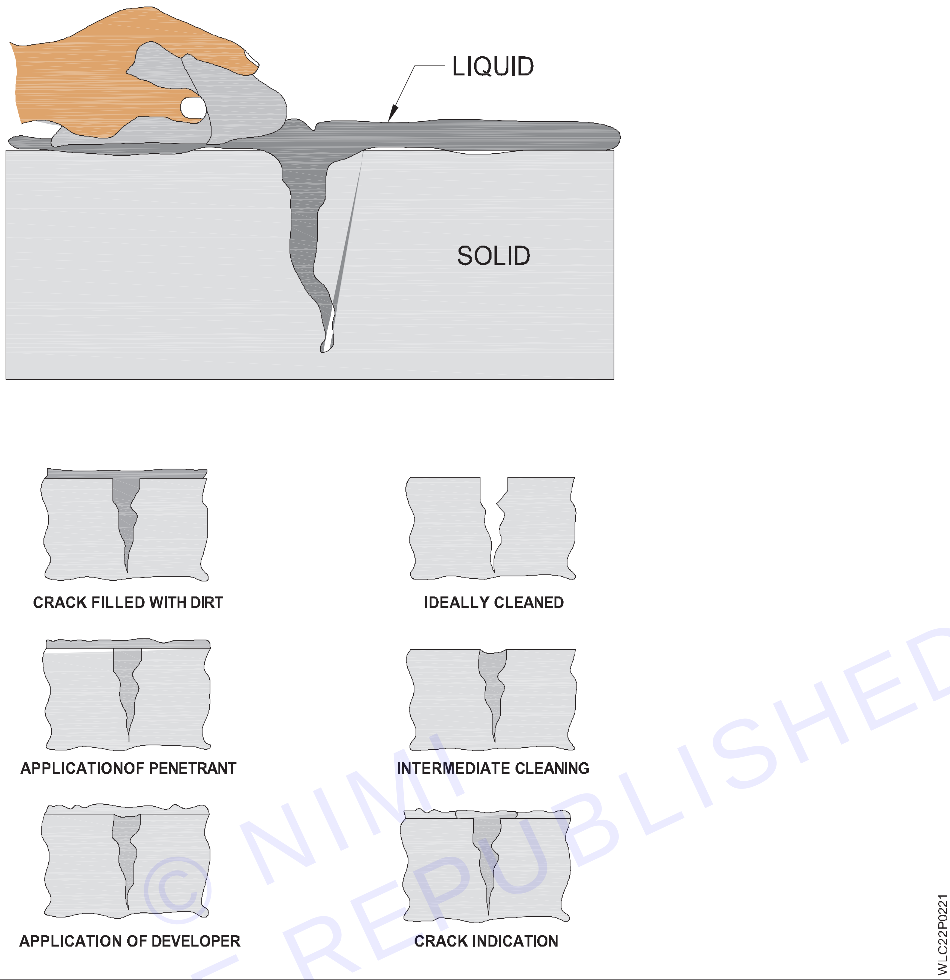
– Gamma ray test

– Ultrasonic test.

Liquid penetrant test: This test is based on the principle that coloured liquid dyes and fluorescent liquid penetrate into the cracks and are used to check for surface defects in metals, plastics, ceramics and glass. A solution of the coloured dye is sprayed on the clean welded joint and allowed to soak. Then the dye is washed off using a cleaner, and the surface dried with soft cloth.

A liquid developer (white in colour) is then sprayed on the weld. The coloured dye comes out in the shape of surface defects into the white developer coating. The defect can be seen in normal light with naked eyes. (Fig 1)

Fig 1


LIQUID
SOLID
CRACK FILLED WITH DIRT
IDEALLY CLEANED
APPLICATIONOF PENETRANT
INTERMEDIATE CLEANING
APPLICATION OF DEVELOPER
CRACK INDICATION
WLC22P0221

EXERCISE 40 : Pipe butt weld butt joint on MS pipe 25mm o.d. 3mm w.t. horizontal position 5G (fixed) - arc welding

Objectives

At the end of this exercise you shall be able to

- cut bevel the pipe for welding
- tack pipes for butt welding
- make root run by rotation method
- make filling run by rotation
- clean the job and inspect for defects.

Job Sequence

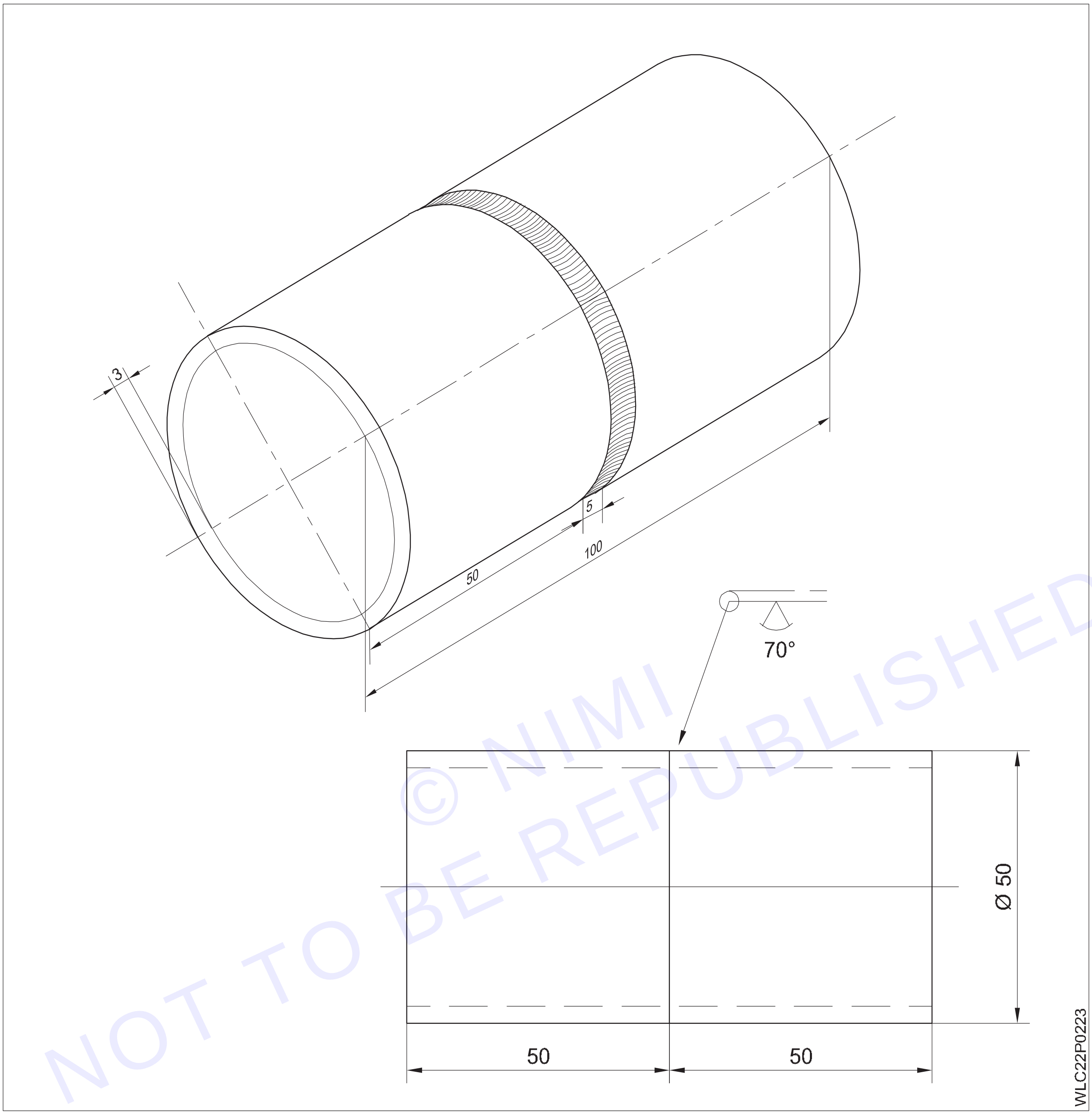
- Cut the pipes to the given size.
- File pipe ends to be at right angle to the pipe axis.
- Grind the edges to 30° to 35" bevel maintaining 1.5 to 1.75mm root face.
- Remove the burrs and rust from the pipe ends.
- Check the perpendicularly of the work piece using the try square.
- Arrange the 2 pipes to form as a butt joint.
- Use a fixture or V profile of an angle iron to align pipes in 6G position.

Note: Wear protective clothing (safety apparels)

- Switch on the machine and select a 3.15mm dia electrode for tacking and the root run and set 100 amps current.
- Put 4 tacks at regular intervals adjusting 2mm root gap between the pipes using spacers.
- Ensure that each tack ends with a keyhole.
- Check and ensure that the pipes are in line after tacking.
- Set 110amps for a 3.15mm dia electrode for root run.
- Deposit the root run in flat position by rotating the pipe.
- Welding using the keyhole technique ensures root penetration.
- Remove slag from the root thoroughly.
- Deposit the second and third run using 3.15mm dia electrodes i.e. the same ad for the root run.
- Clean and inspect the joint.

  a To ensure uniform and correct reinforcement

  b To ensure that the weld face is free from porosity, slag inclusion, unfilled crater, overlap and edge of plate melted off/insufficient throat thickness.


3
5
50
100
70°
Ø 50
50
50
WLC22P0223

EXERCISE 41 : Inspect and clear using LPI testing during root pass and cover pass

Objectives

At the end of this exercise you shall be able to

- inspect welded component for surface defect using
- state the penetration test
- identify the defect.

Job Sequence

- Clean the surface of the test piece spray the colored dye on the surface
- Allow the dye to soak for about 2 to 3 minutes wash the surface with cleaner
- Dry the surface using a test cloth
- Spray the liquid developer on the surface
- Observe the colored due coming out in the shape of the defect in to the white liquid developer analyses the defect

Methods of non destructive tests

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

- explain the non-destructive testing methods
- explain the uses of the common non-destructive methods
- explain the uses of special non-destructive testing.

Non-destructive testing methods are classified as common testing and special testing methods.

Common non-destructive testing

– Visual inspection

– Leak or pressure test

– Stethoscopic test (Sound)

Special non-destructive tests

– Magnetic particle test

– Liquid penetrant test

– Radiography (X-ray) test

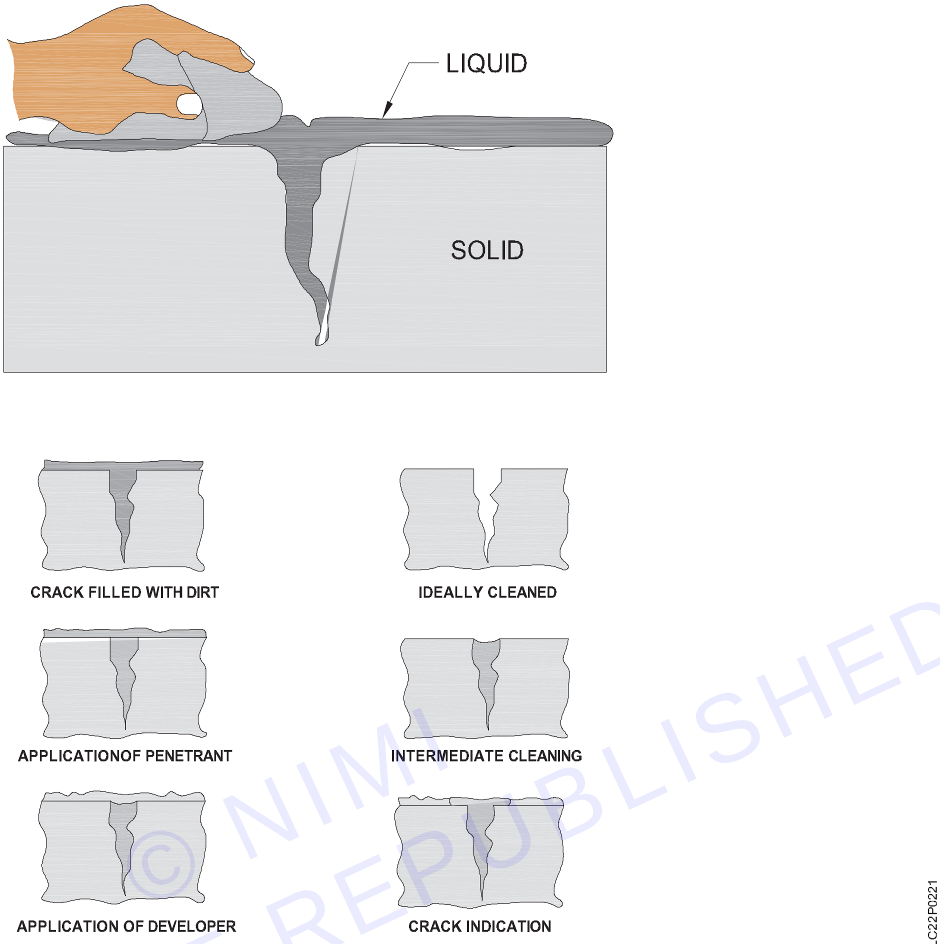
– Gamma ray test

– Ultrasonic test.

Liquid penetrant test: This test is based on the principle that coloured liquid dyes and fluorescent liquid penetrate into the cracks and are used to check for surface defects in metals, plastics, ceramics and glass. A solution of the coloured dye is sprayed on the clean welded joint and allowed to soak. Then the dye is washed off using a cleaner, and the surface dried with soft cloth.

A liquid developer (white in colour) is then sprayed on the weld. The coloured dye comes out in the shape of surface defects into the white developer coating. The defect can be seen in normal light with naked eyes. (Fig 1)

Fig 1


LIQUID
SOLID
CRACK FILLED WITH DIRT
IDEALLY CLEANED
APPLICATIONOF PENETRANT
INTERMEDIATE CLEANING
APPLICATION OF DEVELOPER
CRACK INDICATION
WLC22P0221

EXERCISE 42 : Weld of pipes (schedule 80) in 6G position by SMAW

Objectives

At the end of this exercise you shall be able to

- cut bevel the pipe for welding
- tack pipes for butt welding
- make root run by rotation method
- make filling run by rotation
- clean the job and inspect for defects.

Job Sequence

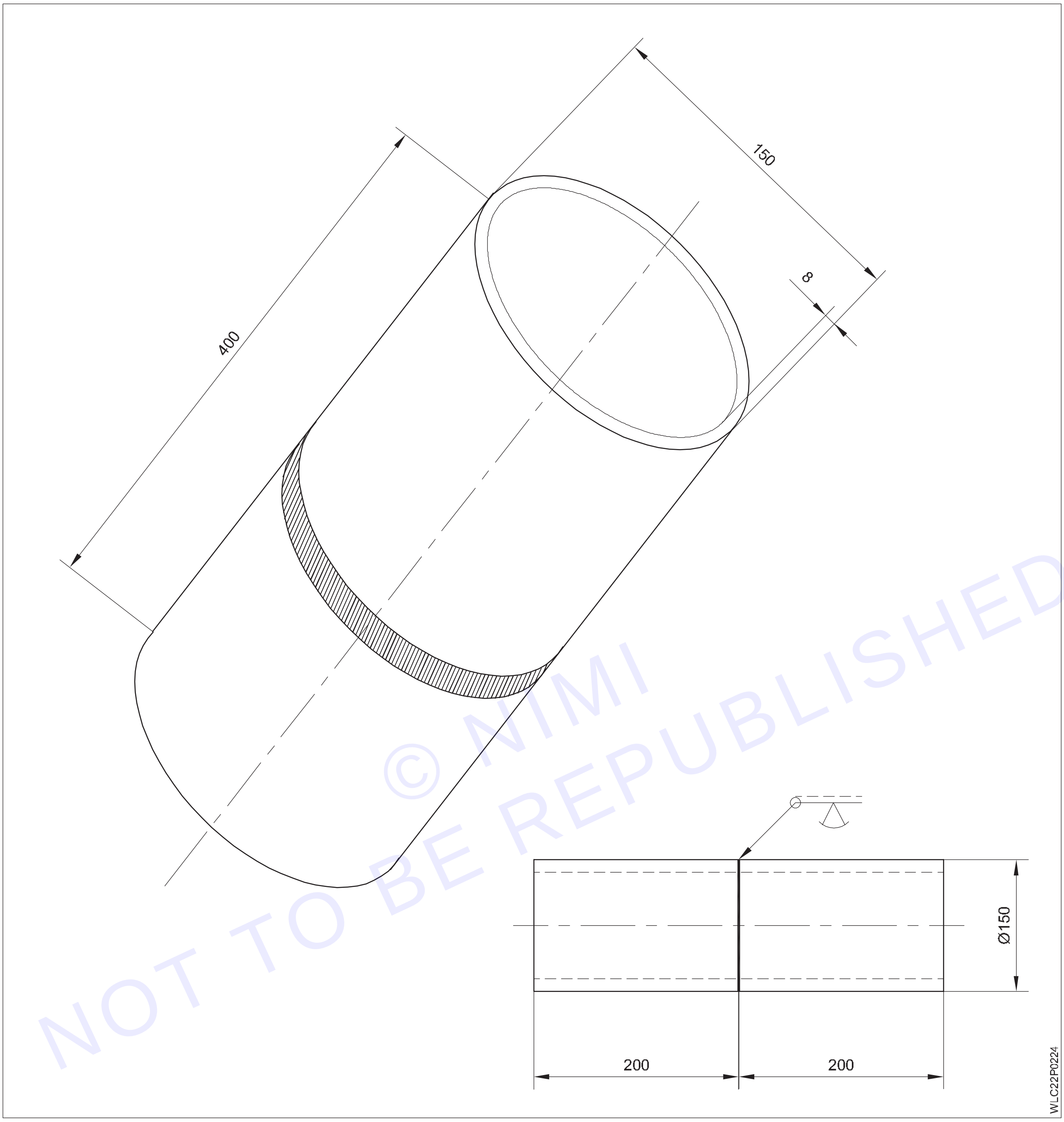
- Cut the pipes to the given size.
- File pipe ends to be at right angle to the pipe axis.
- Grind the edges to 30° to 35" bevel maintaining 1.5 to 1.75mm root face.
- Remove the burrs and rust from the pipe ends.
- Check the perpendicularly of the work piece using the try square.
- Arrange the 2 pipes to form as a butt joint.
- Use a fixture or V profile of an angle iron to align pipes in 6G position.

Note: Wear protective clothing (safety apparels)

- Switch on the machine and select a 3.15mm dia electrode for tacking and the root run and set 100 amps current.
- Put 4 tacks at regular intervals adjusting 2mm root gap between the pipes using spacers.
- Ensure that each tack ends with a keyhole.
- Check and ensure that the pipes are in line after tacking.
- Set 110amps for a 3.15mm dia electrode for root run.
- Deposit the root run in flat position by rotating the pipe.
- Welding using the keyhole technique ensures root penetration.
- Remove slag from the root thoroughly.
- Deposit the second and third run using 3.15mm dia electrodes i.e. the same ad for the root run.
- Clean and inspect the joint.

  a To ensure uniform and correct reinforcement

  b To ensure that the weld face is free from porosity, slag inclusion, unfilled crater, overlap and edge of plate melted off/insufficient throat thickness.



150
8
400
Ø150
200
200
WLC22P0224

EXERCISE 43 : Inspect and clear using LPI testing during root pass and cover pass

Objectives

At the end of this exercise you shall be able to

- inspect welded component for surface defect using
- state the penetration test
- identify the defect.

Job Sequence

- Clean the surface of the test piece spray the colored dye on the surface
- Allow the dye to soak for about 2 to 3 minutes wash the surface with cleaner
- Dry the surface using a test cloth
- Spray the liquid developer on the surface
- Observe the colored due coming out in the shape of the defect in to the white liquid developer analyses the defect

Methods of non destructive tests

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

- explain the non-destructive testing methods
- explain the uses of the common non-destructive methods
- explain the uses of special non-destructive testing.

Non-destructive testing methods are classified as common testing and special testing methods.

Common non-destructive testing

– Visual inspection

– Leak or pressure test

– Stethoscopic test (Sound)

Special non-destructive tests

– Magnetic particle test

– Liquid penetrant test

– Radiography (X-ray) test

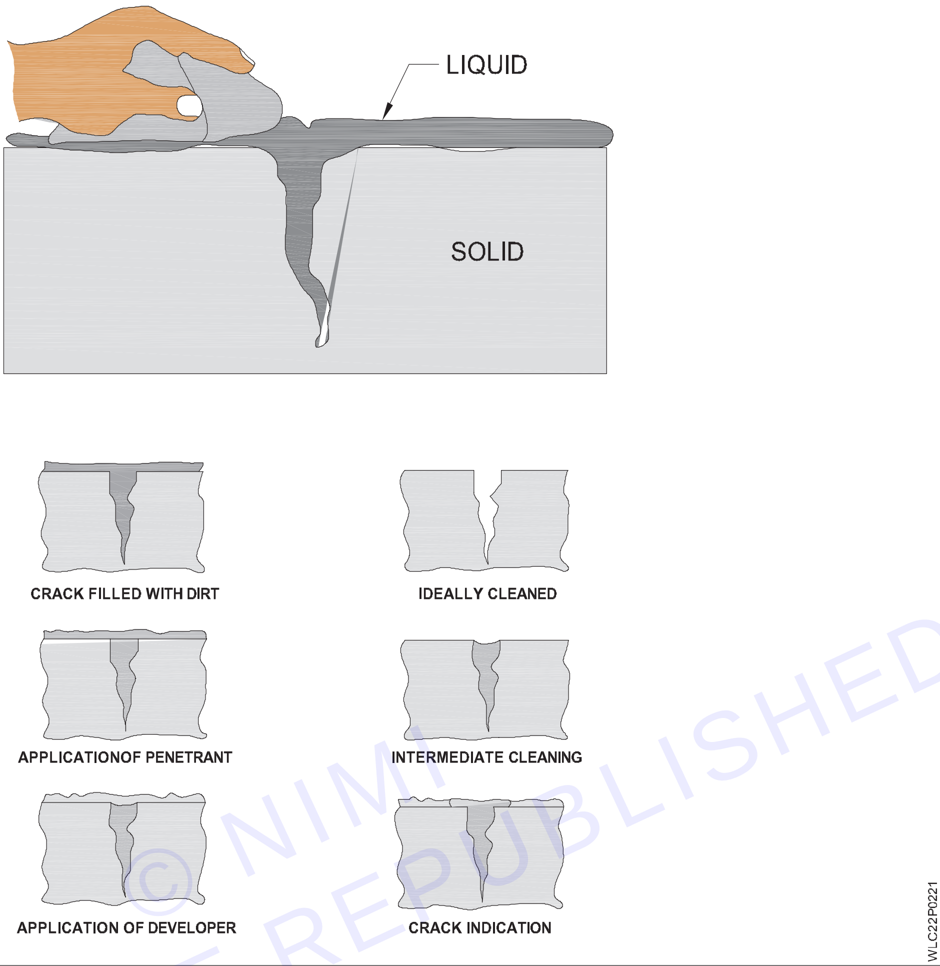
– Gamma ray test

– Ultrasonic test.

Liquid penetrant test: This test is based on the principle that coloured liquid dyes and fluorescent liquid penetrate into the cracks and are used to check for surface defects in metals, plastics, ceramics and glass. A solution of the coloured dye is sprayed on the clean welded joint and allowed to soak. Then the dye is washed off using a cleaner, and the surface dried with soft cloth.

A liquid developer (white in colour) is then sprayed on the weld. The coloured dye comes out in the shape of surface defects into the white developer coating. The defect can be seen in normal light with naked eyes. (Fig 1)

Fig 1


LIQUID
SOLID
CRACK FILLED WITH DIRT
IDEALLY CLEANED
APPLICATIONOF PENETRANT
INTERMEDIATE CLEANING
APPLICATION OF DEVELOPER
CRACK INDICATION
WLC22P0221

EXERCISE 46 : Pipe joints

Objectives

At the end of this exercise you shall be able to

- explain the advantages of welded pipes
- state different methods of pipes welding
- explain the types of pipe joint and pipe welding positions
- describe the methods of welding pipes in '1G' position.

Job Sequence

Specification of Pipes

- In a pipe its size is measured by nominal diameter (or) nominal outside diameter (OD).
- It is also mentioned as nominal pipe size (NPS).
- Pipe is normally used to transport gases or liquids in a process.
- Tube is normally used for standard purpose and it is mentioned as outside diameter and its wall thickness as tube.
- As per Indian standard 1161-1998, it is specified as steel tubes of nominal force, and thickness having outside diameter in mm under light, medium and heavy class. Refer Table 1 as per IS 1161:1998.

Welded pipe joints

- Pipes of all types and sizes are used in great deal today in transporting oil, gas, water etc. They are also used extensively for piping systems in building, refineries and industrial plants.

Advantages of welded pipe

Pipes are mostly made of ferrous and non-ferrous metals and their alloys. They possess the following advantages.

– Improved overall strength.

– Ultimate saving in cost including maintenance.

– Improved flow characteristics.

– Reduction in weight due to its compactness.

– Good appearance.

Method of pipes welding

The following are the methods of pipe welding by arc.

– Metallic arc welding

– Gas metal arc welding

– Tungsten inert gas welding

– Submerged arc welding

– Carbon arc welding

All these methods, except carbon arc welding are commonly used and the choice of welding depends upon the size of the pipe and its application.

Types of pipe joints

1 Butt joint

2 'T' joint

3 Lap joint

4 Angle joint

5 Composite joint

6 Pipe flange joint

7 Y joint

8 Elbow joint

9 Welding of pipe butt joints: Normally joints in pipes

10 And tubes cannot be welded from the inside of the bore.

11 Hence before starting to learn pipe welding, a person should

12 Be proficient in welding in all positions i.e. flat, horizontal,

13 Vertical and overhead.

14 All these positions are used to weld pipes.

15 Pipes welding positions

1G - Pipe weld in flat (roll) position i.e. pipe axis is parallel to the ground.

2G - Pipe weld in horizontal position i.e. pipe axis is perpendicular to the ground.

5G - Pipe weld in flat (fixed) position i.e. pipe axis is parallel to the ground.

6G - Pipe weld in including (fixed) position i.e. pipe axis is including to both horizontal and vertical planes.

During the welding of butt joints the pipe may be

1 Rolled or rotated (1G position)

2 Fixed (2G, 5G and 6G position).

Welding of pipe butt joints by arc can be done in 1G position by a Continuous rotation method and b Segmental method.

1a Pipe welding by arc (in 1G position) by continuous rotation method: Satisfactory welding of butt joints in pipes depends upon the correct preparation of pipe ends and careful assembly of the joint to be welded. Ensure that the bores and root faces are in correct alignment and that the gap is correct.

Clean the edges. Prepare an angle of bevel 35° by gas cutting and filing. A root face 1.5 to 2.5 mm is to be provided.

Setting the pipes for welding: Tack weld together with 4 small equally spaced tacks. The gap should be equal to the root face dimension plus 0.75 mm. Support the tacked assembly on V blocks or rollers so that the assembly can be rolled or rotated with the free hand.

Select a 2.5 mm rutile electrode for 1st run and a 3.15 mm rutile electrode for 2nd run.

Set a current of 70-80A for 1st run and 100-110 for the 2nd run.

Rotate the assembly as welding proceeds. keeping the welding arc within an area between vertical and 10° from the vertical in the direction of welding.

(Use a helmet type screen).

– Direct the electrode centrally at the root of the joint and in line with the radius of the pipe at the point of welding.

– Strike the arc near the top dead center and hold the arc length as short as possible. Continue to weld as the pipe is rotated manually at steady speed.

– Deposit first run by weaving the electrode very slightly from root face to root face.

– Adjust the speed of rotation to obtain full fusion of the root faces without excessive penetration.

– Chip out tack weld as they are approached. Do not weld over tacks otherwise loss of penetration at the tacking points may occur.

– Complete the weld with the second run. Adjust the speed of rotation to secure fusion to the outer edge of each fusion face. The amount of reinforcement should be even around the edge of the joint. 1b Welding of a pipe butt (IG position i.e. by rotation) by segmental welding.

– The edges of the pipe are beveled to 35 to 40° angle with a root gap of 2.5 mm.

– Tack the pipe as before and support the assembly on two ‘V’ blocks.

– Strike the arc at 10° from Top Dead Centre (TDC) and deposit the root run. Use a small weaving motion to achieve fusion of the root faces. Adjust travel speed to control root penetration.

– Move the pipe until the end of the segment is at 10° before TDC.

– Strike the arc on the end of the previous weld run and establish a weld pool.

– Weld a further 60° segment.

– Continue welding in segments until the root run has been completed.

– Move the pipe until the mid point of the segments is at TDC.

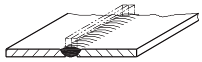
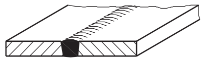
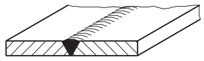
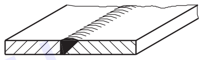
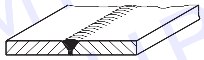
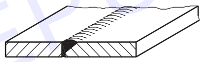
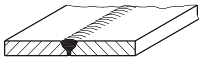
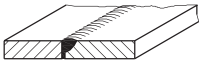
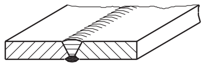
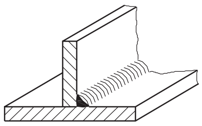
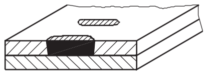
– Strike the arc and deposit the second (filling) run, use a side-to-side weaving position to fill the preparation and to achieve fusion of the pipe edges.

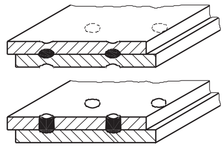
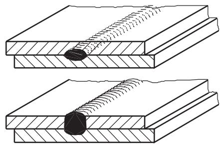
EXERCISE 47 : Illustrate study of welding drawings

Objectives

At the end of this exercise you shall be able to

- Illustrate study of welding drawings

Sl.No	Designation	Illustration	Symbol
1	Butt weld between plates with raised edges (the raised edges being melted down completely)		
	Square butt weld		
	Single V butt weld		
	Single bevel butt weld		
	Single V butt weld with broad root face		
	Single bevel butt weld with broad root face		
	Single U butt weld (Parallel or sloping sides)		
	Single J butt weld		
	Backing run; back or backing weld		
	Fillet weld		
	Plug weld; Plug or slot weld/USA		

	Spot weld		○
	Seam weld		⊖

EXERCISE 48 : Illustrate study of welding codes & standards

Objectives

At the end of this exercise you shall be able to

- illustrate study of welding codes & standards

Job Sequence

American Welding Society (AWS) Standards

The American Welding Society (AWS) publishes over 240 AWS-developed codes, recommended practices and guides which are written in accordance with American National Standards Institute (ANSI) practices The following is a partial list of the more common publications.

AWS A2.4	Standard symbols for welding, brazing, and non-destructive examination
AWS A3.0	Standard welding terms and definitions
AWS A5.1	Specification for carbon steel electrodes for shielded metal arc welding
AWS A5.18	Specification for carbon steel electrodes and rods for gas shielded arc welding
AWS B1.10	Guide for the nondestructive examination of welds
AWS B2.1	Specification for Welding Procedure and Performance Qualification
AWS D1.1	Structural welding (steel)
AWS D1.2	Structural welding (aluminum)
AWS D1.3	Structural welding (sheet steel)
AWS D1.4	Structural welding (reinforcing steel)
AWS D1.5	Bridge welding
AWS D1.6	Structural welding (stainless steel)
AWS D1.7	Structural welding (strengthening and repair)
AWS D1.8	Structural welding seismic supplement
AWS D1.9	Structural welding (titanium)

AWS D3.6R	Underwater welding (Offshore & inland pipelines)
AWS D8.1	Automotive spot welding
AWS D8.6	Automotive spot welding electrodes supplement
AWS D8.7	Automotive spot welding recommendations supplement
AWS D8.8	Automotive arc welding (steel)
AWS D8.9	Automotive spot weld testing
AWS D8.14	Automotive arc welding (aluminum)
AWS D9.1	Sheet metal welding
AWS D10.10	Heating practices for pipe and tube
AWS D10.11	Root pass welding for pipe
AWS D10.12	Pipe welding (mild steel)
AWS D10.13	Tube brazing (copper)
AWS D10.18	Pipe welding (stainless steel)
AWS D11.2	Welding (cast iron)
AWS D14.1	Industrial mill crane welding
AWS D14.3	Earthmoving & agricultural equipment welding
AWS D14.4	Machinery joint welding
AWS D14.5	Press welding
AWS D14.6	Rotating Elements of Equipment
AWS D14.9	Specification for the Welding of Hydraulic Cylinders

AWS D15.1	Railroad welding
AWS D15.2	Railroad welding practice supplement
AWS D16.1	Robotic arc welding safety
AWS D16.2	Robotic arc welding system installation
AWS D16.3	Robotic arc welding risk assessment
AWS D16.4	Robotic arc welder operator qualification
AWS D17.1	Aerospace fusion welding
AWS D17.2	Aerospace resistance welding
AWS D17.3	Aerospace friction stir welding (aluminum)
AWS D18.1	Hygienic tube welding (stainless steel)
AWS D18.2	Stainless steel tube discoloration guide
AWS D18.3	Hygienic equipment welding

British Standards (BS)

British Standards are developed, maintained and published by BSI Standards which is UK's National Standards Body The following is a partial list of standards specific to welding.

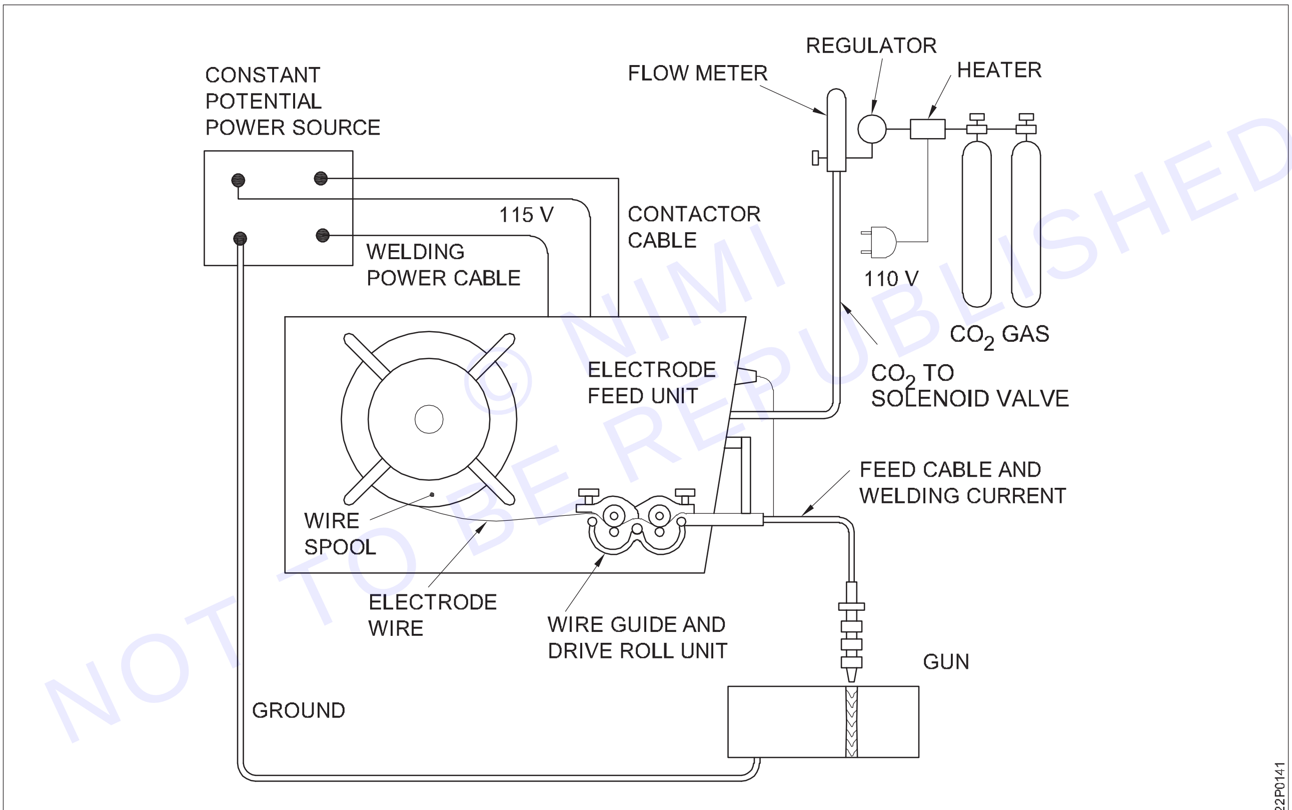
BS 499-1	Welding terms and symbols. Glossary for welding, brazing and thermal cutting
BS 499-2C	Welding terms and symbols. European arc welding symbols in chart form
BS 2633	Specification for Class I arc welding of ferritic steel pipework for carrying fluids
BS 2971	Specification for class II arc welding of carbon steel pipework for carrying fluids
BS 4515-1	Specification for welding of steel pipelines on land and offshore - Part 1: Carbon and carbon manganese steel pipelines
BS 4515-2	Specification for welding of steel pipelines on land and offshore. Duplex stainless steel pipelines
PD 6705-2	Structural use of steel and aluminium. Recommendations for the execution of steel bridges to BS EN 1090-2
PD 6705-3	Structural use of steel and aluminium. Recommendations for the execution of aluminium structures to BS EN 1090-3

EXERCISE 49 : Set up and monitor GMAW welding machine & accessories

Objectives

At the end of this exercise you shall be able to

- set up with proper place, the GMAW machine.
- give properly all electrical connections.
- arrange the proper shielding gas cylinders.
- start the operation with safety.



COMPONENTS OF THE GMAW MIG WELDING SYSTEM

Job Sequence

- Set the machine with all accessories.
- Set the all-Electrical connections properly.
- Give shielding gas connection (Inert gases).
- Start the welding operation.
- Follow the safety norms.

Note: Wear protective clothing.

- Tack-weld on both ends.

- Set the joint in a flat position.
- Deposit root run by using a Ø1.2mm dia 150 amps.

Ensure an electrode angle of 45° with the and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion with150-160amps welding current.

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the size.

- Inspect the weld for surface defects and sizes.

Skill Sequence

Set up and monitor GMAW welding machine & accessories

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

- set up and monitor GMAW welding machine & accessories.

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.

Draw the wire from the spool, pass it on through the inlet wire guide, driver rollers and outlet wire guide.

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 1) to the welding torch outlet through the contact tip.

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 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.

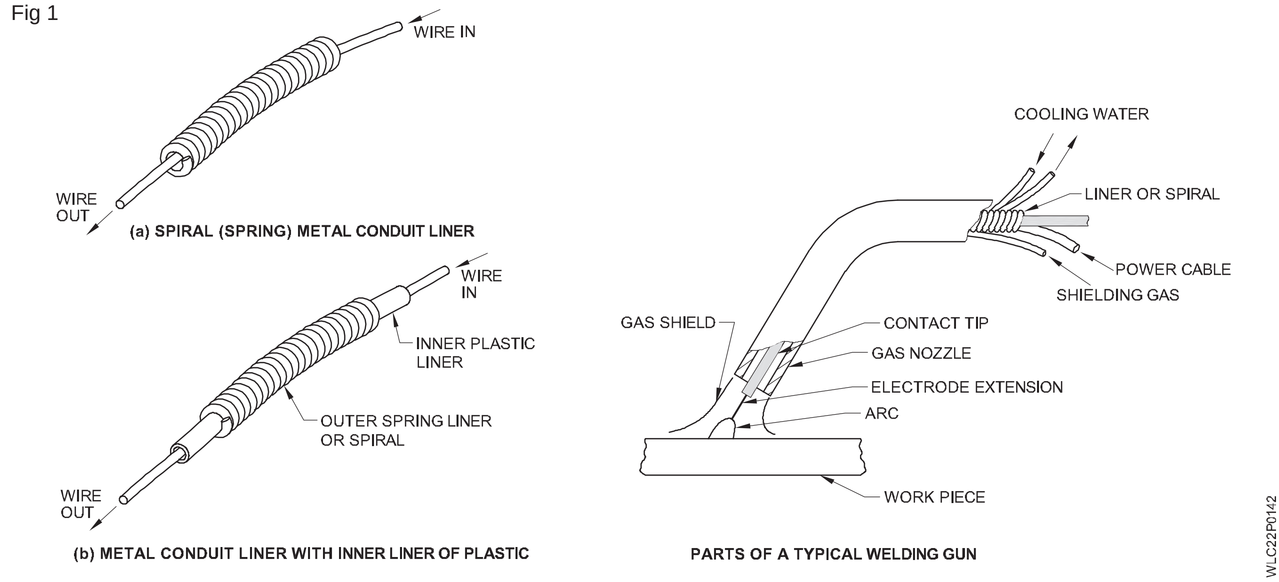
Connecting the heater, regulator and flow meter: The inlet end of the CO_2 gas heater is connected to the CO_2 cylinder. The heater should be connected to either 110V supply from the welding machine (or) 230V supply from the mains.

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

Fig 1

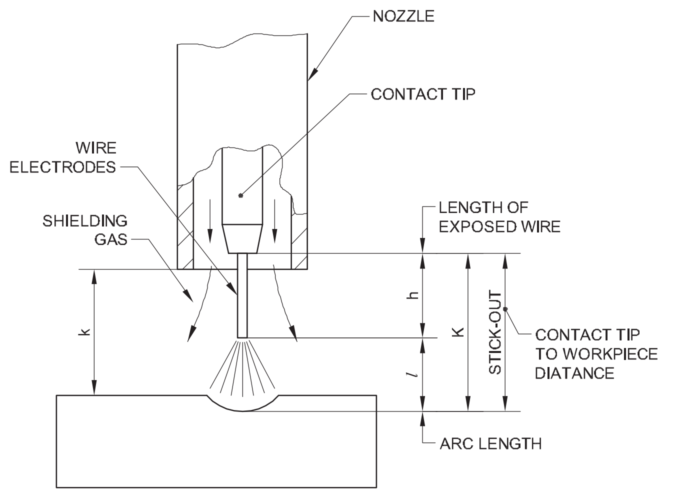


Setting the current level by selecting proper wire feed rate: For this exercise of depositing straightline beads it is desirable to select a smaller diameter wire i.e. 0.8mm dia wire and dip transfer method. Accordingly a current range of 80-100A is to be set for the 0.8mm dia wire. The current to be 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 2). 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 2

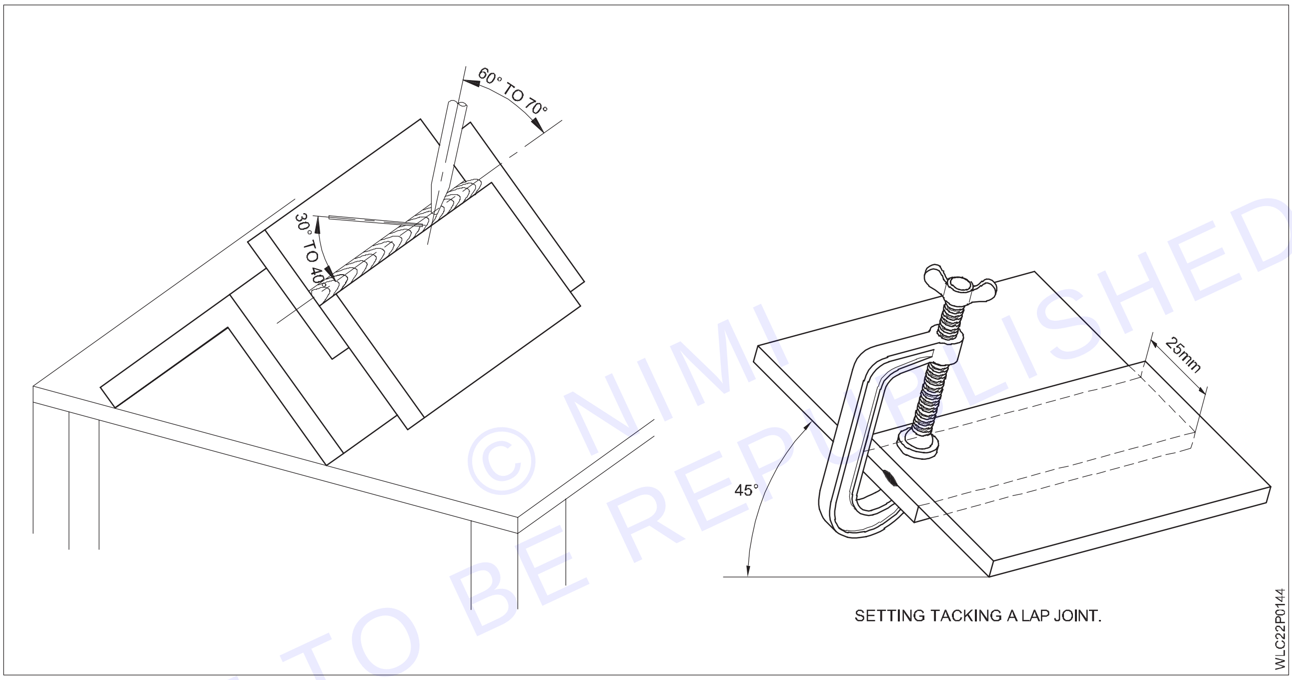


EXERCISE 50(A) : Perform Lap joint on M.S. plate (10 mm. thick plate) in flat position by GMAW

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.
- set up the GMAW machine and set welding parameters.



Job Sequence

- Cut the plates by gas/hacksawing cutting as per drawing
- Set the pieces in the form of Lap as per drawing
- Tack weld on both ends of the tee joint
- Keep the tack welded job
- The welding can be done in flat/down hand position
- Deburr and clean the surface of the plates by carbon steel wire brush and filling.
- Set the plate A on the plate B in the form of lap per drawing
- Clean the root run using steel wire brush

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by using a 100-110 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

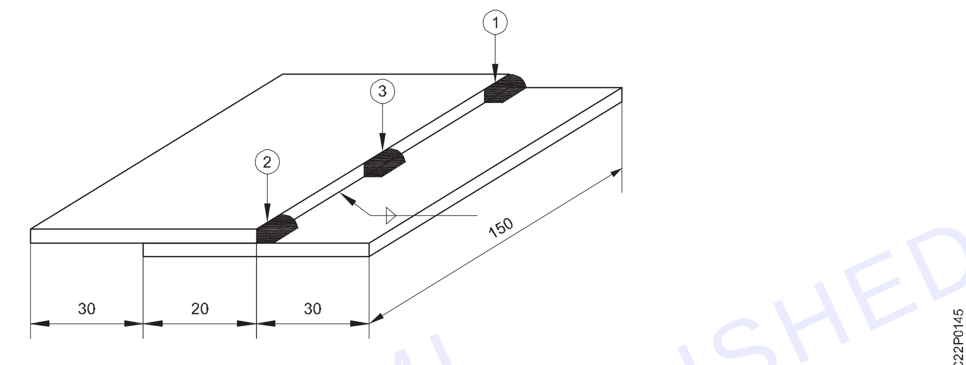
- Check the all connections before welding
- Welding area should be dry area
- Use welding screen and chipping goggle for eyes and face safety

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.



TACKING A LAP JOINT

Skill Sequence

Perform Lap joint on M.S. plate (10 mm. thick plate) in flat position by GMAW

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

- perform Lap joint on M.S. plate (10 mm. thick plate) in flat position by GMAW.

- Cut the plate by using hacksaw cutting as per drawing
- Clean the joining edges and surface of the plates
- Set the plate A on the plate B in the form of tee as per drawing
- Tack weld on both ends of the Lap joint
- Set 90-100A current/corresponding wire feed rate, 19 to 20 arc voltage and deposit the run using dip transfer mode
- Weld the lap joint by using 1.mm dia. Mild steel filler wire and using stringer bead welding technique.
- Ensure good leg length and even fusion of plates.
- Avoid under cut
- Ensure the edges of the plate is not melted off due to excessive weaving
- Ensure there is no undercut at the other toe of the lap weld on plate
- 6 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with a 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

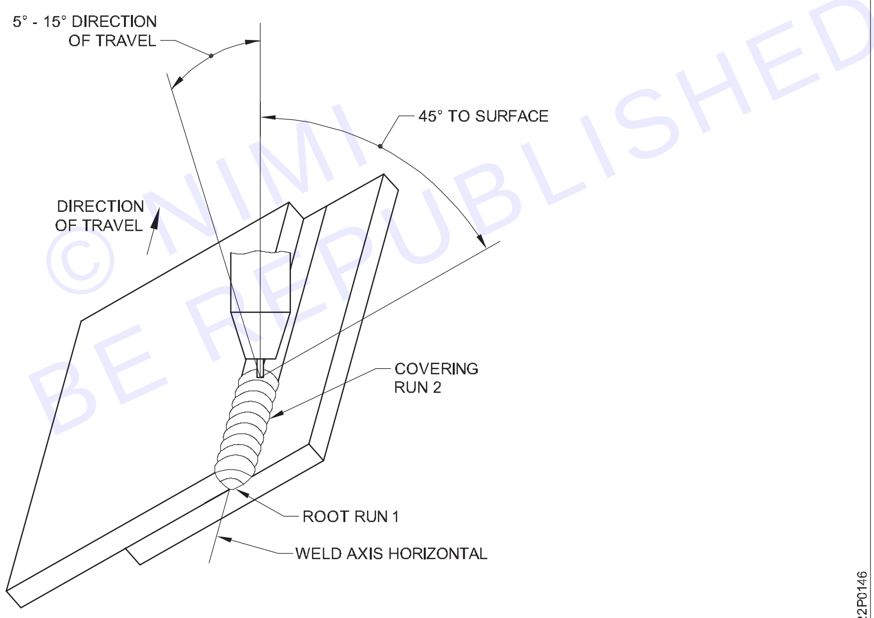
Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld and ensure. (Fig 1)

- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- It is free from surface defects.

Fig 1



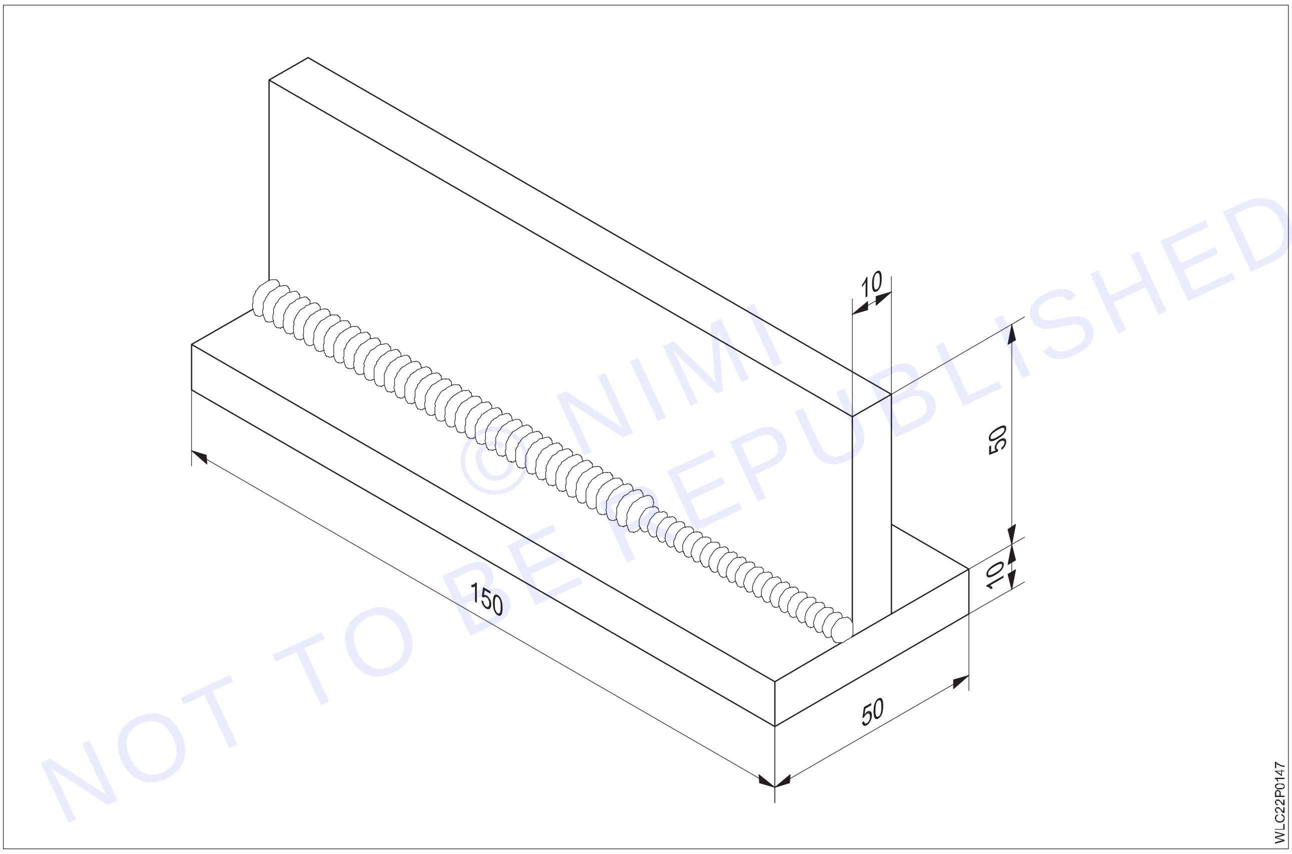
A FILLET WELD ON A LAP JOINT IN THE FLAT POSITION

EXERCISE 50(B) : Perform Tee joint on M.S. plate (10 mm thick plate) in flat position by GMAW

Objectives

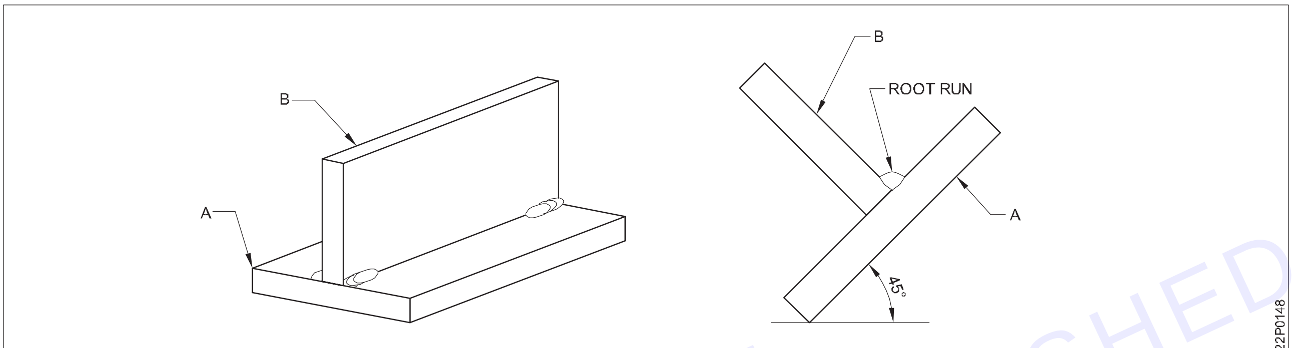
At the end of this exercise you shall be able to

- set and tack plate pieces in alignment as tee joint and by keeping distortion allowance.
- set and tack plate pieces in alignment as tee joint and by keeping distortion allowance.
- deposit root run in tee joint of proper size and penetration.
- set up the GMAW machine and set welding parameters.



Job Sequence

- Cut the plates by gas/hacksaw cutting as per drawing
- Set the pieces in the form of Tee as per drawing
- Tack weld on both ends of the tee joint
- Keep the tack welded job in the channel at 45 degrees from the horizontal plane so that the welding can be done in flat/down hand position
- Select dia 1.2 mm CCMS wire.
- Set 70 to 90 Amp current
- Ensure proper root penetration and even fusion of plate A and B with suitable welding gun / torch angle and Arc travel speed

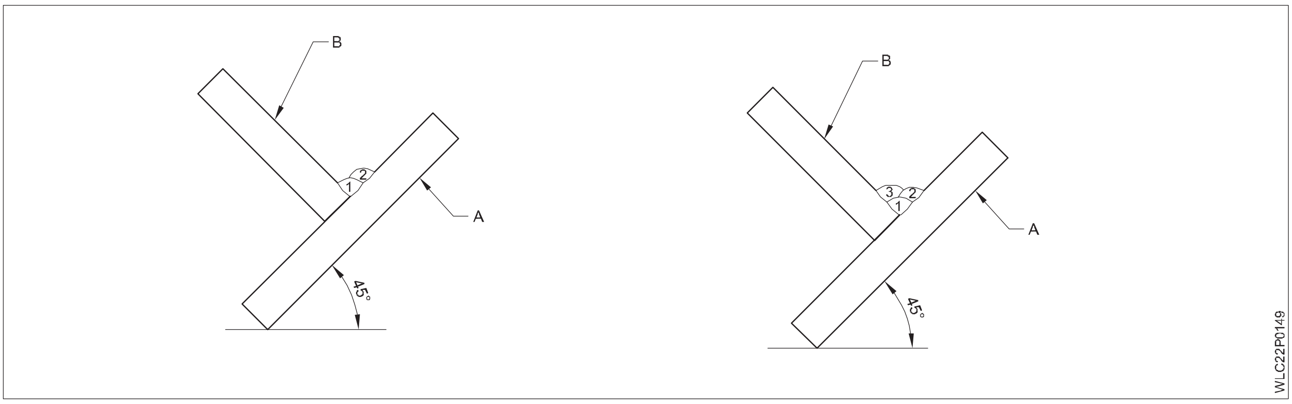


SETTING AND TACKING A TEE JOINT

- Clean the root run using steel wire brush
- Deposit the 2nd run using stringer bead 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.
- Ensure the undercut in bottom plate is avoided and a leg length of plate thickness 10mm is obtained.
- Clean the second run by wire brush
- Use tongs while handling the hot job

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by with 100-110 amps current.



Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Check all the connections before welding
- Welding area should be dry area

- Use welding screen and chipping goggle for eyes and face safety

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.

Skill Sequence

Perform Tee joint on M.S. plate (10 mm thick plate) in flat position by GMAW

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

- perform Tee joint on M.S. plate (10 mm thick plate) in flat position by GMAW.

- Cut the plate by using hacksaw cutting as per drawing.
- Clean the joining edges and surface of the plates.
- Set the plate B on the plate A in the form of tee as per drawing.
- Tack weld on both ends of the tee joint
- Keep the tack welded job in the channel at 45 degrees from the horizontal plane so that the welding can be done in flat/down hand position.
- Connect the torch to positive terminal of the machine.
- Weld the root run of the joint by using 1.mm dia. Mild steel filler wire and using stringer bead welding technique.
- Set 90 to 100 amps current/ corresponding wire feed rate 19 to 20 Arc and deposit the root run.
- Ensure proper root penetration and even fusion of plate A and B with suitable welding gun / torch angle and Arc travel speed.
- Clean the root run using steel wire brush.
- Deposit the 2nd run using stringer bead as shown in (Fig 1) covering the bottom plate A and 2/3 of the width of the root run. parameters under techniques used for the root run.
- Clean the second run by wire brush.

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with a 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld and ensure. (Fig 2)

Fig 1

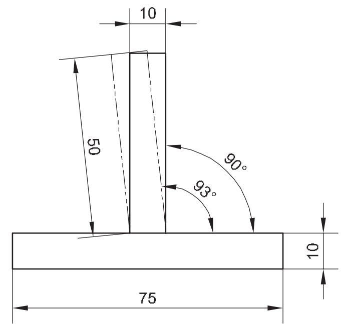
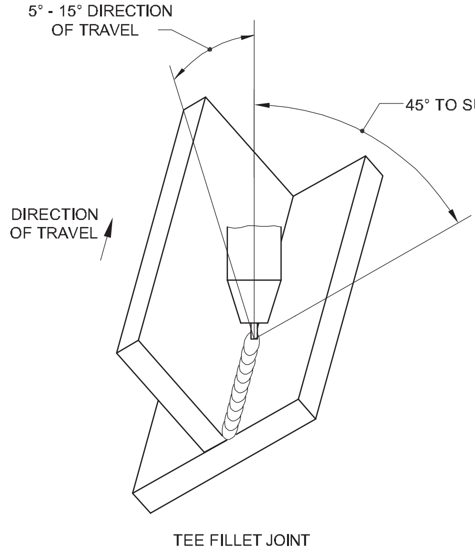

10
50
90°
93°
10
75

Fig 2

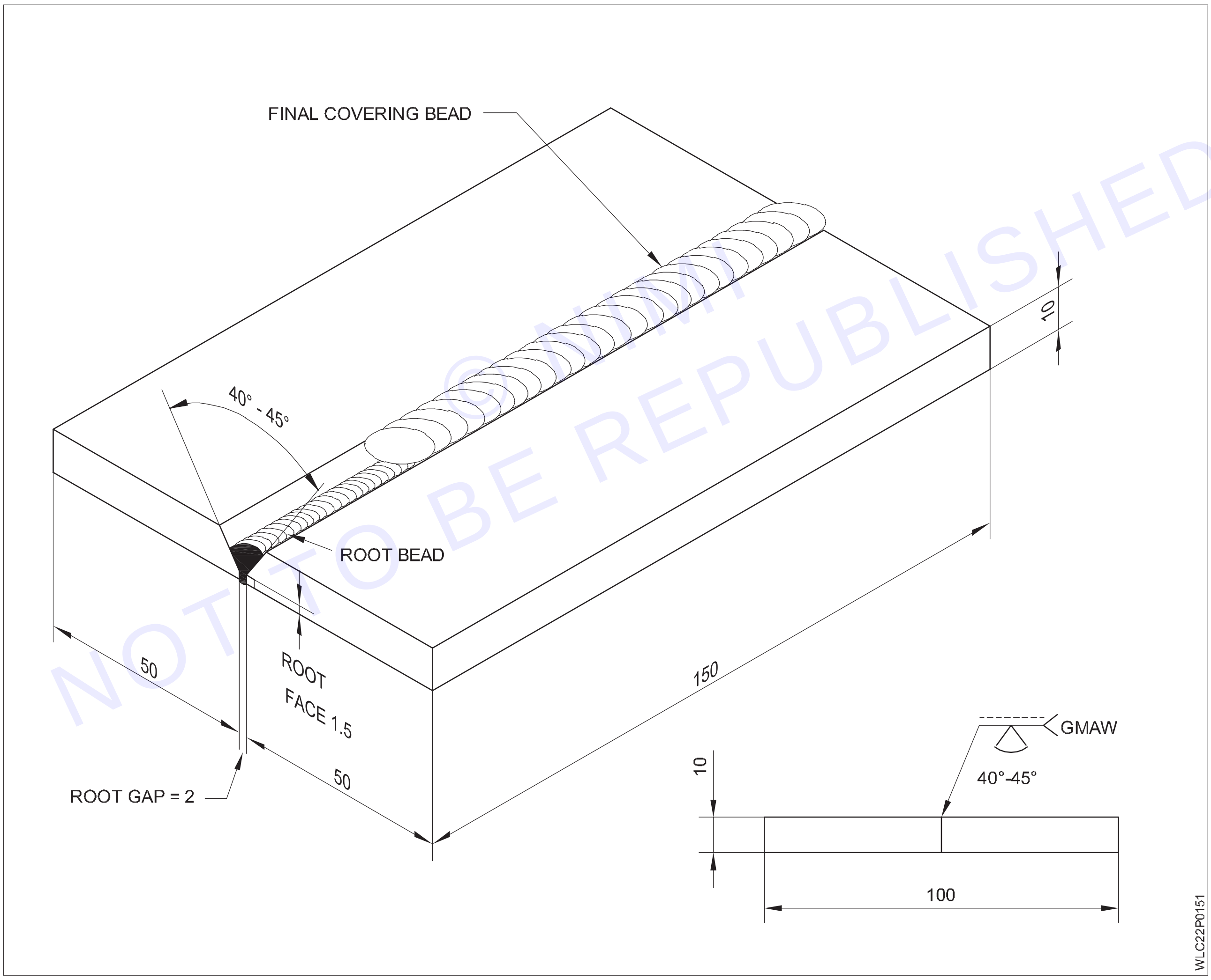

5° - 15° DIRECTION
OF TRAVEL
45° TO SURFACE
DIRECTION
OF TRAVEL
TEE FILLET JOINT
WLC22P0150

EXERCISE 51 : Construct & evaluate single ‘V’ butt joint on M.S. plate (10 mm. thick plate) in flat position by GMAW

Objectives

At the end of this exercise you shall be able to

- prepare the plates with necessary beveling and root face.
- preset the plates in alignment in horizontal plane with necessary root gap and tack weld.
- deposit the root run with root penetration and uniform melting of both root faces of the joint.
- set up the GMAW machine and set welding parameters.



Job Sequence

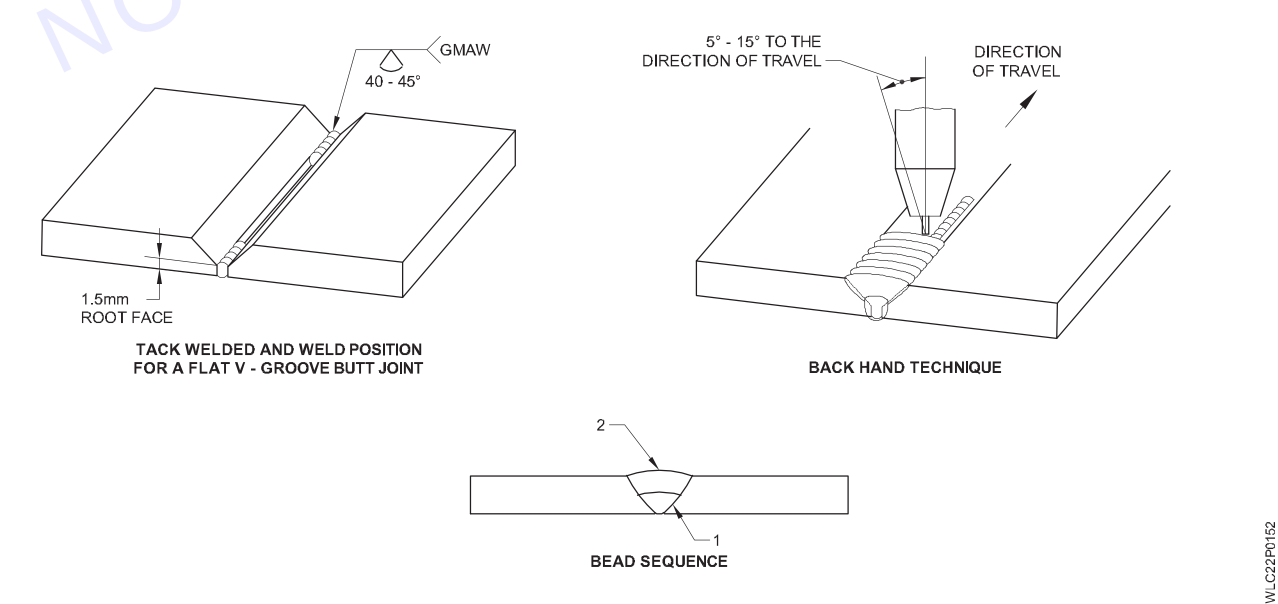
- Cut the plate by using hacksaw cutting as per drawing.
- Clean the joining edges and surface of the plates.
- Adjust the power source and wire feeder to obtain 18 to 19 volts and 90 and 100 ampere, gas flow 8-10 LPM.
- Thoroughly clean the pieces to be joined. Pay particular attention to the top of the plate, the side walls of the groove and the underside of the joint. Grind or file a 1.5 mm root face one each bevel edge.
- Tack the pieces together and position.
- Put spacers under the plate so that you don't weld the plate to your table.
- 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 back hand technique. 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 all other arc to go too far upon 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.
- Complete the joint using the bead sequence. Use a slight weave to help the weld flow and to fuse to the sidewalls of the groove and the previous beads.
- 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. There in forcement should be atleast 1mm above the surface of the base metal and also should not exceed beyond 1.5.

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by using a with 100-110 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.



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

BACK HAND TECHNIQUE

BEAD SEQUENCE

- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion with150-160amps welding current.

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.

Skill Sequence

Construct & evaluate single v butt joint on m.s. plate (10 mm. thick plate) in flat position by GMAW

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

- Construct & evaluate single v butt joint on m.s. plate (10 mm. thick plate) in flat position by GMAW.

Setting and tacking the lap joint (Fig 1)

Set the joint with an overlap of 2.5mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. (Fig 1) Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly. Use 120-amp current for tacking.

Set the joint in a flat position using angle iron (Fig 2).

Welding the lap fillet joint in flat position

Deposit root run with 100-110 amp curre

Maintain 80° angle to the line of the weld and 45° between the weld faces. (Fig 2)

Maintain a short arc to get uniform fusion and root penetration.

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with a 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld and ensure.

Fig 1

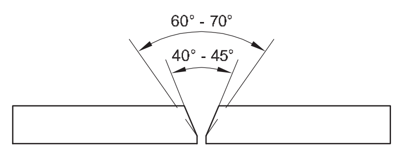
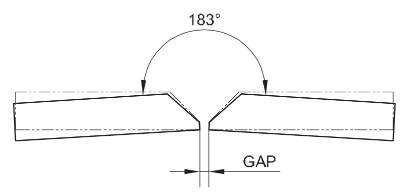


Fig 2



PRE-SETTING TO COMPENSATE FOR ANGULAR DISTORTION

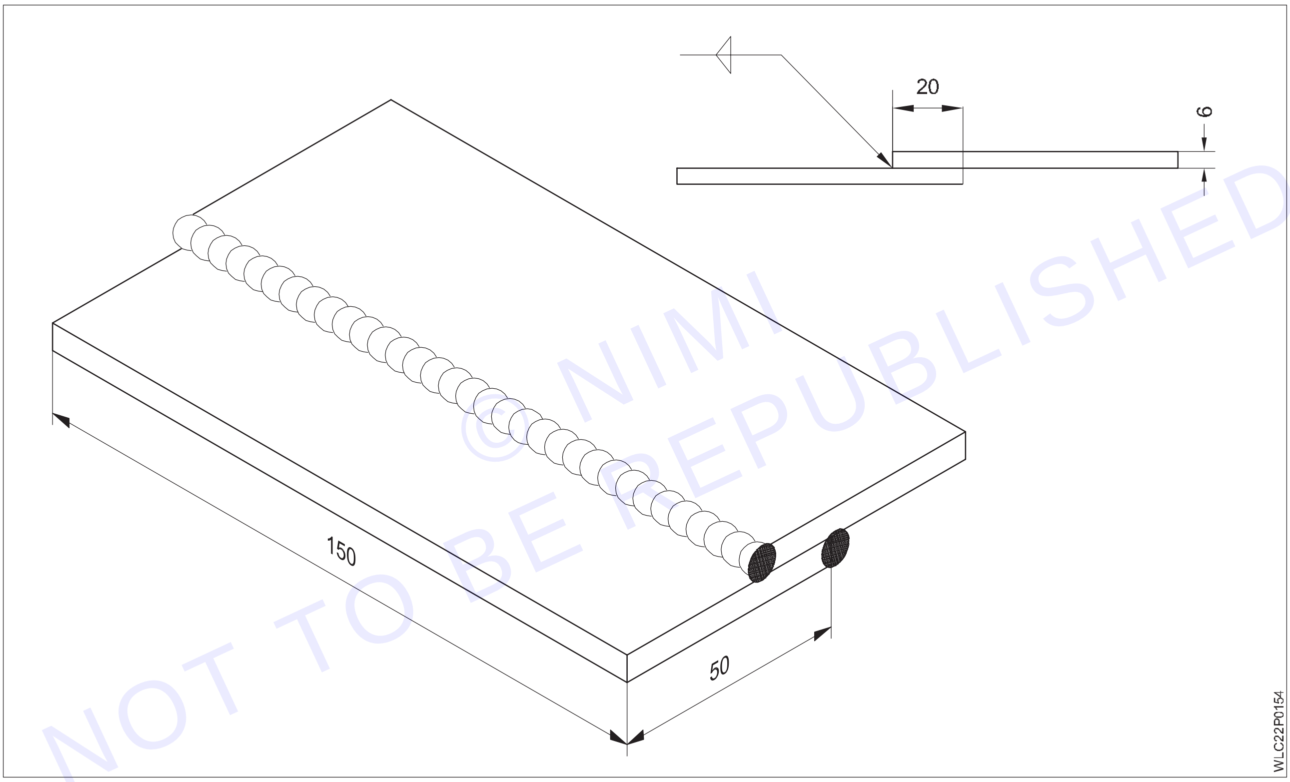
WLC22P0153

EXERCISE 52(A) : 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.



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.

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

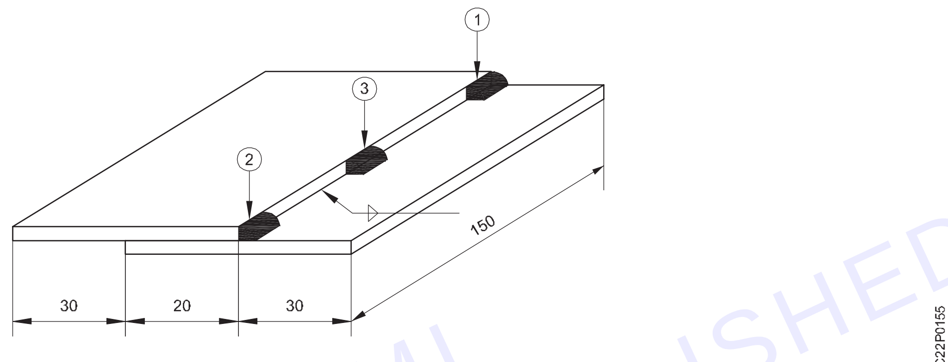
13 Ensure the edges of the plate is not melted off due to excessive weaving

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.

Fig 1



TACKING A LAP JOINT

Skill Sequence

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

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

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.

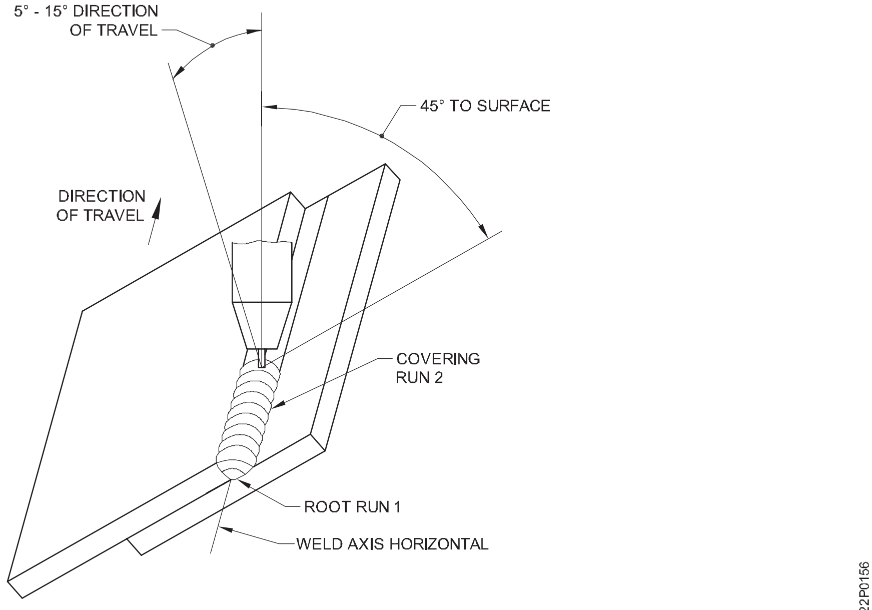
For welding the joints in flat position it is convenient to use the channel to position the joints. This weld permits the tack welded job to be kept at 450 angle with the horizontal plane.

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



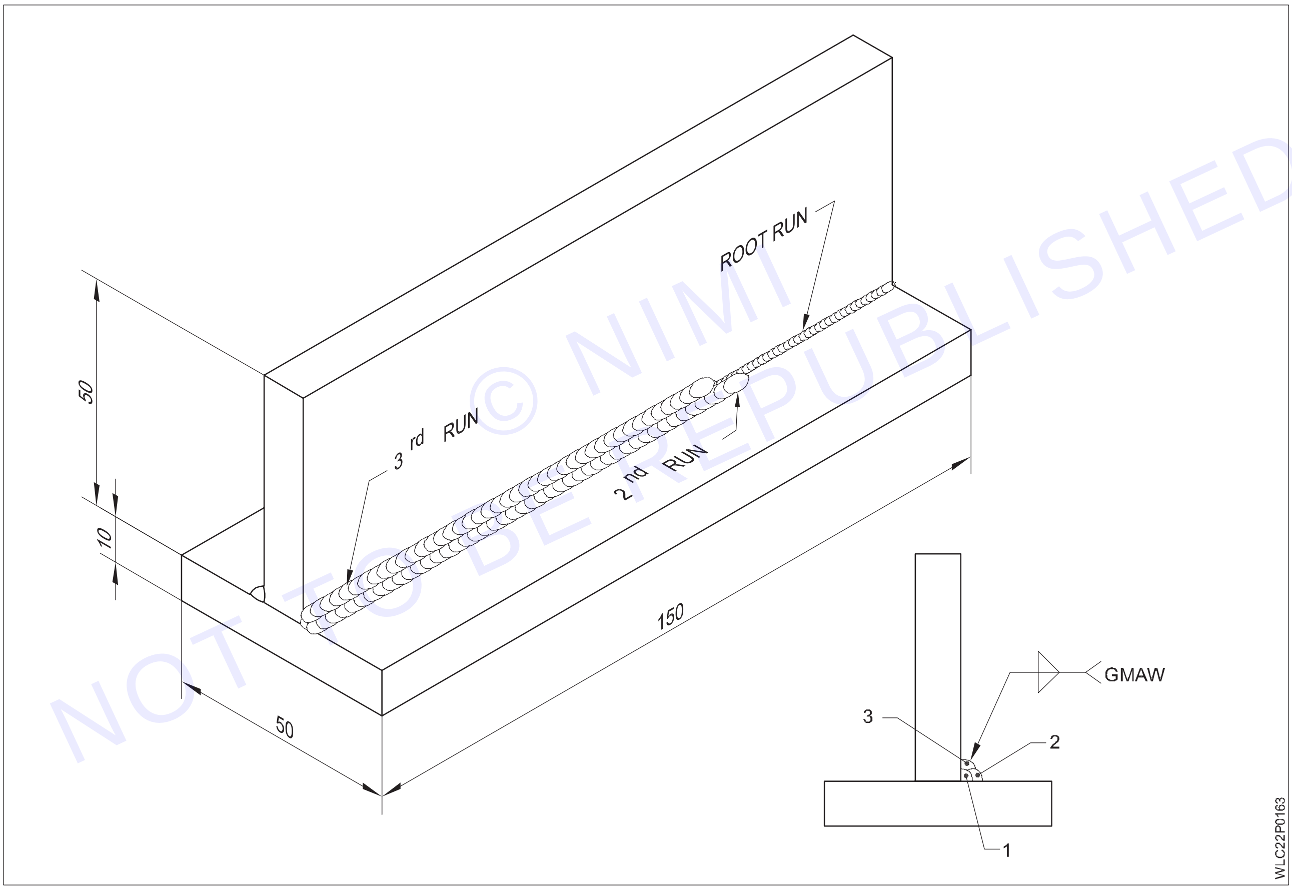
A FILLET WELD ON A LAP JOINT IN THE FLAT POSITION

EXERCISE 52(B) : Construct & evaluate Tee joint on M.S. plate (10 mm. thick plate) in horizontal position by GMAW

Objectives

At the end of this exercise you shall be able to

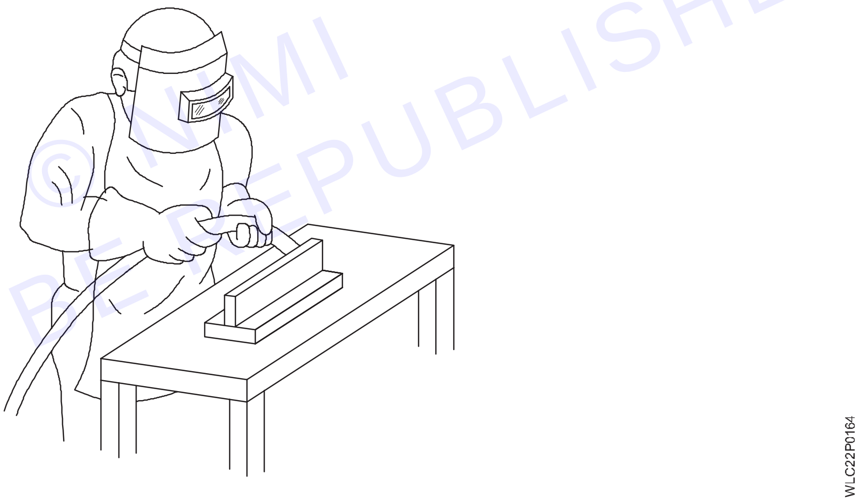
- prepare the plates with necessary beveling and root face.
- preset the plates in alignment in horizontal plane with necessary root gap and tack weld.
- deposit the root run with root penetration and uniform melting of both root faces of the joint.
- set up the GMAW machine and set welding parameters.



Job Sequence

- Prepare the plates to size (i.e 150 x 50 x 10mm) using gas cutting, grinding and filing.
- Clean the base metal surface along the welding line with a carbon steel wire brush.
- Set the plates in the form of an inverted "T".
- Wear all protective devices Fig.1.
- Tack weld the 2 plates on either end keeping the T joint in Horizontal position.
- Set the welding parameters as done in earlier exercises.
- Strike the arc keeping proper angles for the torch.
- Deposit the root run without weaving and ensure proper penetration and fill the crater.
- Clean the root run.
- Deposit the 2nd run using stringer bead.
- Clean the 2nd run with wire brush.
- Deposit the 3rd run using stringer bead.
- Clean the 3rd run.
- Check for defects like overlap, undercut, porosity and check for corret leg size and throat thickness.

Fig 1



Skill Sequence

Construct & evaluate single v butt joint on m.s. plate (10 mm. thick plate) in horizontal position by GMAW

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

- Construct & evaluate single v butt joint on m.s. plate (10 mm. thick plate) in horizontal position by GMAW.

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.

Tack weld the two plates at the ends.

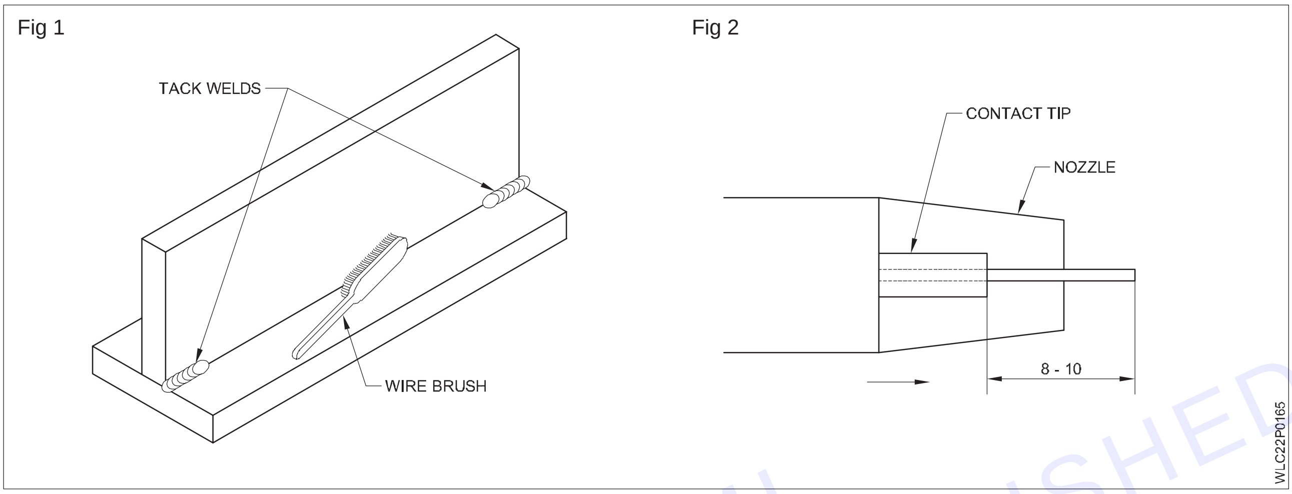
Set the welding conditions: Adjust the gas flow rate to 8 to 10 LPM.

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.

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.

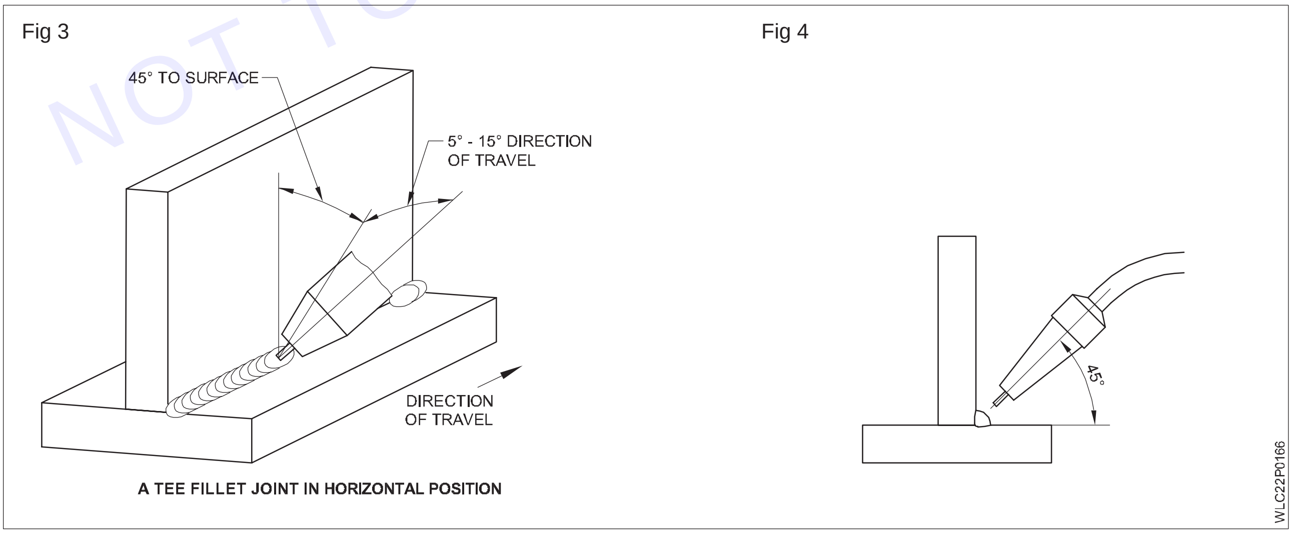
Hold the torch at about 70 to 800 against the welding direction and at 450 against the base metal surface.

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

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 2nd and 3rd 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.

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 3rd run.

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

Fig 5

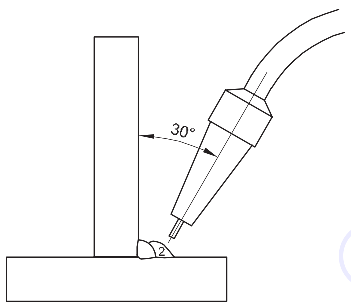
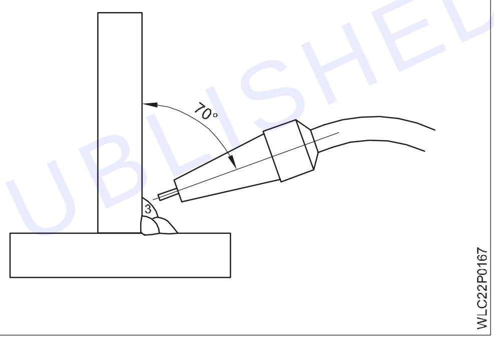


Fig 6

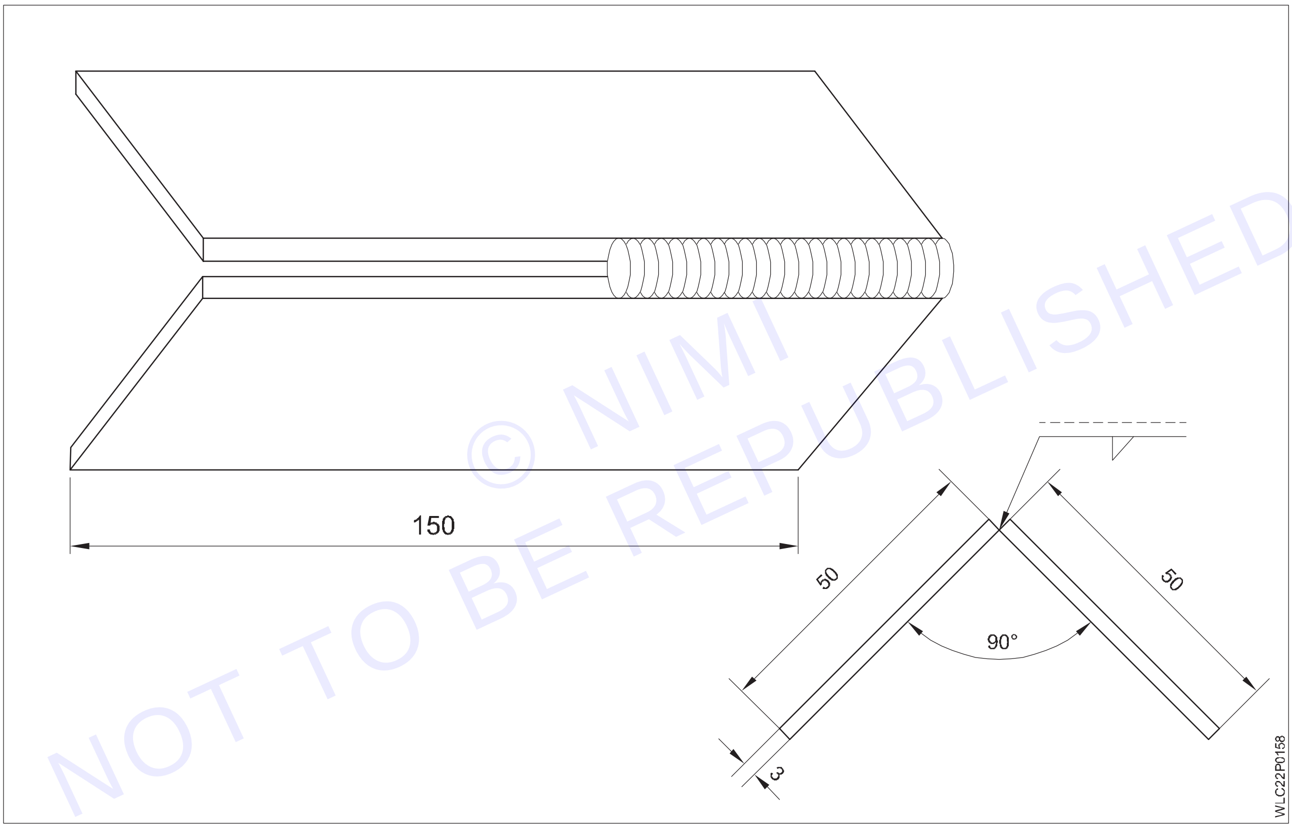


EXERCISE 52(C) : Construct corner joints on M.S. Sheet (3 mm. thick plate) in horizontal position

Objectives

At the end of this exercise you shall be able to

- set the plate as a Lap joint in horizontal position.
- deposit the root run using 0.8 mm diameter filler wire to get a root penetration and fusion.
- avoid overlap on the bottom plate and undercut on the vertical plate.
- set and tack weld the plates in alignment as corner joint.



Job Sequence

- Cut the sheet by shearing machine as per drawing.
- Grind and file the edges of sheet to square.
- Deburr and clean the surface of the plates by carbon steel wire brush and filing.
- Set the plate in the form of Corner joint at 90 degrees with specified root gap in flat position as per drawing.
- Wear protective clothing.
- Connect the torch to positive terminal of the machine.
- Select dia 0.8 mm M.S. electrode
- Set 70 to 90 amps current
- Ensure proper root penetration and even fusion of plate A and B with suitable welding gun/torch angle and arc travel speed.

- Clean the root run using steel wire brush.
- Ensure the undercut in bottom plate is avoided and a leg length of plate thickness 3mm is obtained.
- Clean the second run by wire brush.
- Use tongs while handling the hot job.

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by using a with 100-110 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

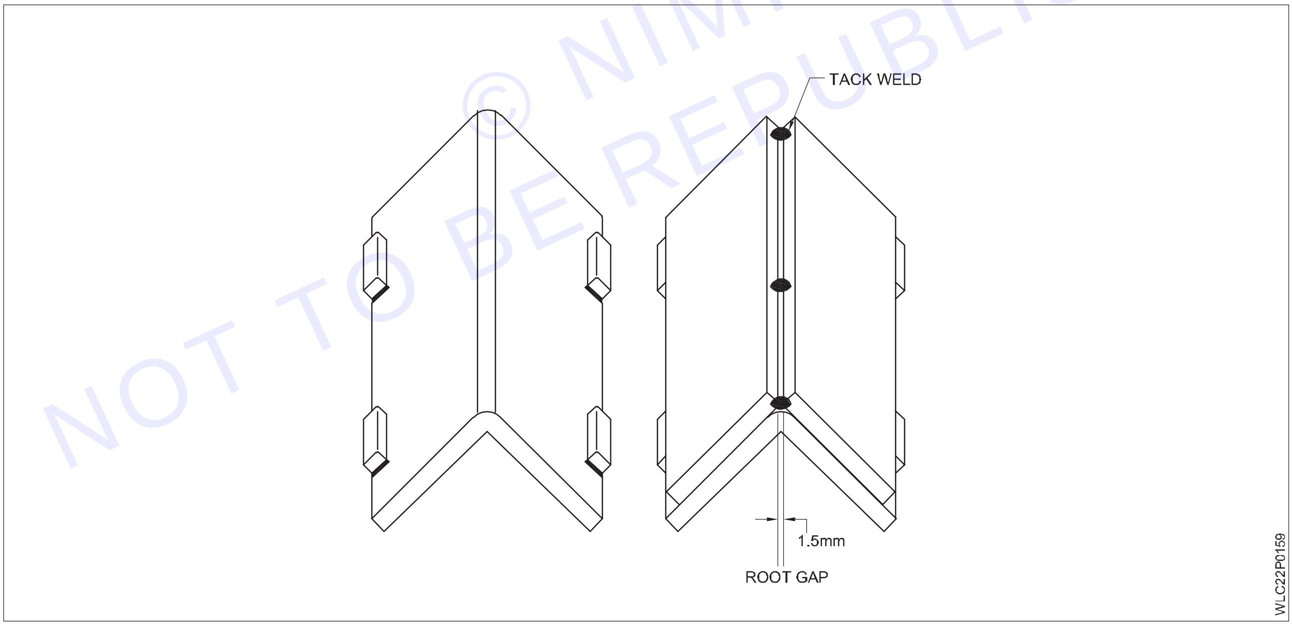
- Check the all connections before welding.
- Welding area should be dry.
- Use welding screen and chipping goggle for eyes and face safety.

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.



Skill Sequence

Construct corner joint on M.S. plate (3 mm. thick plate) in horizontal position by GMAW

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

- construct corner joint on m.s. plate (3 mm. thick plate) in horizontal position by GMAW.

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 90degrees with specified root gap in flat position as per drawing.

5 Wear protective clothing.

6 Connect the torch to positive terminal of the machine.

7 Set current to 90 - 100 amperes/corresponding wire feeding rate 19 to 20 arc voltage and deposit the root.

8 Run using dip transfer mode.

9 Tack weld (min 10 mm length) on both ends of the corner joint.

10 Keep the tack welded job in horizontal position.

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

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

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

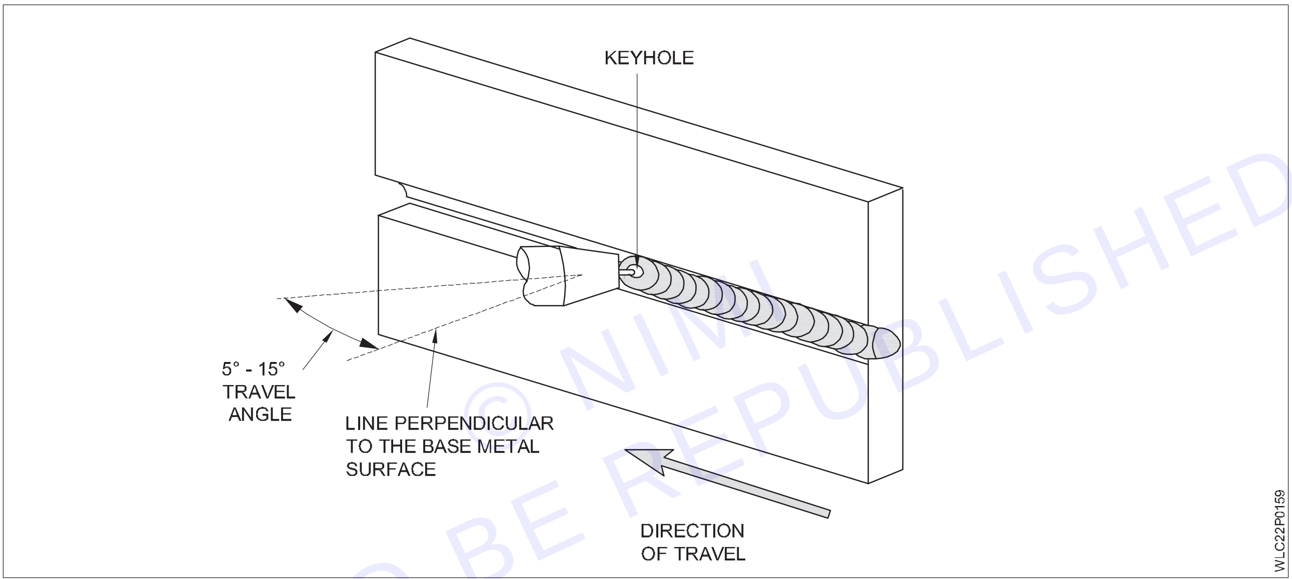
Inspect the fillet corner weld and ensure.

EXERCISE 53 : Make single 'V' butt joint on M.S. (10mm. thick plate) in horizontal position by GMAW

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 Co2 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.



Job Sequence

- Prepare the plates to size (i.e 150 x 50 x 10mm) using gas cutting, grinding and filing.
- Clean the base metal surface along the welding line with a carbon steel wire brush.
- Set the plates in the form of an inverted "T".
- Wear all protective devices.
- Tack weld the 2 plates on either end keeping the T joint in Horizontal position.
- Set the welding parameters as done in earlier exercises.
- Strike the arc keeping proper angles for the torch.
- Deposit the root run without weaving and ensure proper penetration and fill the crater.
- Clean the root run.
- Deposit the 2nd run using stringer bead.
- Clean the 2nd run with wire brush.
- Deposit the 3rd run using stringer bead.
- Clean the 3rd run.
- Check for defects like overlap, undercut, porosity and check for corret leg size and throat thickness.

Skill Sequence

Make single 'V' butt joint on M.S. (10mm. thick plate) in horizontal position by GMAW

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

- make single 'V' butt joint on M.S. (10mm. thick plate) in horizontal position by GMAW.

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 to form an inverted T joint.

Tack weld the two plates at the ends.

Set the welding conditions: Adjust the gas flow rate to 8 to 10 LPM.

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

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

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 800 against the welding direction and at 450 against the base metal surface.

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

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.

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 2nd run using stringer bead technique such that the bead covers two thirds of the root run deposit and the bottom plate.

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

Deposit the 3rd run using stringer bead technique such that the bead covers the root run, two thirds of 2nd run and the vertical plate member.

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

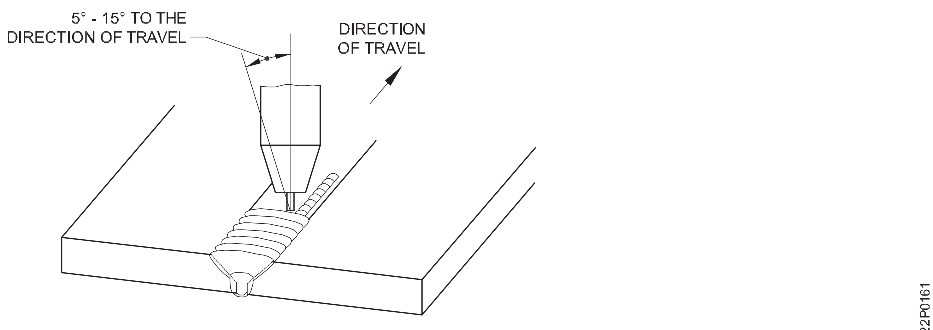
The torch angle between the plates has to be changed.

The torch angles are to be changed for 2nd and 3rd 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.

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 3rd run.

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



BACK HAND TECHNIQUE

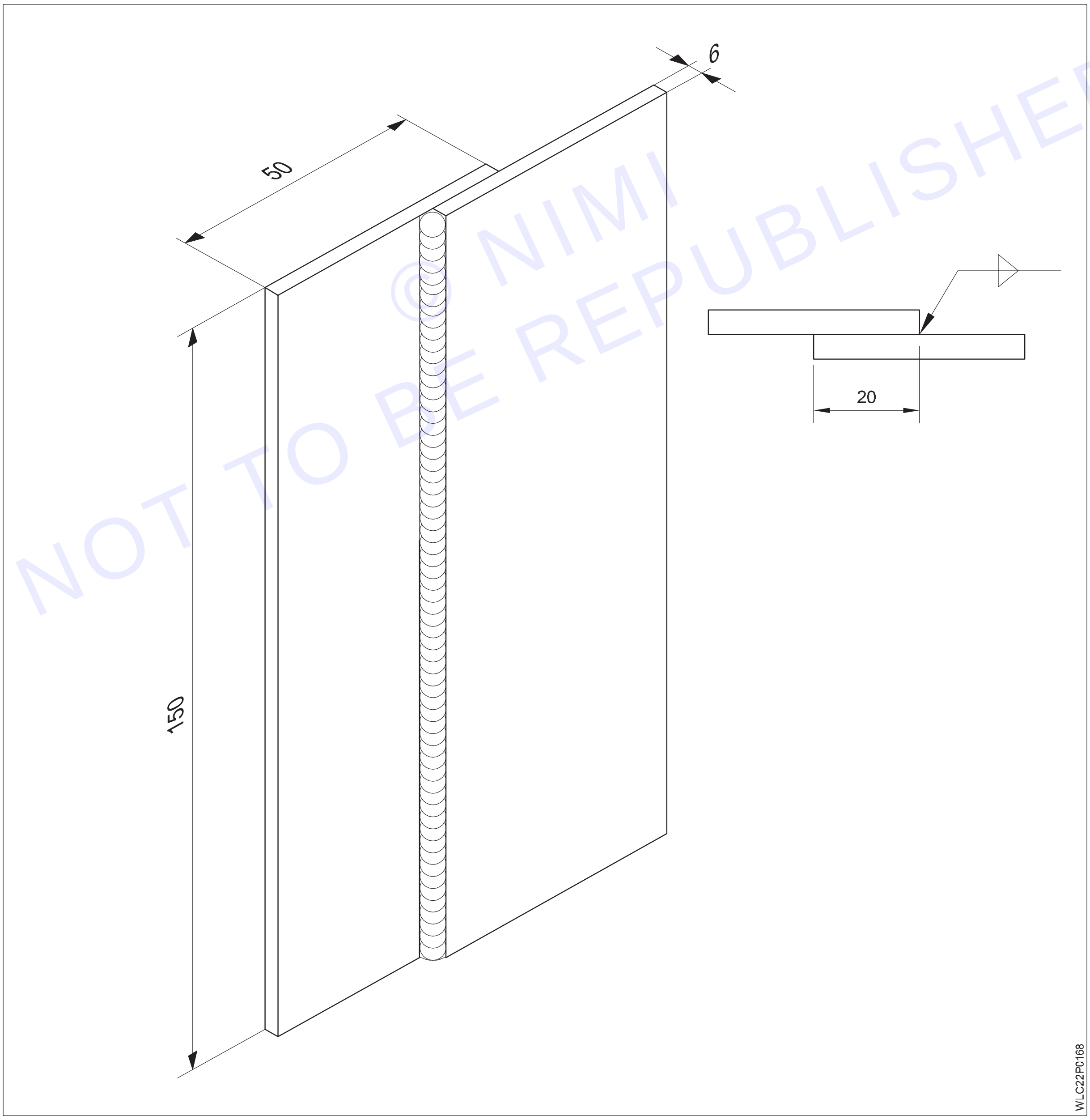
PRE-SETTING TO COMPENSATE FOR ANGULAR DISTORTION

EXERCISE 54(A) : Demonstrate fabrication of lap joint on M.S. plate (sheet 6 mm. thick plate) in vertical downward progression by GMAW

Objectives

At the end of this exercise you shall be able to

- prepare the plates and tack weld them as lap joint.
- set the tack welded joint in the weld positioner in vertical position.
- set the root run and 2ndrun 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.



Job Sequence

- Cut the sheet by shearing machine as per drawing.
- Grind and file the edges of sheets to square.
- Deburr and clean the surface of the plates by carbon steel wire brush and filling.
- Set the plate A on the plate B In the form of lap as per drawing.
- Wear protective clothes.
- Connect the torch to the positive terminal of the machine.

Electrode:

- Select dia 0.8.mm M.S. electrode - Set 70 to 90 amps current
- Ensure proper root penetration and even fusion of plate A and B with suitable welding gun / torch angle and Arc travel speed

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run with 100-110 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

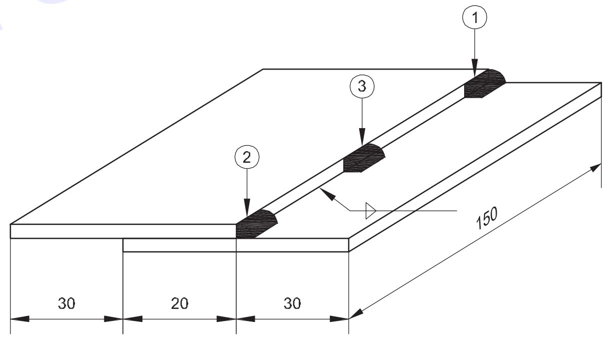
- Check the all connections before welding
- Welding area should be dry area
- Use welding screen and chipping goggle for eyes and face safety

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.



TACKING A LAP JOINT

Skill Sequence

Demonstrate fabrication of lap joint on m.s. plate (sheet 6 mm. thick plate) in vertical downward 0progression by GMAW

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

- demonstrate fabrication of lap joint on m.s. plate (sheet 6 mm. thick plate) in vertical downward progression by GMAW.

- Cut the sheet by shearing machine as per drawing.
- Grind and file the edges of sheets to square.
- Deburr and clean the surface of the plates by carbon steel wire brush and filling.
- Set the plate A on the plate B in the form of lap as per drawing.
- Wear protective clothes.
- Connect the torch to the positive terminal of the machine
- Set 90-100A current/corresponding wire feed rate, 19 to 20 arc voltage and deposit the run using Dip transfer mode.
- Tack weld (min. 10mm length) on both ends of the lap joint
- Keep the tack welded job in vertical position on a weld positioner.
- Strike anare and move the torch steady straight from the bottom if the joint upwards.
- Weld the lap joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique.
- Ensure good leg length and even fusion of plates. 13 Avoid under cut.
- Ensure the edges of the plate is not melted off due to excessive weaving.
- Ensure there is no undercut at the other toe of the lap weld on plate.
- Clean the bead by wire brush.
- Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with a 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

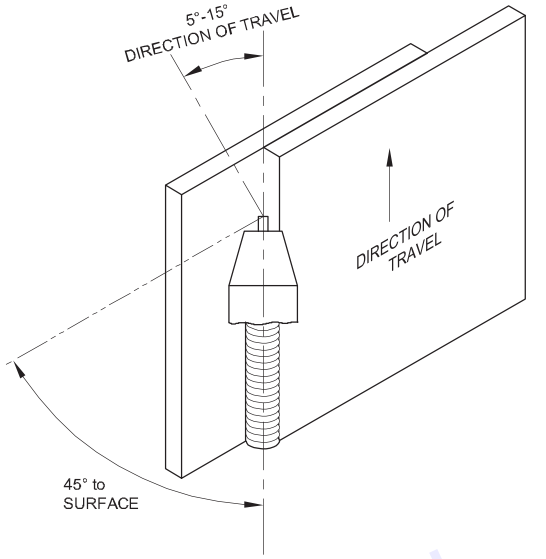
Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld and ensure. (Fig 1)

- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- it is free from surface defects.

Fig 1

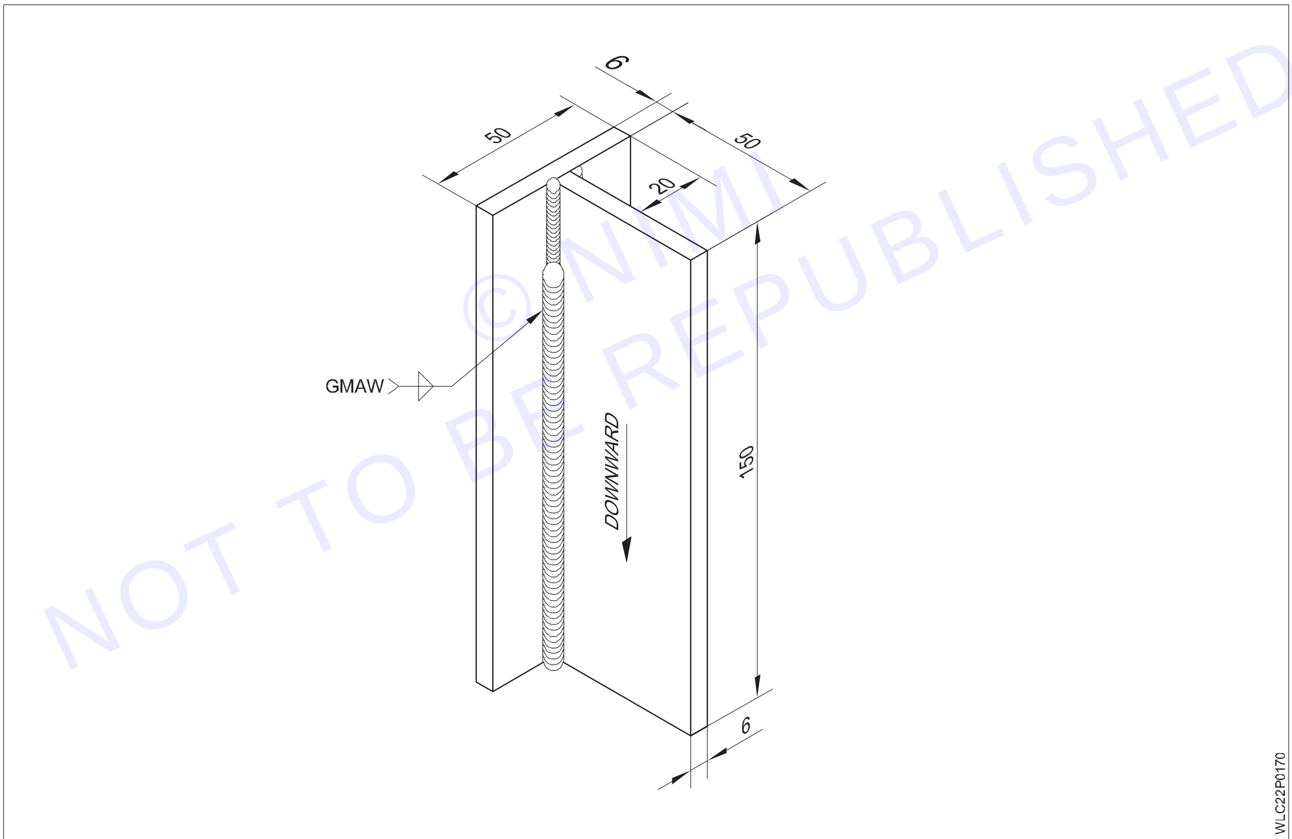


EXERCISE 54(B) : Demonstrate fabrication of tee joint on M.S. plate (sheet 6 mm. thick plate) in vertical downward progression by GMAW

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 2ndrun 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 inter bead cleaning.



Job Sequence

- Cut the sheet by shearing machine as per drawing.
- Grind and file the edges of sheet to square.
- Deburr and clean the surface of the plates by carbon steel wire brush and filing.
- Wear protective clothing.
- Connect the torch to positive terminal of the machine.
- Select dia 0.8.mm ms electrode

- Set 70 to 90 amps current
- Ensure proper root penetration and even fusion of plate A and B with suitable welding gun / torch angle and Arc travel speed
- Clean the root run using steel wire brush

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run with 100-110 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Ensure the undercut in bottom plate is avoided and a leg length of plate thickness 10 mm is obtained.
- Clean the second run by wire brush
- Use tongs while handling the hot job
- Check the all connections before welding
- Welding area should be dry area
- Use welding screen and chipping goggle for eyes and face safety

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.

Skill Sequence

Demonstrate fabrication of tee joint on m.s. plate (sheet 6 mm. thick plate) in vertical downward progression by GMAW

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

- demonstrate fabrication of tee joint on m.s. plate (sheet 6 mm thick plate) in vertical downward progression by GMAW.

1 Prepare the plates to size (i.e150x50x10 mm) 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 welds 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 Depositthe2ndrun.

11 Clean the 2ndrun.

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

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with a 4mmø medium coated MS electrode and 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

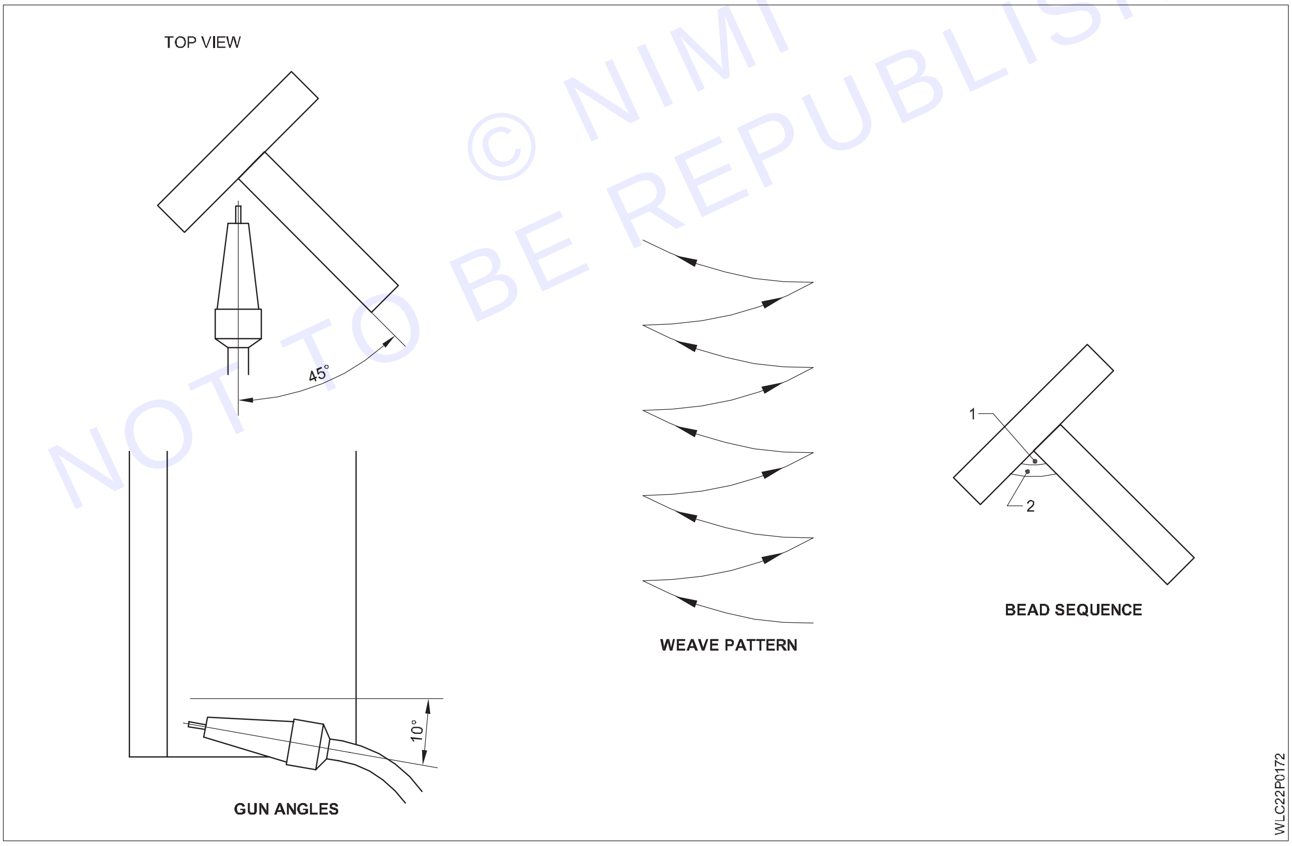
Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the T fillet weld and ensure.

Safetyprecautions:

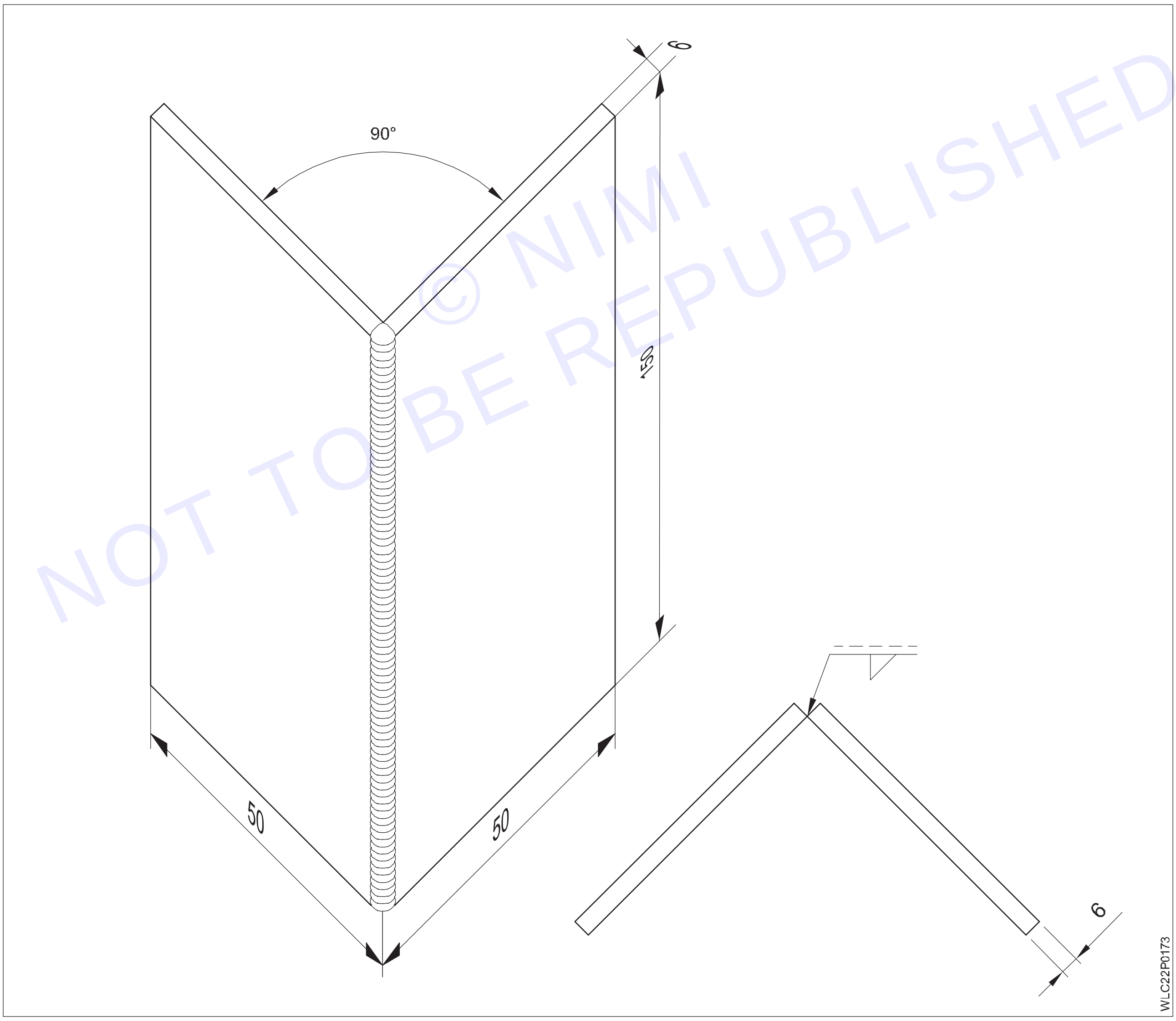
- Check the all connections before welding
- Welding area should be dry area
- Use welding screen and chipping goggle for eyes and face safety
- Wear protective clothing's



EXERCISE 54(C) : Demonstrate fabrication of corner joints on m.s. plate (sheet 6 mm thick plate) in vertical downward progression by GMAW

Objectives

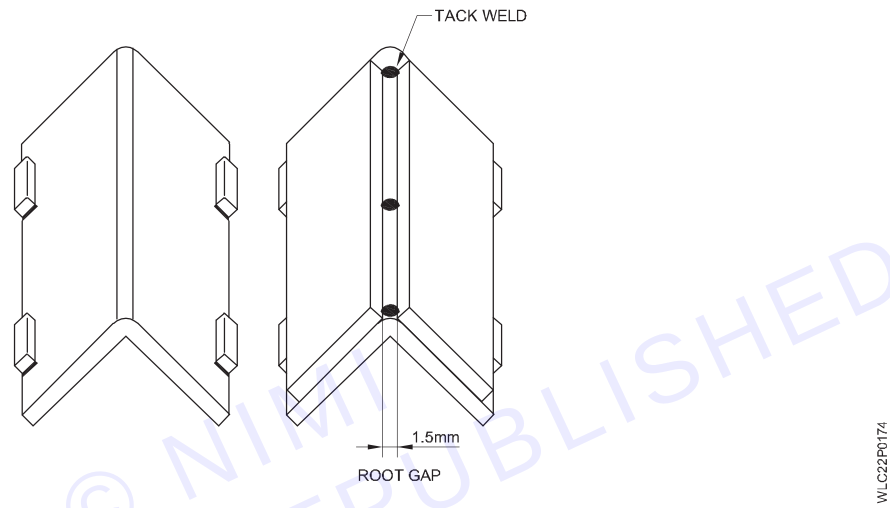
At the end of this exercise you shall be able to
- prepare plate pieces to size as per drawing.
- set and tack weld the plates in alignment as corner joint.
- set the corner joint in vertical position for welding.
- deposit the bead with appropriate amount of filler metal.
- clean and inspect for surface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



Job Sequence

- Cut the sheet by shearing machine as per drawing.
- Grind and filet heed gas of sheets to square.
- Deburr and clean the surface of the plates by carbon steel wire brush and filling.
- Set the plate in the form of corner as per drawing.
- Wear protective clothes.
- Connect the torch to the positive terminal of the machine.
- Set 90-100 A current/corresponding wire feed rate, 19 to 20 arc voltage and deposit the run using Dips transfer mode.
- Tack weld (min. 10mm length) on both ends of the corner joint as showing Fig 1.

Fig 1



- Keep the tack welded job in vertical position on a weld positioner.
- Strike an arc and move the torch steady straight from the tor if the joint down wards.
- Weld the corner joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique.
- Ensure good leg length and even fusion of plates.
- Avoid under cut
- Ensure the edges of the plate is not melted off due to excessive weaving.
- Ensure the region under cut at the toe of the weld on plate.
- Clean the bead by wire brush.
- Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by using a 3.15mm dia. Medium coated M.S. electrode with 100-110 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Check the all connections before welding
- Welding area should be dry area
- Use welding screen and chipping goggle for eyes and face safety

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size

- Inspect the lap fillet weld for surface defects and size.

Skill Sequence

Demonstrate fabrication of corner joints on M.S. plate (sheet 6 mm thick plate) in vertical downward progression by GMAW

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

- demonstrate fabrication of corner joints on m.s. plate (sheet 6 mm thick plate) in vertical downward progression by GMAW.

- Cut the sheet by shearing machine as per drawing.
- Grind and filet heed gas of sheets to square.
- Deburr and clean the surface of the plates by carbon steel wire brush and filling.
- Set the plate in the form of corner as per drawing.
- Wear protective clothes.
- Connect the torch to the positive terminal of the machine.
- Set 90-100 A current/corresponding wire feed rate, 19 to 20 arc voltage and deposit the run using Dips transfer mode.
- Tack weld (min. 10mm length) on both ends of the corner joint as showing Fig1.
- Keep the tack welded job in vertical position on a weld positioner.
- Strike an arc and move the torch steady straight from the tor if the joint down wards.
- Weld the corner joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique.
- Ensure good leg length and even fusion of plates.
- Avoid under cut
- Ensure the edges of the plate is not melted off due to excessive weaving.
- Ensure the region under cut at the toe of the weld on plate.
- Clean the bead by wire brush.
- Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead

Noe: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with a 4mmø medium coated MS electrode and 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld and ensure.

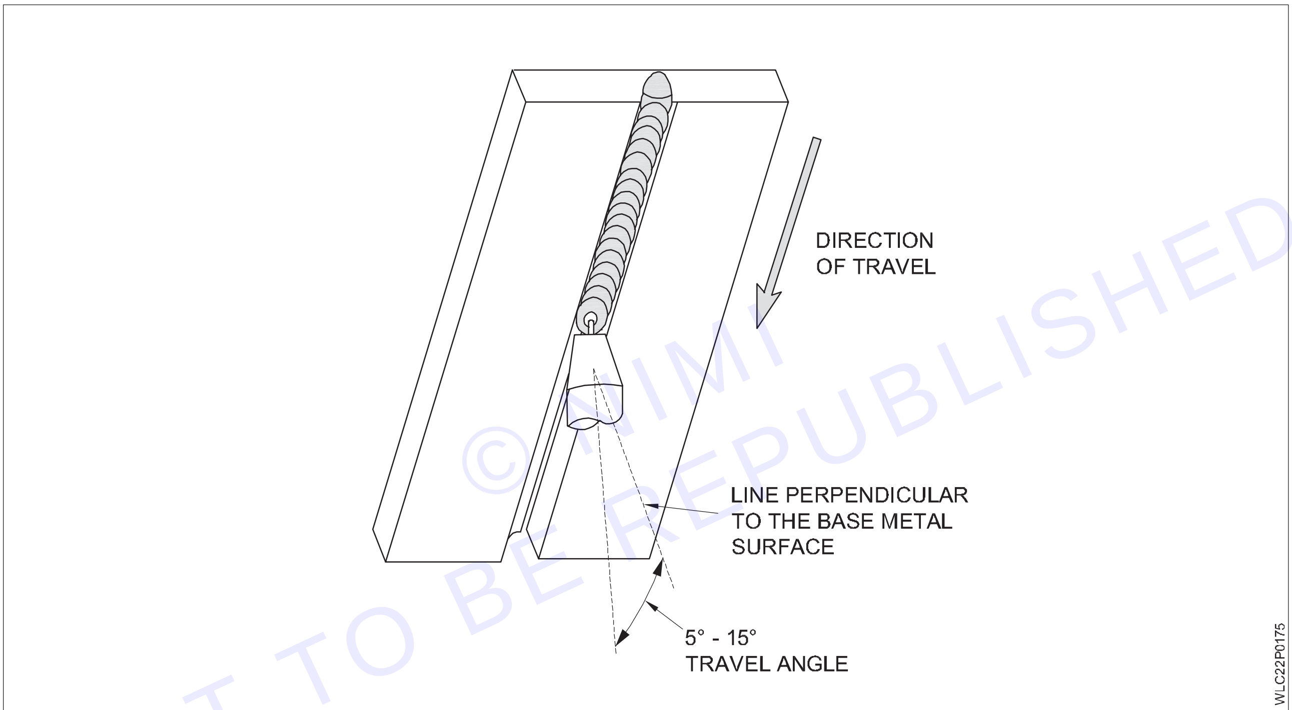
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- It is free from surface defects.

EXERCISE 55 : Make single v butt joint on m.s. (10 mm. thick plate) in vertical position by GMAW

Objectives

At the end of this exercise you shall be able to

- prepare the plates with necessary bevelling and root face
- preset the plates in alignment in vertical plane with necessary root gap and tack weld
- deposit the root run with root penetration and uniform melting of both root faces of the joint
- set up the GMAW machine and set welding parameters.



Job Sequence

- Cut the plate by using hacksaw cutting as per drawing
- Clean the joining edges and surface of the plates
- Adjust the power source and wire feeder to obtain 18 to 19 volts and 90 and 100 amperes, gas flow 8-10 LPM.
- Thoroughly clean the pieces to be joined. Pay particular attention to the top of the plate, the side walls of the groove and the underside of the joint. Grind or file a1.5 mm root face on each beveled edge
- Tack the pieces together and position
- Put spacers under the plate so that you don't weld the plate to your table
- 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 back hand technique. 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 upon 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

- Complete the joint using the bead sequence. Use as light weave to help the weld flow and to use to the side walls of the groove and the previous beads
- 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 at least 1mm above the surface of the base metal and also should not exceed beyond 1.5.

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run with 100-110 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion with150-160amps welding current.

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the butt fillet weld for surface defects and size.

Skill Sequence

Make single V butt joint on M.S. (10 mm. thick plate) in vertical position by GMAW

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

- make single v butt joint on m.s. (10 mm. thick plate) in vertical position by GMAW.

Setting and tacking the butt joint.

Set the butt joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 surfaces are perfectly cleaned and they contact each other properly. with 120-amp current for tacking.

Set the joint in a vertical position using angle iron.

Note: Welding the lap fillet joint in flat position

Deposit root run with 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

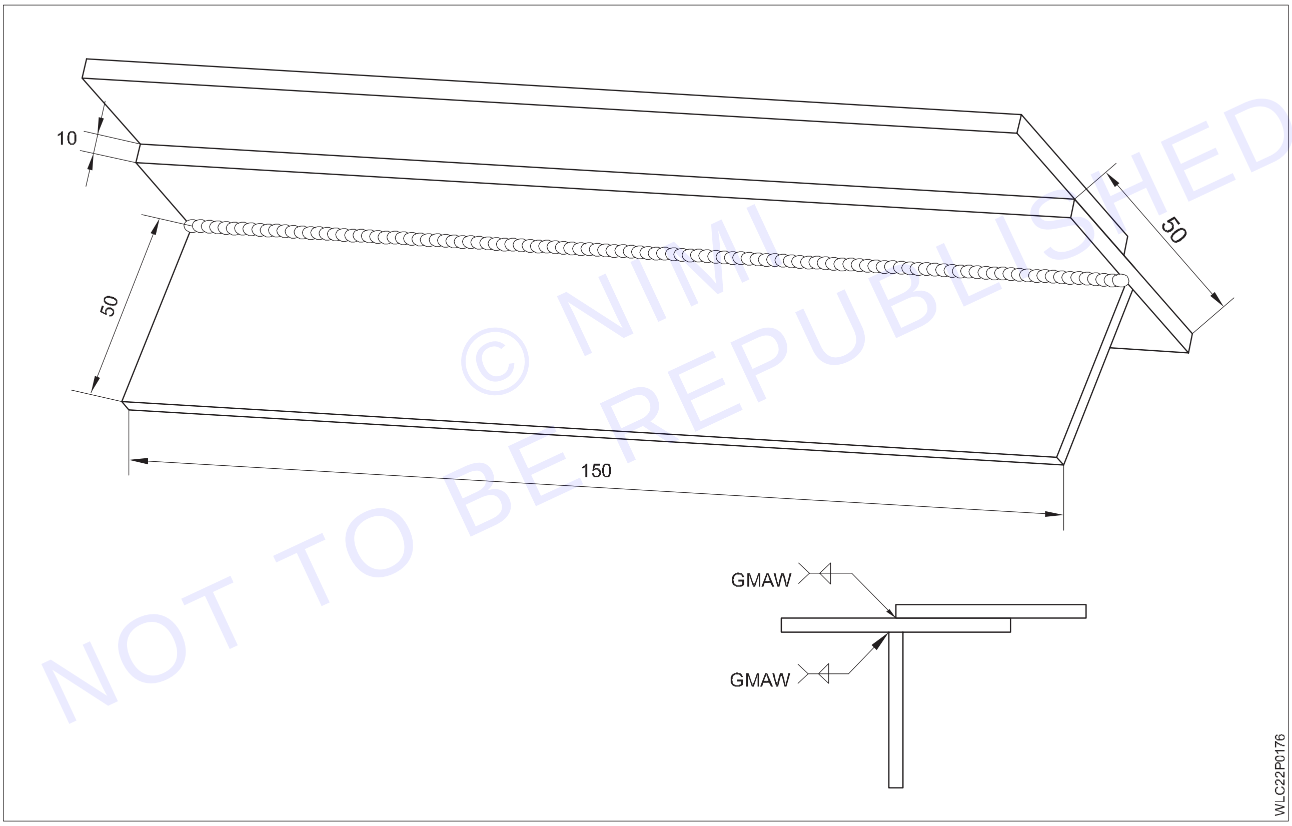
Inspect the butt weld and ensure.

EXERCISE 56 : Progression Lap, Tee and joints on M.S. plate (10 mm. thick plate) in Overhead position by GMAW

Objectives

At the end of this exercise you shall be able to

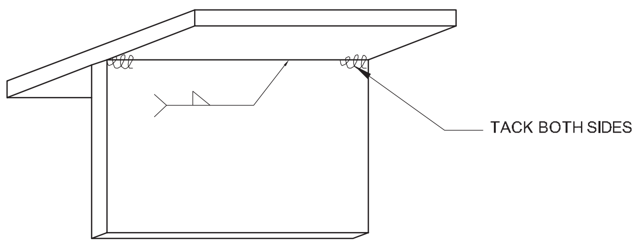
- prepare plate pieces to size as per drawing
- setand tack weld the plates as lap and 'T' as per drawing
- set the lap and 'T' joints in overhead position for welding
- deposit the metal in the joints with proper leg length
- inspect for surface defects on the weld and bead appearance.



Job Sequence

- Cut the sheets by power shearing machine as per drawing.
- Grind and file the edges of sheets to square.
- Use plain goggles while grinding
- Deburr and clean the surface of the sheets by carbon steel wire brush and filling.
- Set the sheet B on the sheet A in the form of Tee as per drawing
- Tack weld (min.10 mm length) on both ends of theT eejoint
- Set the sheet Cas Lap joint as per drawing Fig 1 on the 50mm wide sheet A.

Fig 1



- Tack weld (keeping minimum length of 10mm) on both sides of the lap joint
- Ensure proper leg length and even fusion of sheets A and Bwith suitable welding gun/torch angle and arc travel speed.
- Clean the welded joint by wire brush.
- Deposit the bead on the lap joint (joint II) with the same parameters and technique used for theTee joint.
- Ensure good penetration and even fusion of sheets A and C with suitable torch angle and arc travel.
- Avoid under cut on sheet C
- Ensure the edge of the sheet A (at the toe of the weld) is not melted off due to excessive weaving.
- Ensure there is noundercutattheothertoeofthelapweldonsheetC.
- Clean the bead and the lap joint with wire brush
- Inspect the welded joint for undercut, uneven bead,edgeoftheplatemeltedoff,distortion and good bead profile.

Note : Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by using a 3.15mm dia. Medium coated M.S. electrode with 100-110 amps current.

Note : Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

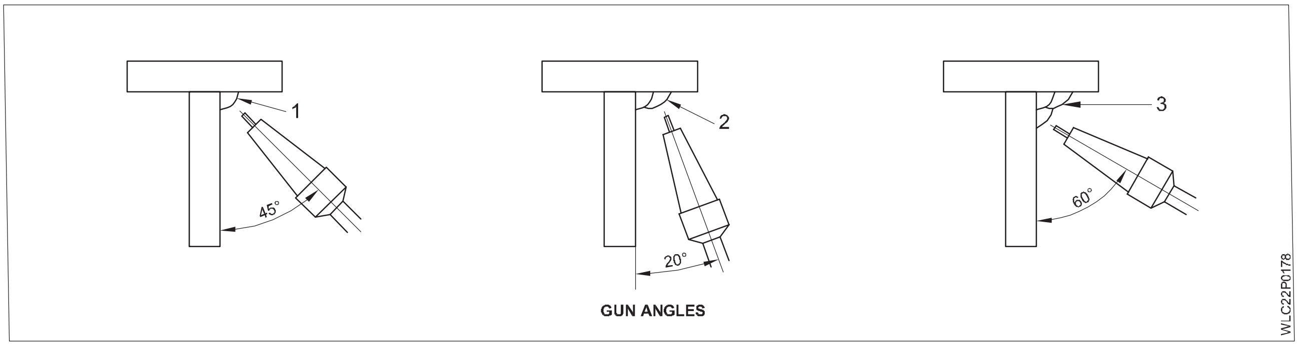
- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion using a 4.00 mm dia. Medium coated M.S. electrode with150-160amps welding current.

Note : Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note : Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.



Skill Sequence

Progression Lap, Tee and joints on M.S. plate (10 mm. thick plate) in Overhead position by GMAW

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

- progression lap, tee and joints on m.S. Plate (10 mm.thick plate) in overhead position by GMAW.

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.

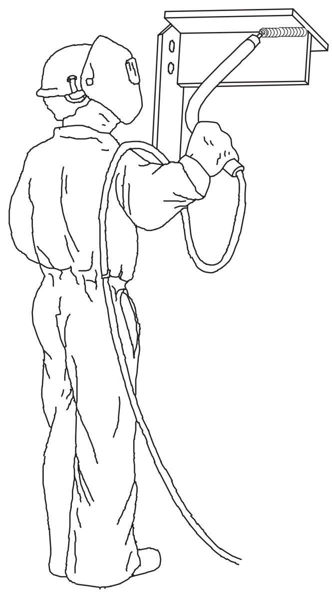
Ensure that the torch assembly hose, containing the spiral, filler wire, gas hose etc is long enough so that it can be carried over your shoulder while welding in over head position refer Fig 1.

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

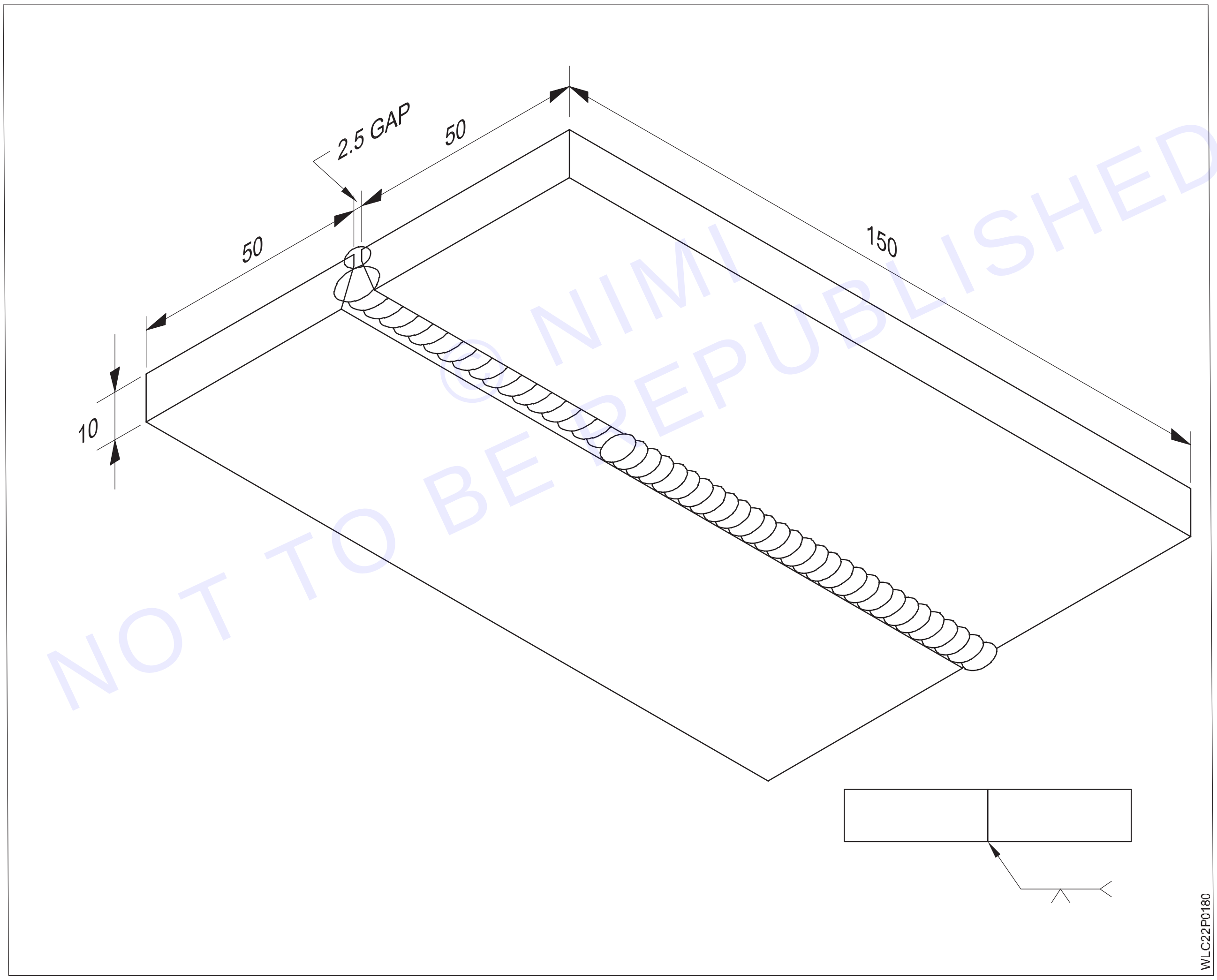


EXERCISE 57 : Review single V butt joint on M.S. plate (10 mm. thick plate) in over head position by GMAW

Objectives

At the end of this exercise you shall be able to

- prepare the plates with necessary bevelling and root face
- preset the plates in alignment in vertical plane with necessary root gap and tack weld
- deposit the root run with root penetration and uniform melting of both root faces of the joint
- set up the GMAW machine and set welding parameters.



Job Sequence

- Cut the plate by using hacksaw cutting as per drawing
- Clean the joining edges and surface of the plates
- Adjust the power source and wire feeder to obtain 18 to 19 volts and 90 and 100 amperes, gas flow 8-10 LPM.

- 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 a1.5 mm root face on each beveled edge
- Tack the pieces together and position
- Put spacers under the plate so that you don't weld the plate to your table
- 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 back hand technique. 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 leadingedge of the puddle, you can cause the bead to penetrate through the joint and fuse both rootfaces.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 to of ar upon 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
- Complete the joint using the bead sequence. Use a slight weave to help the weld flow and to fuse to the side walls of the groove and the previous beads
- When you have completed the weld, cool it and examine it. The root should show full penetration along the entirelength. The rootreinforcement should protrude beyond the joint from 0.5 to 1mm. The face of the weld should merge smoothly with the base metal. There inforcement should be atleast 1mm above the surface of the base metal and also should not exceed beyond 1.5.

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the 'V' joint in a flat position.
- Deposit root run by using with 100-110 amps current. By outer head position.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion with150-160amps welding current.

Note: Prevent the upper edge of the plate from melting off.

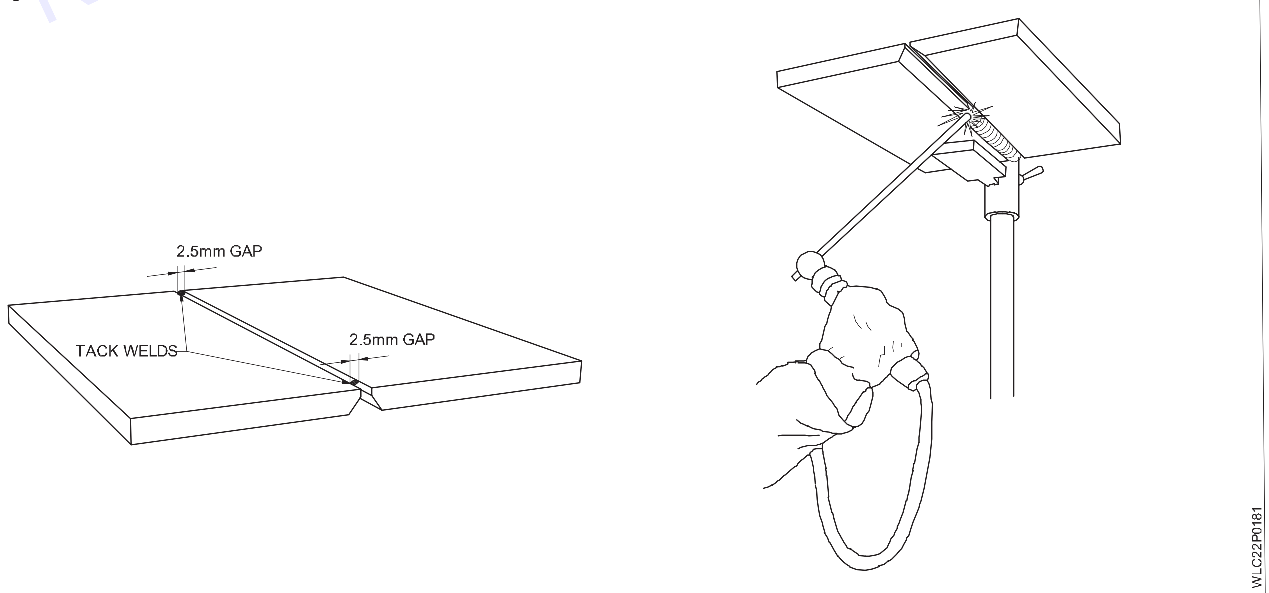
- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.

Setting and tacking the lap joint (Fig 1)

Fig 1



Skill Sequence

Reviewsingle V butt joint on M.S. plate (10 mm. thick plate) in over head position by GMAW

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

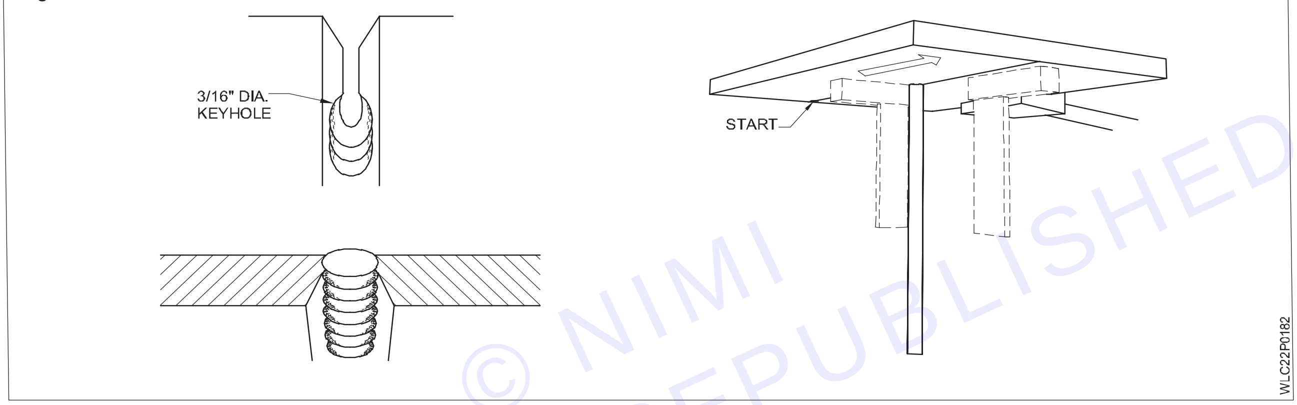
- review single v butt joint on m.s. plate (10 mm. thick plate) in over head position by GMAW.

Use the gun angle shown in Fig 1 and use back hand technique to put in the first pass. Weave the gun slightly to ensure fusion along the toe of the weld.

Cool the plate, clean it, and put in two more passes using the gun angles shown in Fig 1.

Cool the plate and weld the second side of the T assembly, using the backhand technique and the gun angles shown in Fig 1.

Fig 1



It is important to ensure that the T 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 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 overhead position.

This will help in maintaining the constant distance between the torch and the Joint (base metal) to be welded.

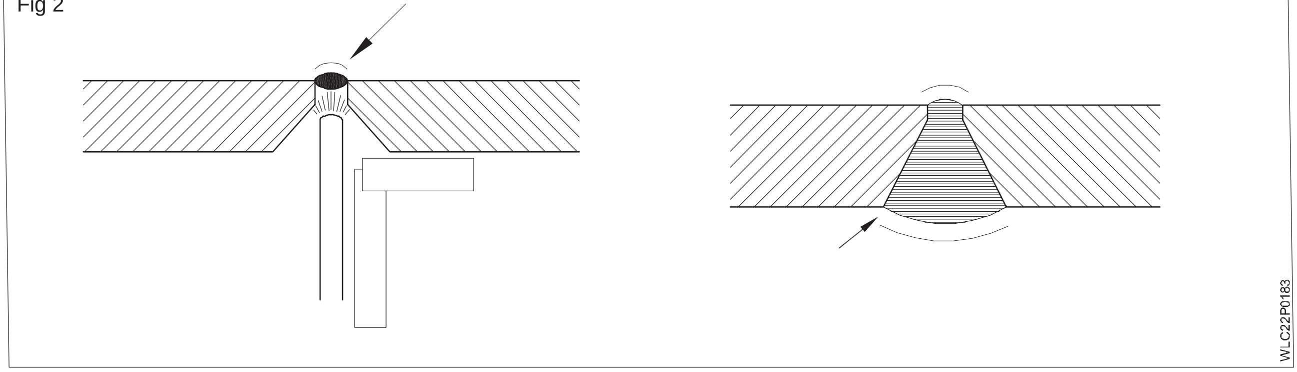
Using a welding helmet and wearing a welder's overall is very essential to protect the whole body from the weld spatters in overhead welding position.

Use back hand welding technique and stringer bead technique.

For depositing the root, 2nd and 3rd runs, the torch is held at angles shown in the Fig 2.

The torch angle with the vertical plate of the T is changed for root, 2nd and 3rd runs in order to get the metal deposited at proper places as shown in the (Fig 2) and to get the necessary leg length and throat thickness for the fillet weld.

Fig 2

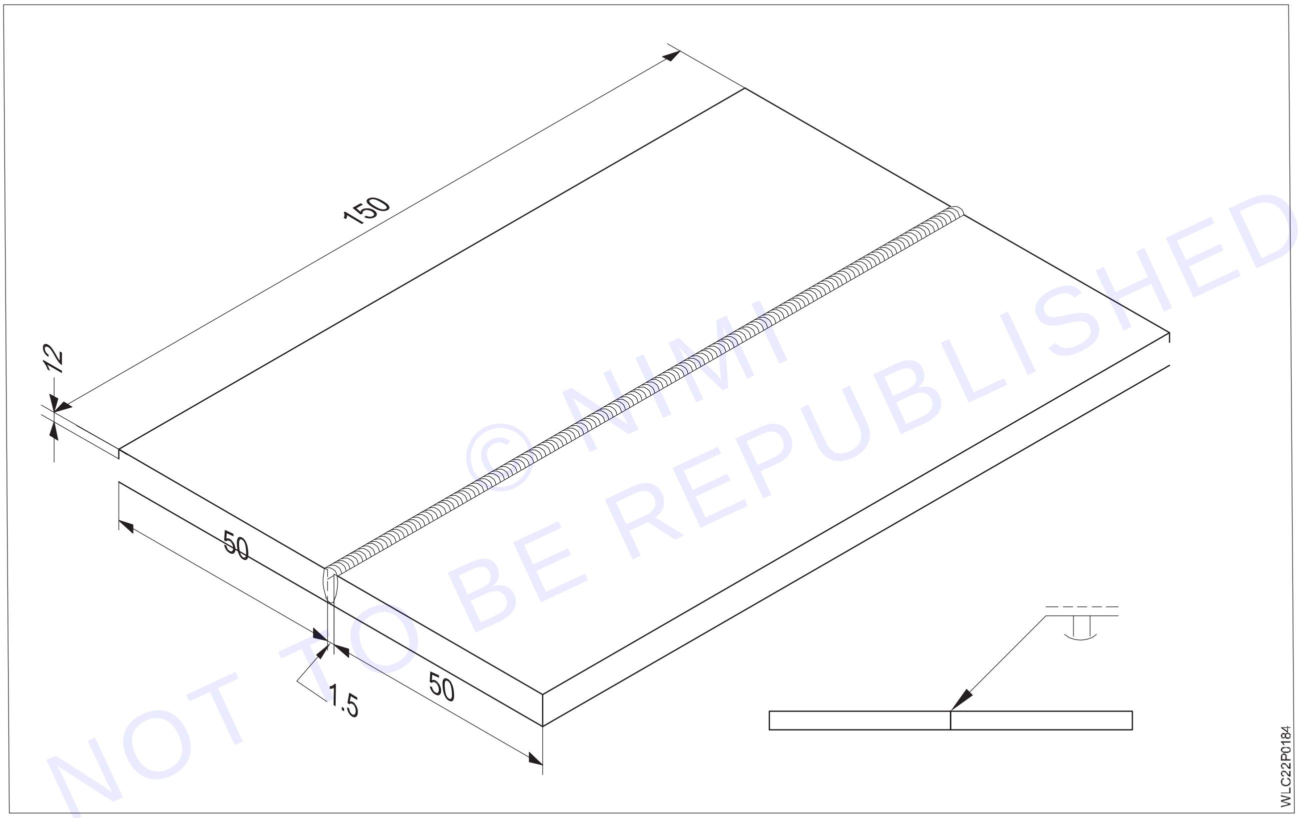


EXERCISE 58(A) : Monitor square butt joint by flex cored arc welding (on 12mm thick plate)

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.
- deposited the bead with appropriate amount of filler metal.
- clean and inspect for surface defects and penetration and bead appearance.



Job Sequence

- Prepare the sheets as per drawing using shearing and grinding.
- Use necessary safety precautions.
- Clean the edges of the sheet.
- Set the sheets as a square butt joint and tack weld at the end
- Fix the joint in on backing strip in flat position.
- Strike an arc and move the torch steadily.
- Use proper torch angles with slight weaving.

Note: Wear protective clothing.

- Tack-weld on both ends.

- Set the V joint in a flat position.
- Deposit root run by using appropriate dia. Flux coared electrode with 100-110 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Check the all connections before welding
- Welding area should be dry area
- Use welding screen and chipping goggle for eyes and face safety

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.

Skill Sequence

Monitor square butt joint by flex cored arc welding (on 12mm thick plate)

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

- monitor square butt joint by flex cored arc welding (on 12mm thick plate)

- Prepare the sheets as per drawing using shearing and grinding.
- Use necessary safety precautions.
- Clean the edges of the sheet.
- Set the sheets as a square butt joint and tack weld at the end
- Fix the joint in on backing strip in flat position.
- Strike an arc and move the torch steadily.
- Use proper torch angles with slight weaving.

Note: Avoid side-to-side movement of the electrode.

- Deslag and clean the root bead thoroughly.
- Deposit the final covering run with and 160 amp current.
- Give side-to-side movement to the electrode not more than 2.5 times its dia.
- Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

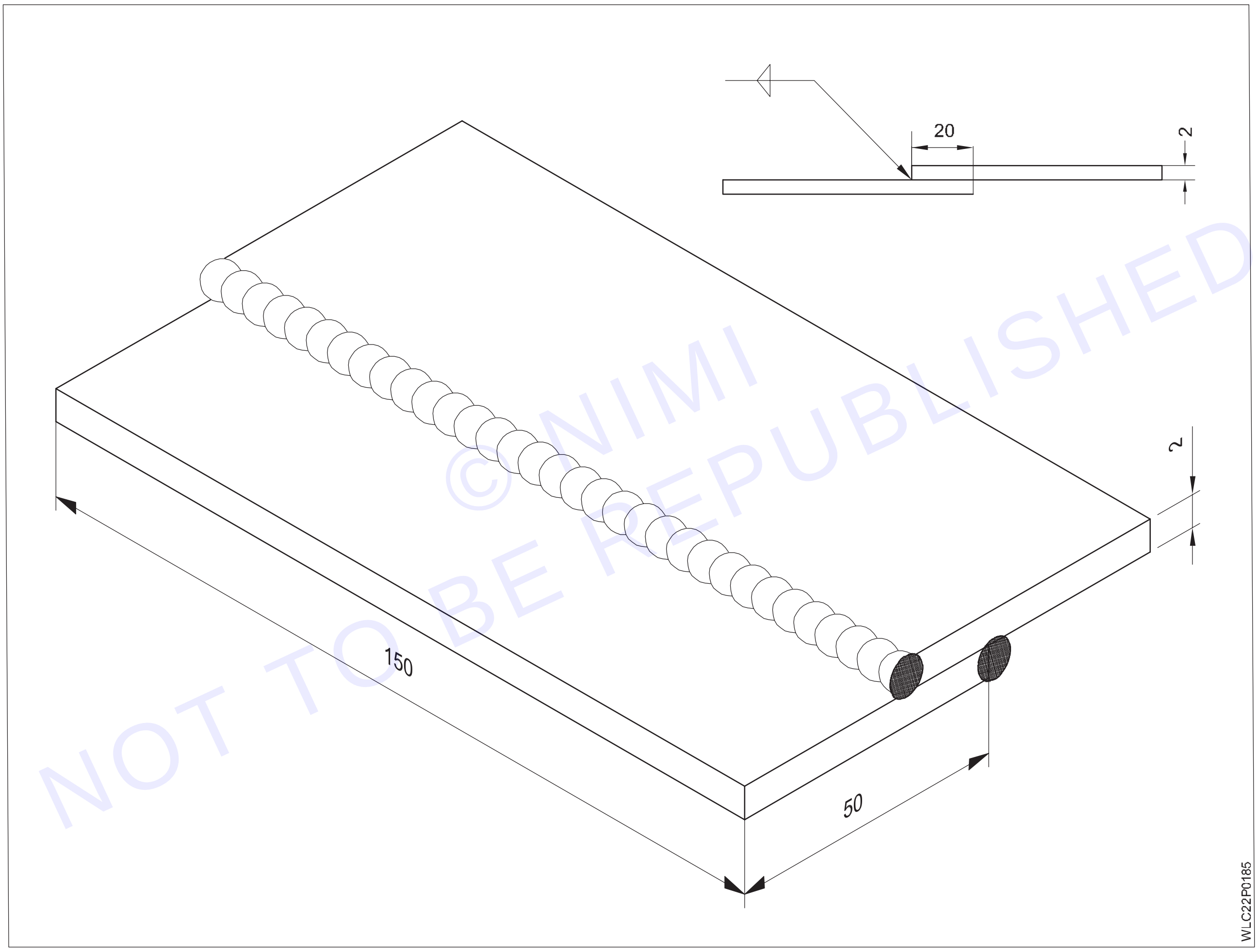
- Remove the slag with a chipping hammer.
- Clean the weld with a steel wire brush.
- Inspect the lap fillet weld and ensure.
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- It is free from surface defects.

EXERCISE 58(B) : Lap joint on S.S. sheet 2mm thick by GMAW

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.
- set up the GMAW machine and set welding parameters.



Job Sequence

- Cut the plate by using hacksaw cutting as per drawing
- Clean the joining edges and surface of the plates
- Set the plate A on the plate B in the form of tee as per drawing
- Tack weld on both ends of the Lap joint
- Set 90-100A current/corresponding wire feed rate, 19 to 20 arc voltage and deposit the run using Dip transfer mode
- Weld the lap joint by using 0.5 mm dia. Mild steel filler wire and using stringer bead welding technique.
- Ensure good leg length and even fusion of plates.

- Avoid under cut
- Ensure the edges of the plate is not melted off due to excessive weaving
- Ensure there is no undercut at the other toe of the lap weld on plate

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion using a 4.00 mm dia. Medium coated M.S. electrode with150-160amps welding current.

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.

Skill Sequence

Lap joint on S.S. sheet 2 mm thick by GMAW

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

- lap joint on S.S. sheet 2mm thick by GMAW.

Setting and tacking the lap joint

Set the lap joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly. Use current for tacking.

Set the joint in a flat position using angle iron.

Welding the lap fillet joint in flat position

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Use the same wire angle as was used for the root bead.

Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld and ensure:

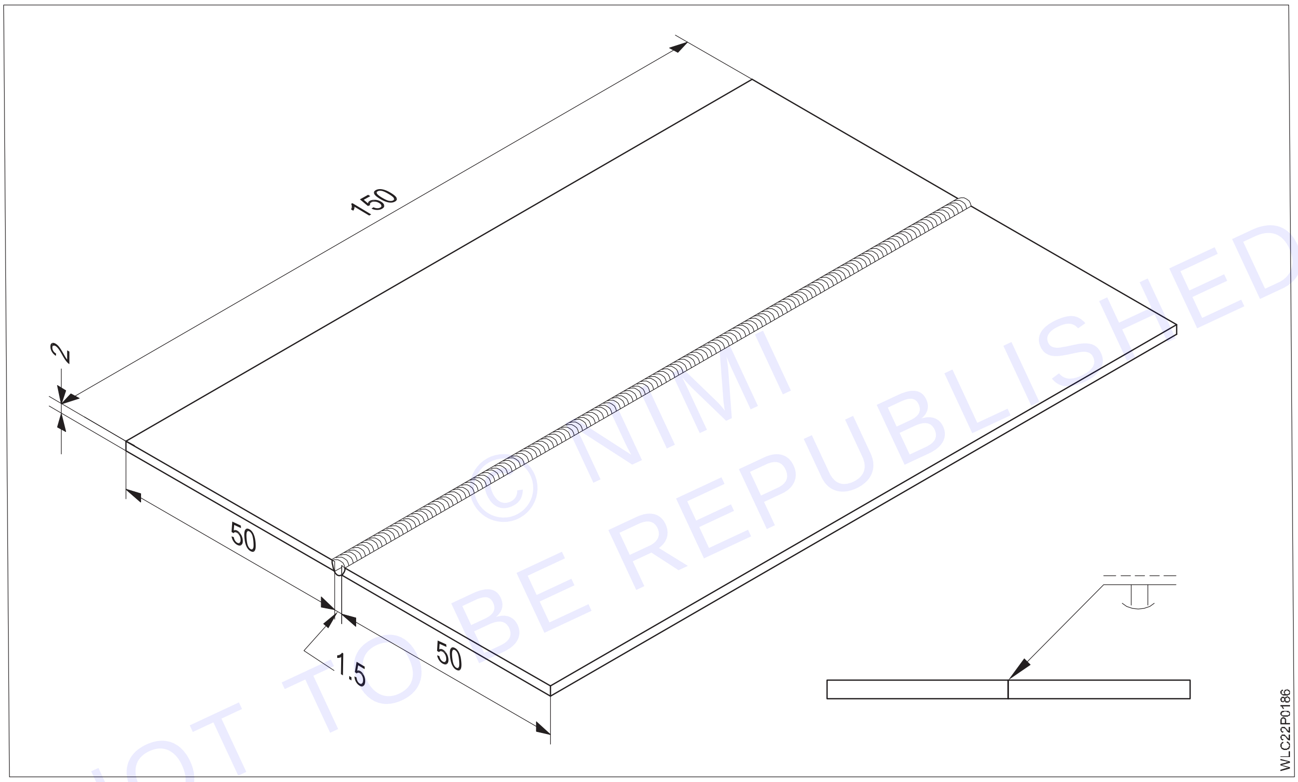
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- It is free from surface defects.

EXERCISE 58(C) : Monitor square butt joint on S.S sheet 2 mm thick by GMAW

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.
- deposited the bead with appropriate amount of filler metal
- clean and inspect for surface defects and penetration and bead appearance.



Job Sequence

- Cut the plates by gas cutting as per drawing
- Set the pieces in the form of as per drawing single Square Butt joint
- As per required
- Set 90 to 100 amps current
- Adjust the power source and wire feeder to obtain 18 to 19volts and 90 and 100 amperes, gas flow 8-10 LPM
- 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 a0.5 mm root face on each beveled edge

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the butt joint in a flat position.
- Deposit root run by using with 100-110 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion using with150-160amps welding current.

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the butt fillet weld for surface defects and size.

Skill Sequence

Monitor square butt joint on S.S sheet. 2 mm thick by GMAW

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

- monitor square butt joint on s.s sheet. 2 mm thick by GMAW.

Setting and tacking the butt joint

Set the butt joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly current for tacking.

Set the joint in a flat position using angle iron.

Welding the butt joint in flat position

Deposit root run with a with 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with a 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the butt fillet weld and ensure:

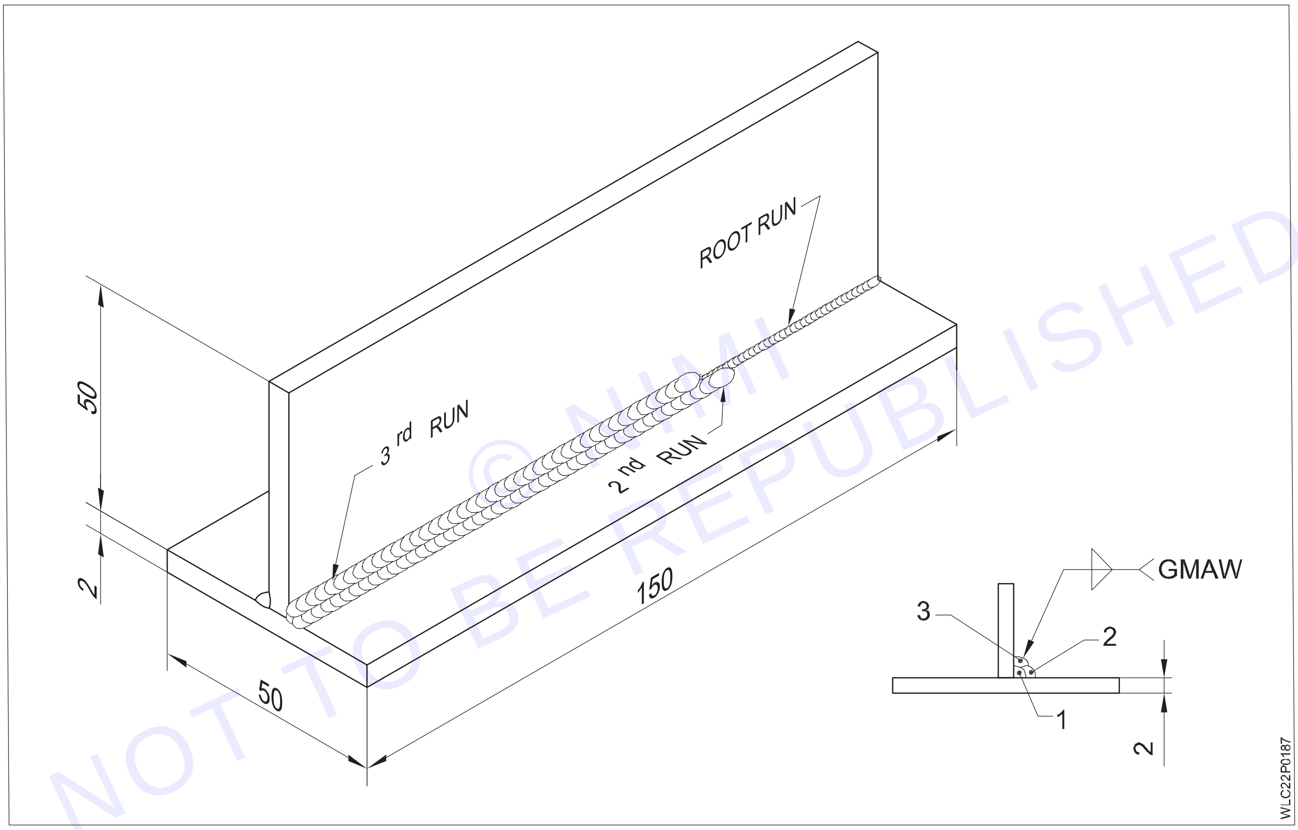
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- It is free from surface defects.

EXERCISE 58(D) : Monitor Tee joint on S.S sheet. 2 mm thick by GMAW

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 weld
- clean and inspect for surface defects and penetration.



Job Sequence

- Cut the plates by gas cutting as per drawing
- Set the pieces in the form of corner joint as per drawing
- Tack weld on both ends of the corner joint
- Set the joint on the welding table in flat position
- Connect the torch to the positive terminal of the machine
- Set90-100 Acurrent/corresponding wire feed rate,19to20 arc voltage and deposit the run using Dip transfer mode
- Deposit run in the joint by forming a key hole and obtain complete penetration and even fusion of plates
- Ensure good leg length and even fusion of plates

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by using flux cored wire with 100-110 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion with150-160amps welding current.

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the T fillet weld for surface defects and size.

Skill Sequence

Monitor Tee-joint on s.s sheet. 2 mm thick by GMAW

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

- monitor t-joint on S.S sheet. 2 mm thick by GMAW.

Setting and tacking the lap joint.

Set the 'T' joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly. Use a 3.15mmø MS electrode with 120-amp current for tacking.

Set the joint in a flat position using angle iron.

Welding the lap fillet joint in flat position

Deposit root run with a 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

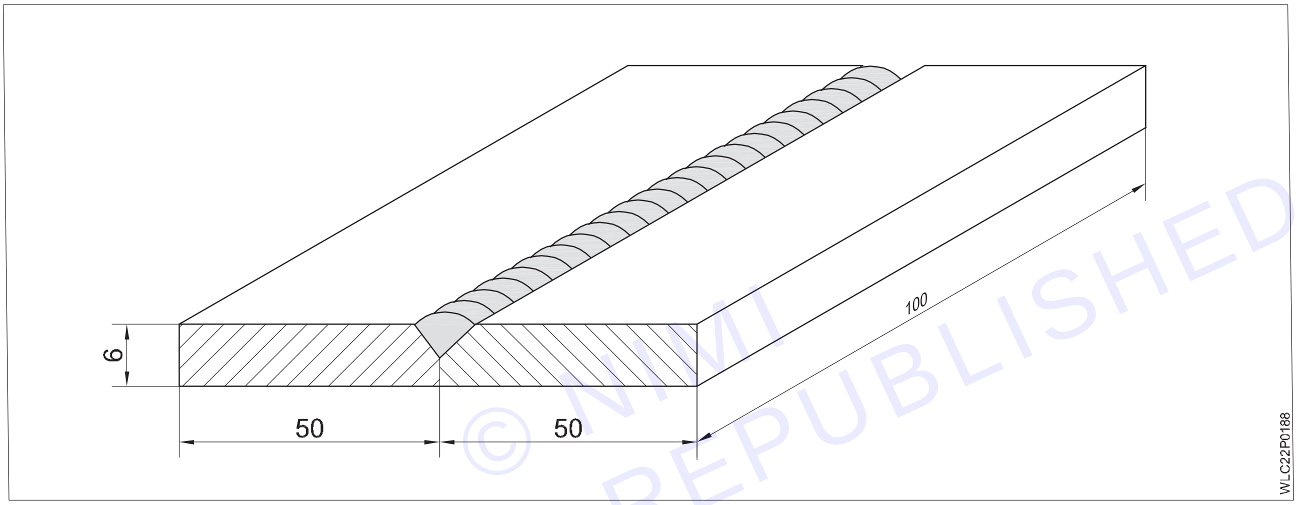
Inspect the lap fillet weld and ensure:

EXERCISE 59(A) : Evaluate single "V" joint on aluminium plate (thickness 6 mm) by GMAW

Objectives

At the end of this exercise you shall be able to

- prepare the plates with necessary beveling and root face
- preset the plates in alignment in vertical plane with necessary root gap and tack weld
- deposit-the root run with root penetration and uniform melting of both root faces of the joint
- set up the GMAW machine and set welding parameters.



Job Sequence

- Cut the plate by using hacksaw cutting as per drawing
- Clean the joining edges and surface of the plates
- Adjust the power source and wire feeder to obtain 18 to 19 volts and 90 and 100 amperes, gas flow 8-10 LPM.
- 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 a1.5 mm root face on each beveled edge
- Tack the pieces together and position
- Put spacers under the plate so that you don't weld the plate to your table
- 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 back hand technique. 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 leadingedge 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 to of ar upon 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
- Complete the joint using the bead sequence. Use a slight weave to help the weld flow and to fuse to the side walls of the groove and the previous beads
- When you have completed the weld, cool it and examine it. The root should show full penetration along the entirelength. The rootreinforcement should protrude beyond the joint from 0.5 to 1mm. The face of the weld should merge smoothly with the base metal. There inforcement should be atleast 1mm above the surface of the base metal and also should not exceed beyond 1.5.

Note: Wear protective clothing.

- Check the all connections before welding
- Protect your self from fire hazards.
- Consider the risks.
- Maintain your equipment
- Wear protective clothing's

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion using a with150-160amps welding current.

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the 'V' groove weld for surface defects and size.

Skill Sequence

Evaluate single "V" joint on aluminium plate (thickness 6 mm) by GMAW

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

- evaluate single "V" joint on aluminium plate (thickness 6 mm) by GMAW.

Setting and tacking the lap joint

Set the lap joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly with 120-amp current for tacking.

Set the joint in a flat position using angle iron.

Welding the lap fillet joint in flat position

Deposit root run with a 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with a 4mmø medium coated MS electrode and 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld and ensure:

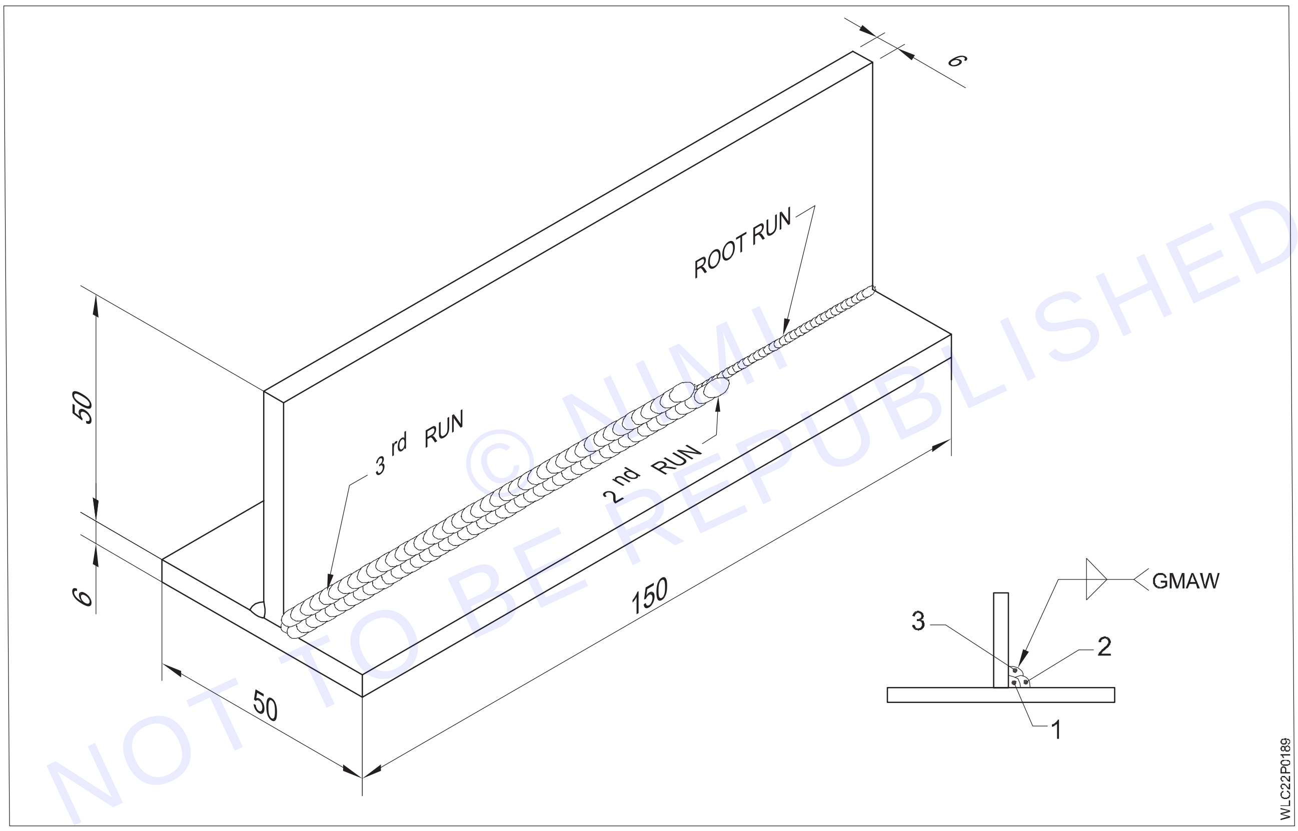
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- it is free from surface defects.

EXERCISE 59(B) : Fillet T joint on aluminium plate. 6 mm thick by GMAW

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 weld
- clean and inspect for surface defects and penetration.



Job Sequence

- Cut the plates by gas cutting as per drawing
- Set the pieces in the form of corner joint as per drawing
- Tack weld on both ends of the corner joint
- Set the joint on the welding table in flat position
- Connect the torch to the positive terminal of the machine
- Set 90-100 A current/corresponding wire feed rate,19 to 20 arc voltage and deposit the run using Dip transfer mode
- Deposit run in the joint by forming a key hole and obtain complete penetration and even fusion of plates
- Ensure good leg length and even fusion of plates

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by M.S. electrode with 100-110 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion using with150-160amps welding current.

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.

Skill Sequence

Fillet T joint on aluminium plate. 6 mm thick by GMAW

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

- fillet T joint on aluminium plate. 6 mm thick by GMAW.

Setting and tacking the lap joint.

Set the lap joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly. Use a 110 amp current for tacking.

Set the joint in a flat position using angle iron.

Welding the lap fillet joint in flat position

Deposit root run with with 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with a 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the 'T' fillet weld and ensure:

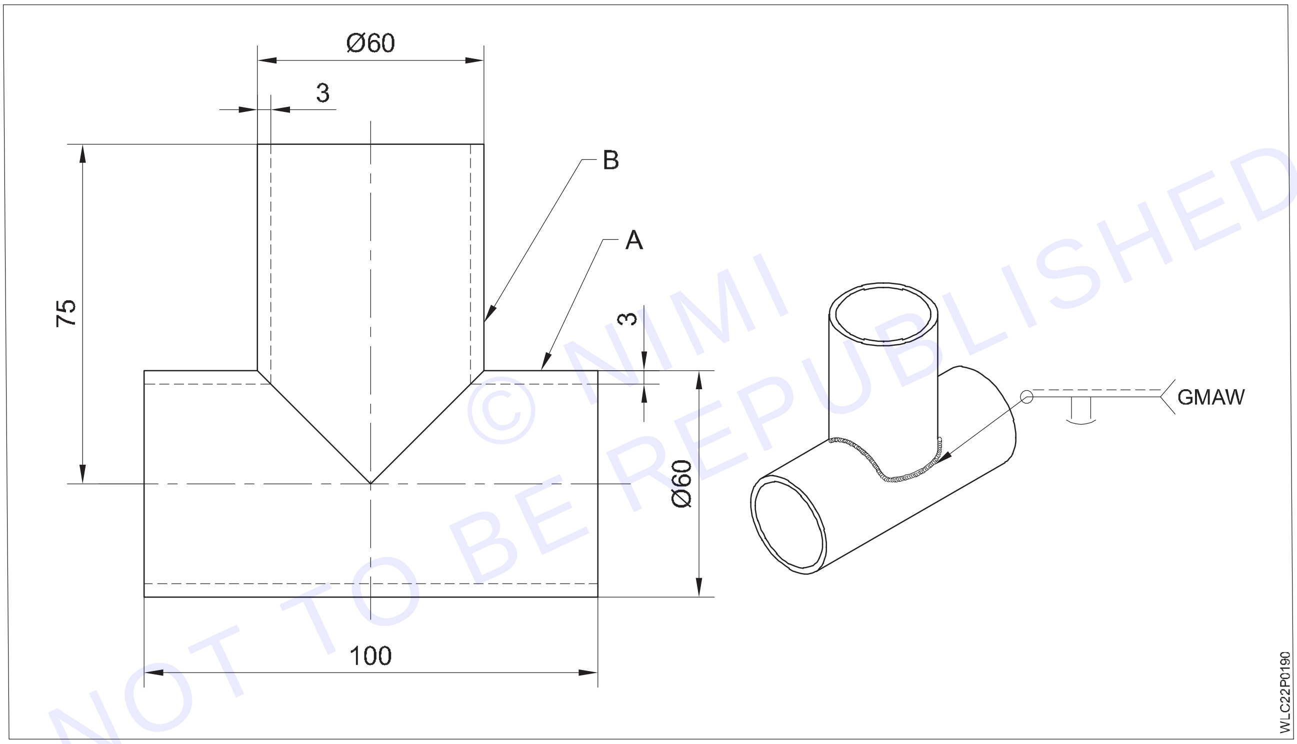
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- it is free from surface defects.

EXERCISE 60 : Monitor & assess tee joints on MS pipe 60 mm od x 3 mm wt in flat position - arc constant (rolling) by GMAW

Objectives

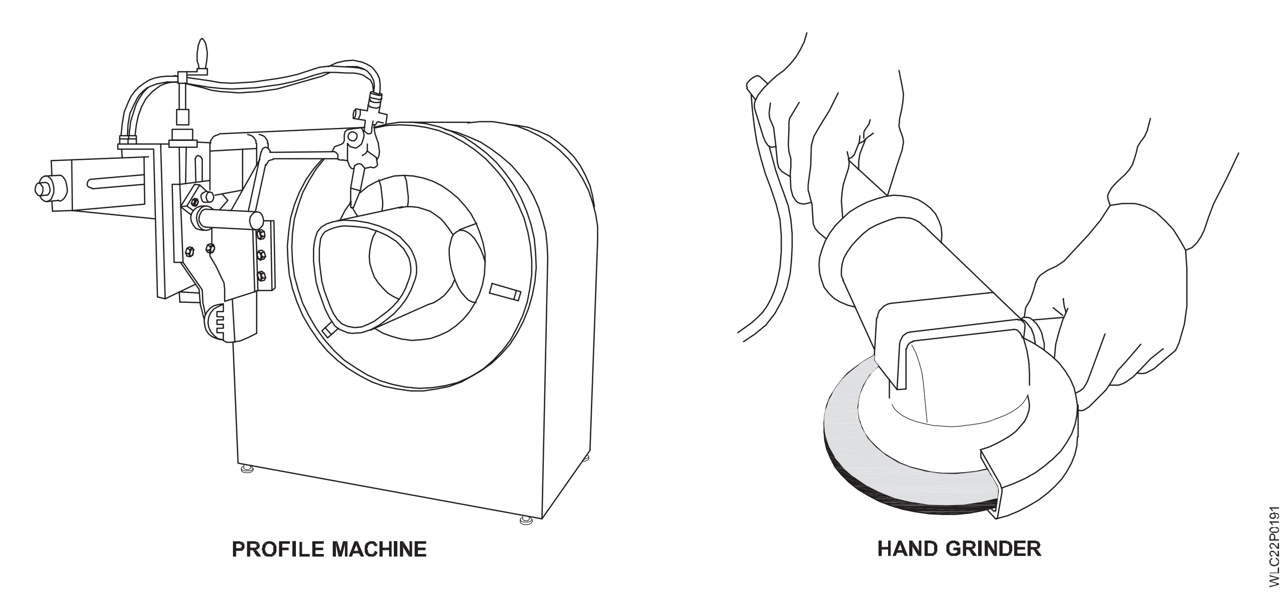
At the end of this exercise you shall be able to

- prepare the edges and set the pipe in alignment
- tack-weld and deposit root pass
- depositetherootandsecondrunsofweldbeads
- inspect the completed pipe weld.



Job Sequence

- Cut the pipes to the given size
- 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
- Scriber or pointed chalk followed by centre punching.The branch can then be produced by cutting to the marked out line, using manually operated oxy-fuel gas cutting equipment
- Oxy-fuel gas profiling machines,whichcut the hole and produce the required angle for weld preparation
- 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
- After cutting to length, remove any burrs on the inside of the pipe by reaming or filing.
- Ensure the correct size of pipes.
- Prepare development for 90°Tee



- Mark the development on the pipe and cut accordingly.
- Deburr the cutting edges and file the edges.
- Clean the surface of the pipe if any oxide is found.
- Setand align the branch pipe with the main pipe at an angle of 90°.
- Tack-weld the joint with a 2 mm root gap to control distortion and to obtain penetration
- On Tee joint ,angle joints and cluster joints use a sequenceweldingtechnique.This prevents weld metal on traction from pulling the pipe out of line. illustrate sone satisfactory sequence for aT-pipe assembly. When ever possible, do all the welding in a down hand position. As in all pipe welding, the weld metal must be well fused into the base metal. There must be good penetration and nounder cutting
- Manipulation of the torch during welding the'Tee' joint should be correctly followed.
- Weld and complete the joint-clean

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by using a 3.15mm dia. Medium coated M.S. electrode with 100-110 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

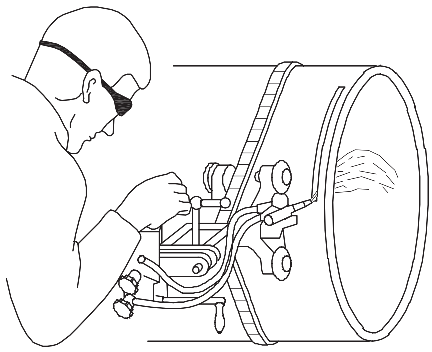
- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion using a 4.00 mm dia. Medium coated M.S. electrode with150-160amps welding current.

Note: Prevent the upper edge of the plate from melting off.

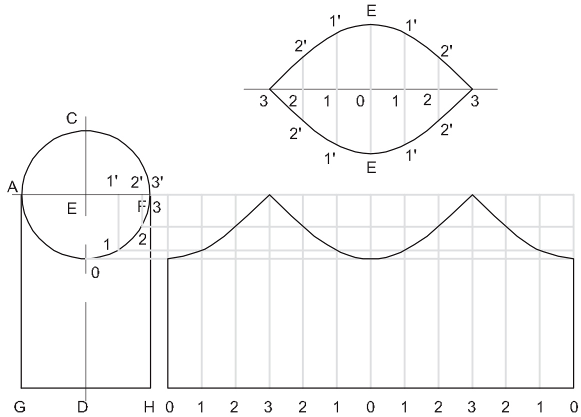
- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.



ROTATED PIPE-CUTTING HEAD



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

WLC22P0192

Skill Sequence

Monitor & assess tee joints on MS pipe 0 60 mm od x 3 mm wt in flat position - arc constant (rolling) by GMAW

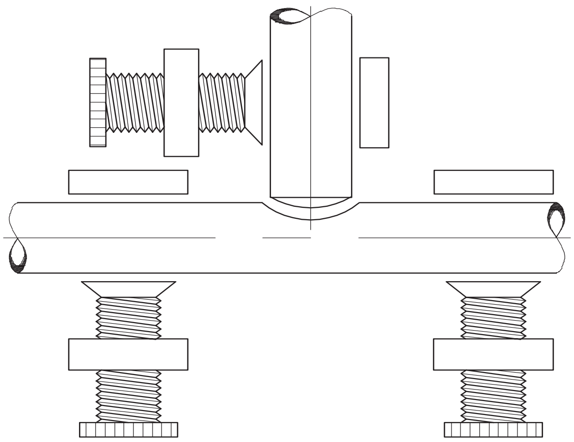
Objectives: At the end of this exercise you shall be able to

- monitor & assess tee joints on ms pipe 0 60 mm od x 3 mm wt in flat position - arc constant (rolling) by GMAW.

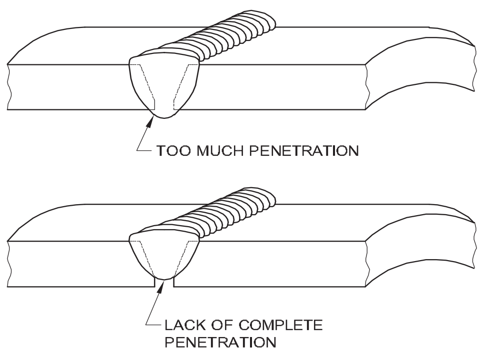
One difficulty encountered with all pipe and tube welding is the distortion or misalignment of the pipes/tubes after welding is completed. One, very frequently used method to prevent or reduce distortion is to clamp the pipes or tubes in a fixture while welding and allow it to cool before removing the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



CLAMPING FIXTURE



TUBE JOINT WELD SHOWING TWO COMMON PENETRATION DEFECTS

WLC22P0193

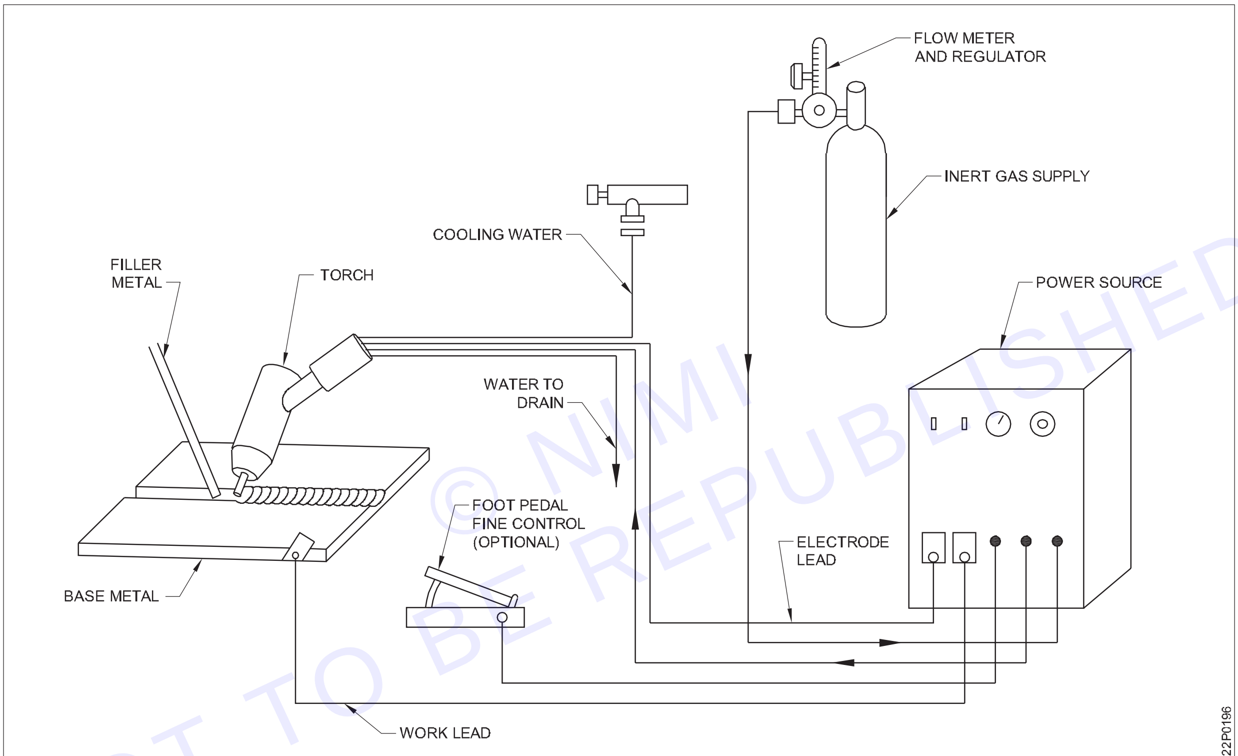
MODULE 7 : GTAW

EXERCISE 61: Set up and monitor GTAW welding machine & accessories

Objectives

At the end of this exercise you shall be able to

- identify the GTAW welding machine an accessories
- describe the welding technics of GTAW



A DIAGRAMMATIC DRAWING OF A COMPLETE GAS TUNGSTEN ARC WELDING

Job Sequence

- 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.
- 15 © NIMI, Not to be republished 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 inert gas heater is connected to the inert in cylinder.
- 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 inert gas at regulator and flow meter.
- Fix a twostage 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.
- 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 turbulences and in turn contaminates weld.

Note : Wear protective clothing.

- Tack weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run.

Note : Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion using electrode.

Note : Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note : Use a weld gauge to check the fillet size.

- Inspect the weld for surface defects and size.

Skill Sequence

Set up and monitor GTAW welding machine & accessories 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.

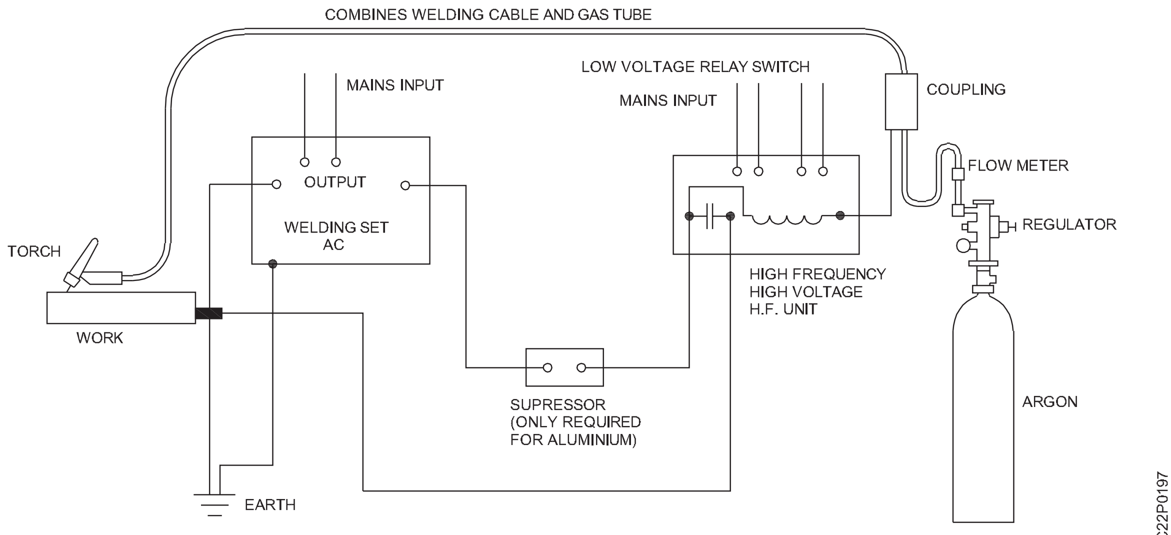
Follow leftward technique.

The filler rod and torch are held at an angle of 10 to 150 and 70 to 80° 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.



CONNECTIONS FOR INERT GAS WELDING USING AIR-COOLED TORCH

Table 1

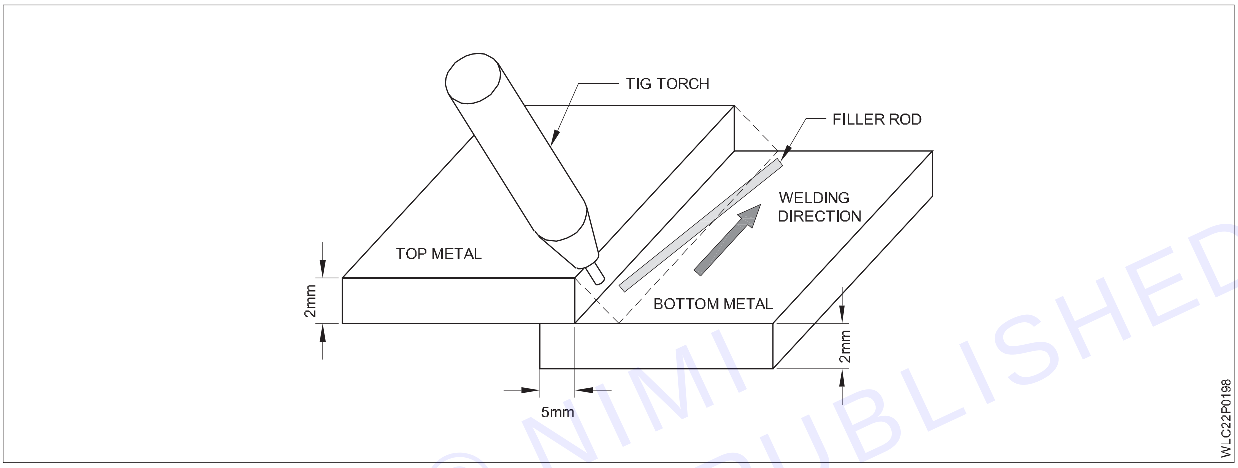
Metal thickness	Joint type	Diameter of tungsten alloy electrode with 1 to 27 Zirconium	Filler rod diameter (if required)	Amperage	Gas	
					Type	L/min
2 mm	Butt & Corner	1.6 mm	1.6 mm	60 – 85	Argon	7
	Fillet	1.6 mm	1.6 mm	75 – 100	Argon	7
3.15	Butt & Corner	3.15 mm	2.4 mm	120 - 150	Argon	9.5
	Fillet	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

EXERCISE 62: Make Corner joint on MS sheet in down hand position by GTAW

Objectives

At the end of this exercise you shall be able to

- produce molten pool of required size by the manipulation of torch
- add filler metal at the required rate and place by manipulation the filler rod
- deposit fusion run with filler rod in flat position and maintain uniform arc travel speed
- clean and inspect the deposited beads for surface defects.



Job Sequence

- Cut the plate by using hacksaw cutting as per drawing
- Set the sheets and tack weld in the form of a “Lap” joint on the welding in flat position
- Fill the crater
- Manipulate the torch and filler rod in the correct position with respect job
- Stop the weld at the left•hand edge of the joint after filling up in the crater at the end of the weld
- The angular distortion between the vertical and horizontal sheets of the Tee joint is automatically controlled
- The current set is 10 to 15 amperes
- At the end of the welding perform the carter filler treatment by repeating the torch switch ON•OFF
- Cut the arc and hold at the finishing point unit molten metal solidifies
- Visual inspection: slight convexity, uniform width, uniform ripples And free from under cut at the toes of the weld indicate a smooth

Note : Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by using a ∅ 2.4 Tungsten electrode with 100•110 amps current.

Note :Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.

- Deposit the final covering run with a weave motion using a 4.00 mm dia. Medium coated M.S. electrode with150 160amps welding current.

Note : Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note : Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.

Skill Sequence

Make Lap joint on MS sheet in down hand position by GTAW

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

- make Lap joint on MS sheet in down hand position by GTAW.

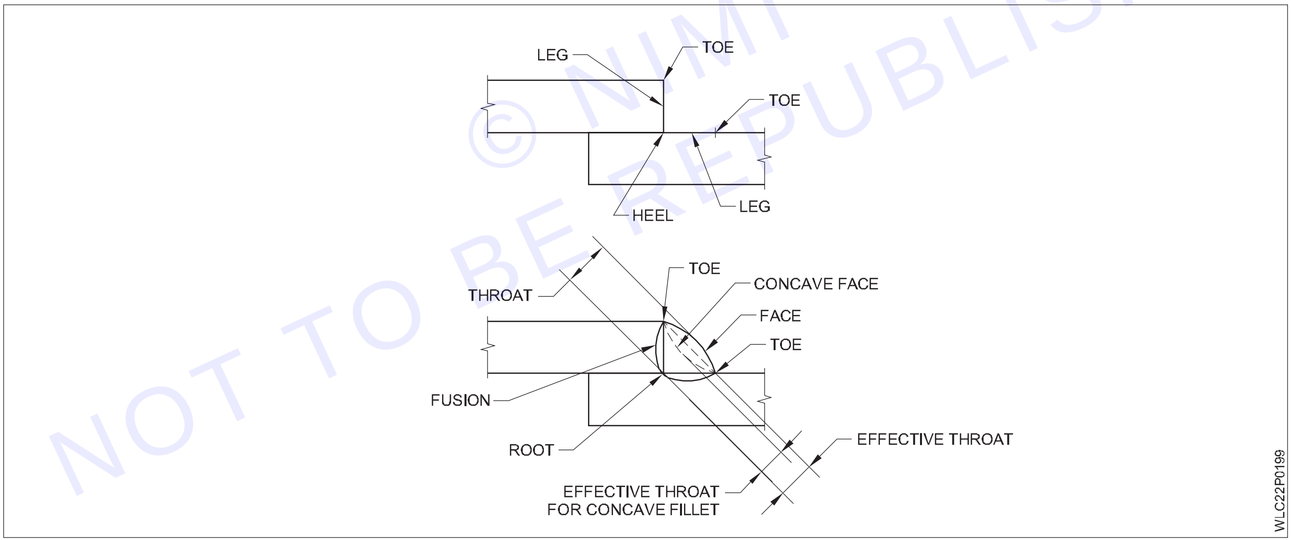
Setting and lacking the lap joint

Penetration must be obtained completely without undercut and melting off of the edge of the upper plate.

Equal leg length and smooth ripple appearance to be maintained.

In this lap joint, legs, toes, effect throat and other condition should fulfil.

Ensure the edge of the top sheet is not melted away. Avoid concentrating the arc for longer time at the top edge of the top sheet.

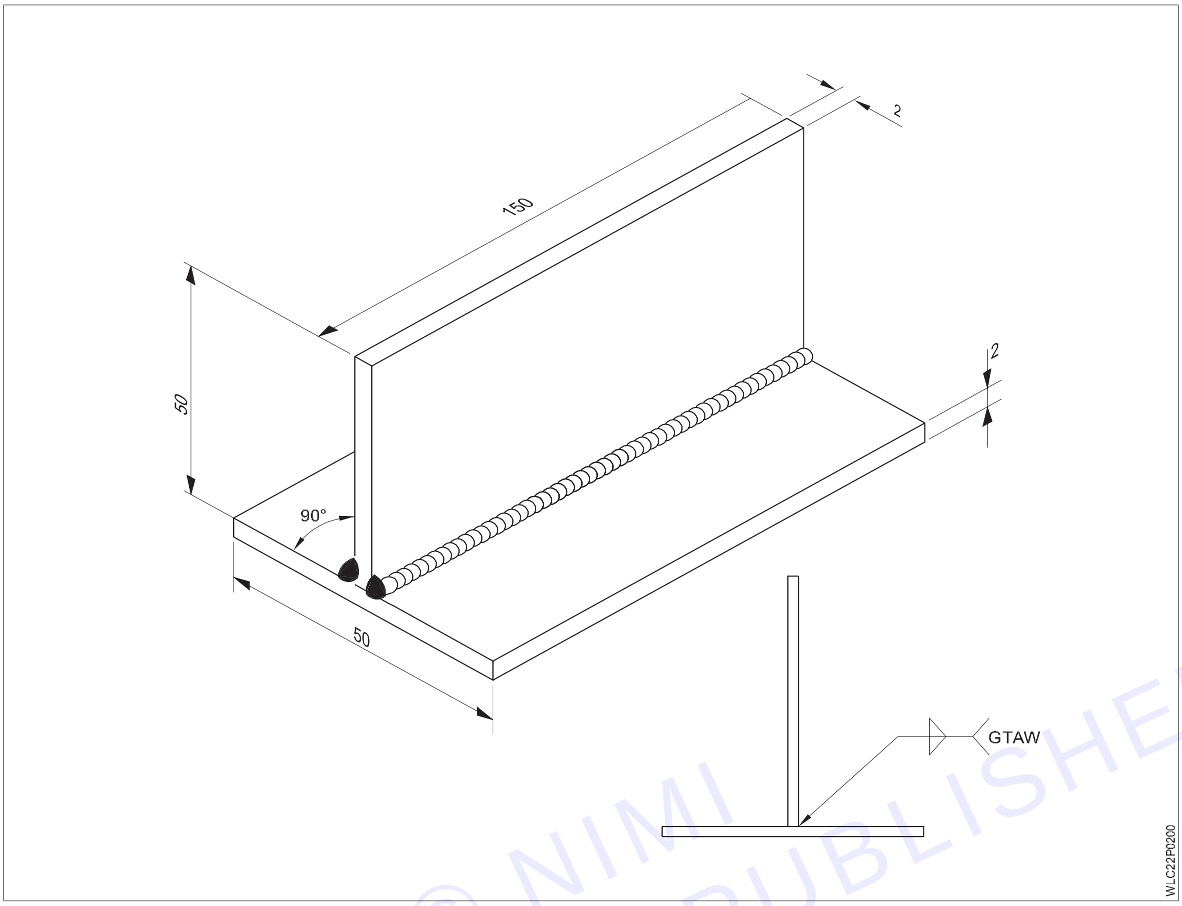


Lap MS Sheet O.H by GTAW

Objectives

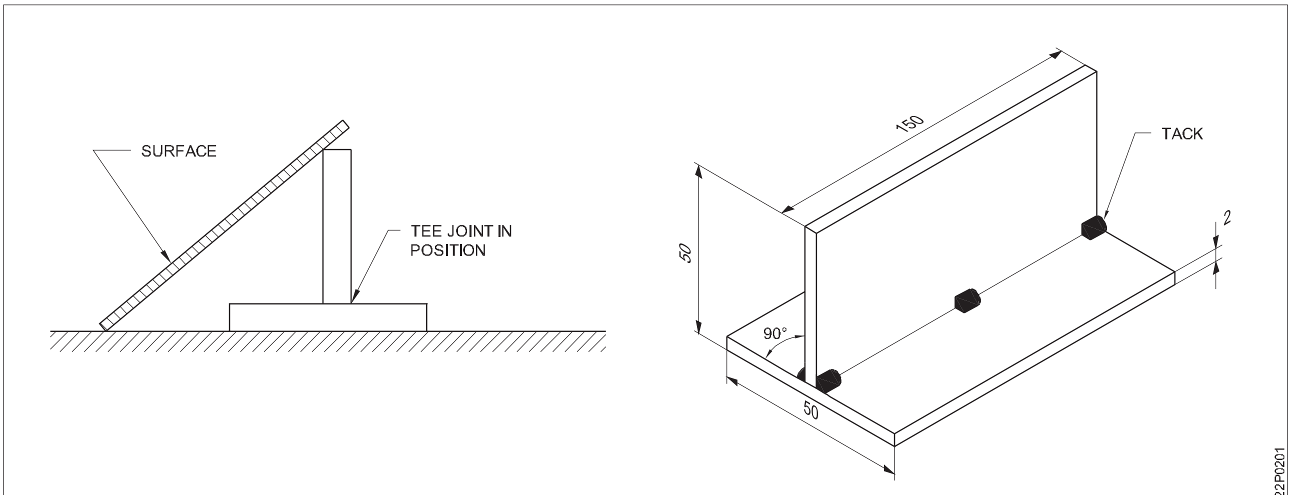
At the end of this exercise, you will be able to:

- set and tack plate pieces in alignment as Tee joint
- set the current, gas flow rate, polarity
- select a proper filler rod, shielding gas and electrode size for welding
- weld the Tee joints maintaining the leg length



Job Sequence

- Cut the plate by using hacksaw cutting as per drawing
- Set the sheets and tack weld in the form of a "Tee" joint on the welding in flat position
- Fill the crater
- Manipulate the torch and filler rod in the correct position with respect job
- Stop the weld at the left-hand edge of the joint after filling up in the crater at the end of the weld
- The angular distortion between the vertical and horizontal sheets of the Tee joint is automatically controlled
- The current set is 10 to 15 ampere



ASSEMBLING A TEE JOINT

- At the end of the welding perform the carter filler treatment by repeating the torch switch ON-OFF
- Cut the arc and hold at the finishing point unit molten metal solidifies
- Visual inspection: slight convexity, uniform width, uniform ripples and free from under cut at the toes of the weld indicate a smooth

Note: Wear protective clothing.

Skill Sequence

Make Tee joint on MS sheet in down hand position by GTAW

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.

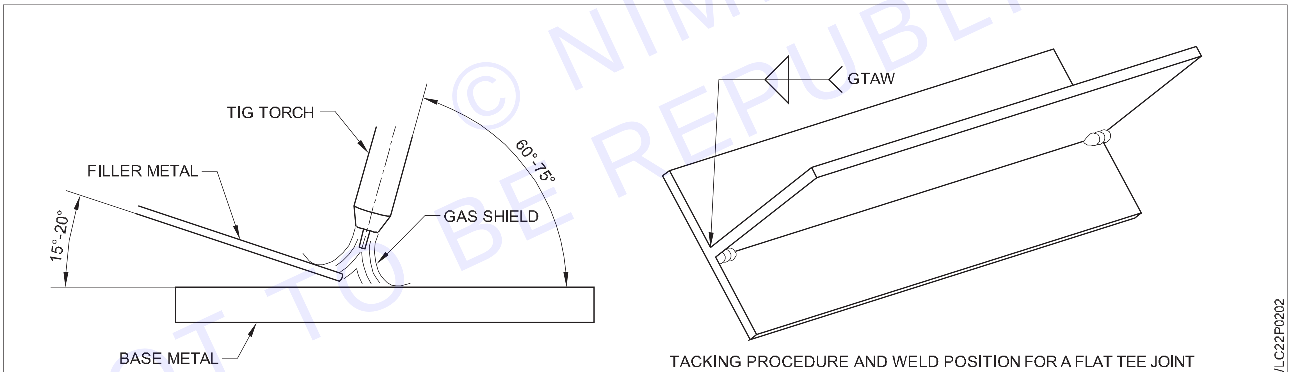
Follow the recommendations for the correct gas flow, otherwise the shielding gas will not be effective.

Welding the lap fillet joint in flat position

Deposit root run with ∅ 2.4 Tungsten electrode with 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.



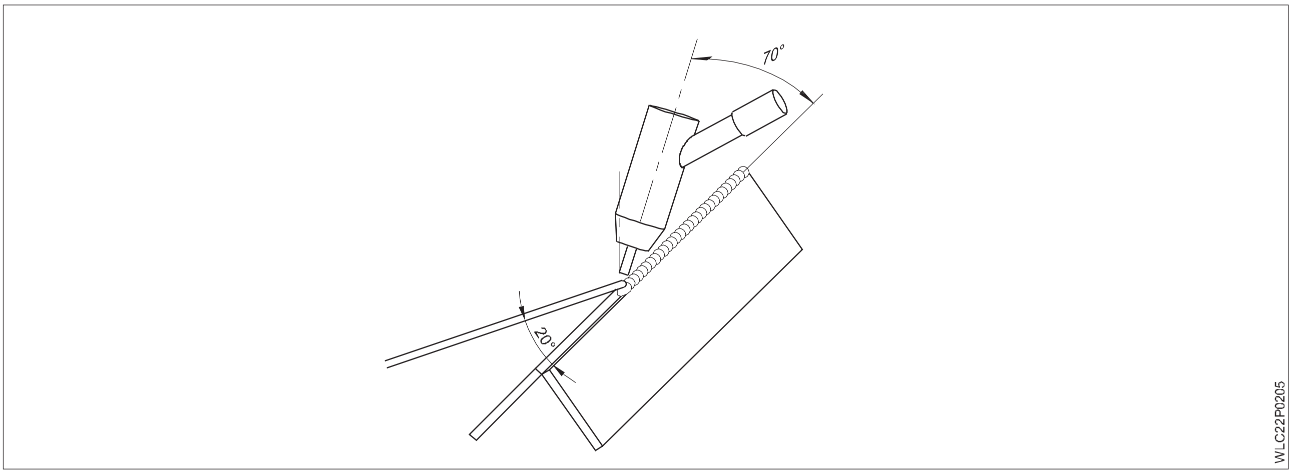
TACKING PROCEDURE AND WELD POSITION FOR A FLAT TEE JOINT

Make Corner joint on MS sheet in down hand position by GTAW

Objectives

At the end of this exercise, you will be able to:

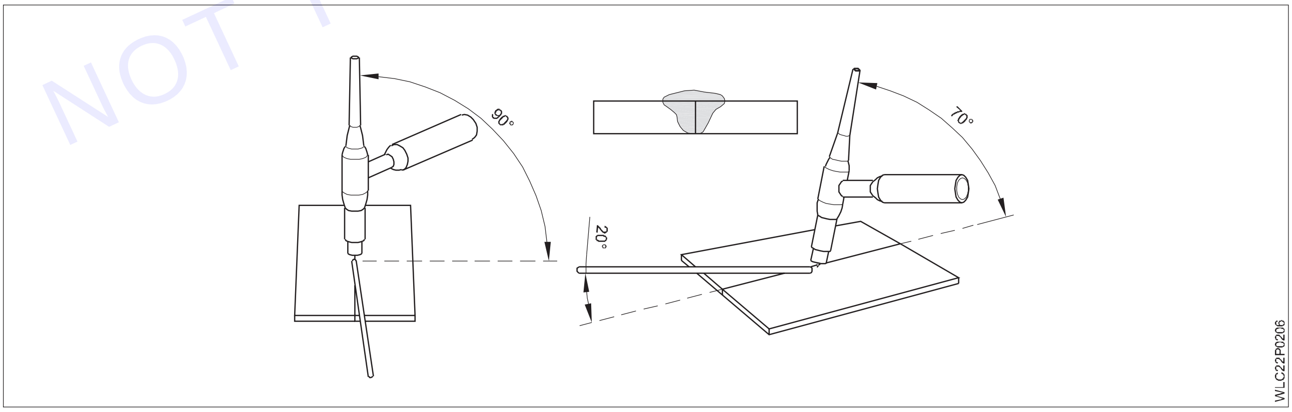
- select and set electrode size, filler rod, current, gas flow rate and polarity
- weld the joint using proper manipulation and angles for the torch and filler rod
- deposit fusion run with filler rod in flat position and maintain uniform arc travel speed
- clean and inspect the deposited beads for surface defects.



Job Sequence

- Cut the plate by using hacksaw cutting as per drawing
- Set the sheets and tack weld in the form of a “Corner” joint on the welding in flat position
- Fill the crater
- Manipulate the torch and filler rod in the correct position with respect job
- Stop the weld at the left-hand edge of the joint after filling up in the crater at the end of the weld
- The angular distortion between the vertical and horizontal sheets of the Tee joint is automatically controlled
- The current set is 10 to 15 amperes
- At the end of the welding perform the carter filler treatment by repeating the torch switch ON-OFF
- Cut the arc and hold at the finishing point unit molten metal solidifies
- Visual inspection: slight convexity, uniform width, uniform ripples and free from under cut at the toes of the weld indicate a smooth

Note : Wear protective clothing.



Skill Sequence

Make Corner joint on MS sheet in down hand position by GTAW

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

- make Corner joint on MS sheet in down hand position by GTAW

Setting and tacking the lap joint

Set the job to form an outside corner joint 900 with correct alignment.

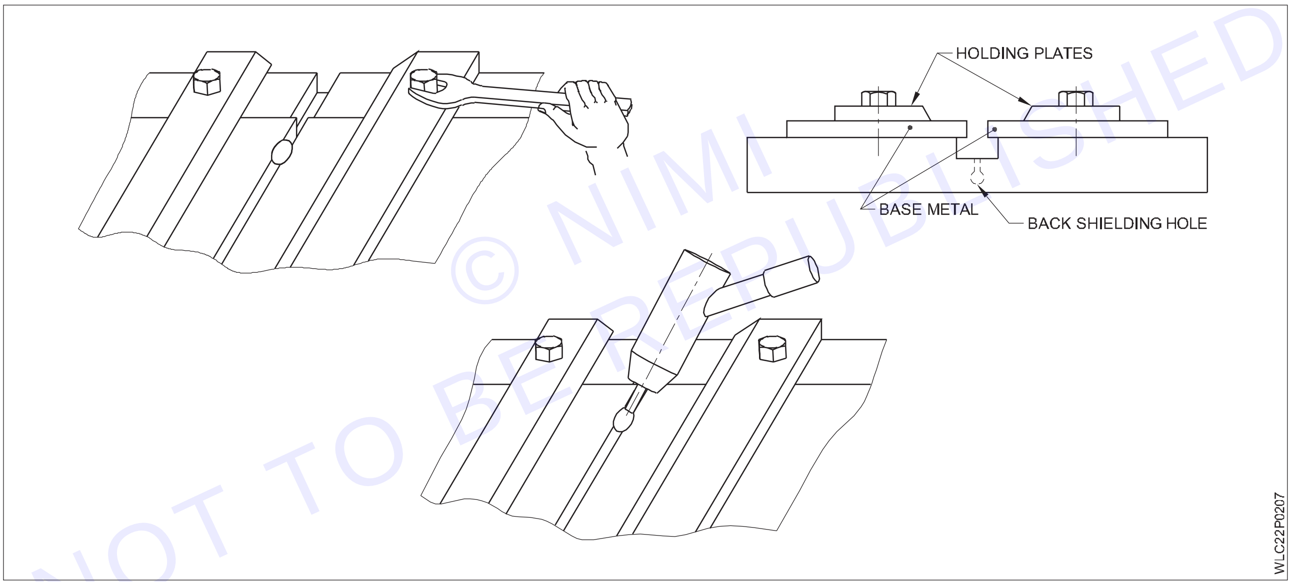
Tack the job on both ends in appropriate position.

Manipulate the torch and filler wire 700 and 200 to the line of weld respectively.

Both edges of the bead should blend smoothly with the metal surfaces.

There should be no overlapping or undercutting.

The bead must be straight and have a uniform width and contour.

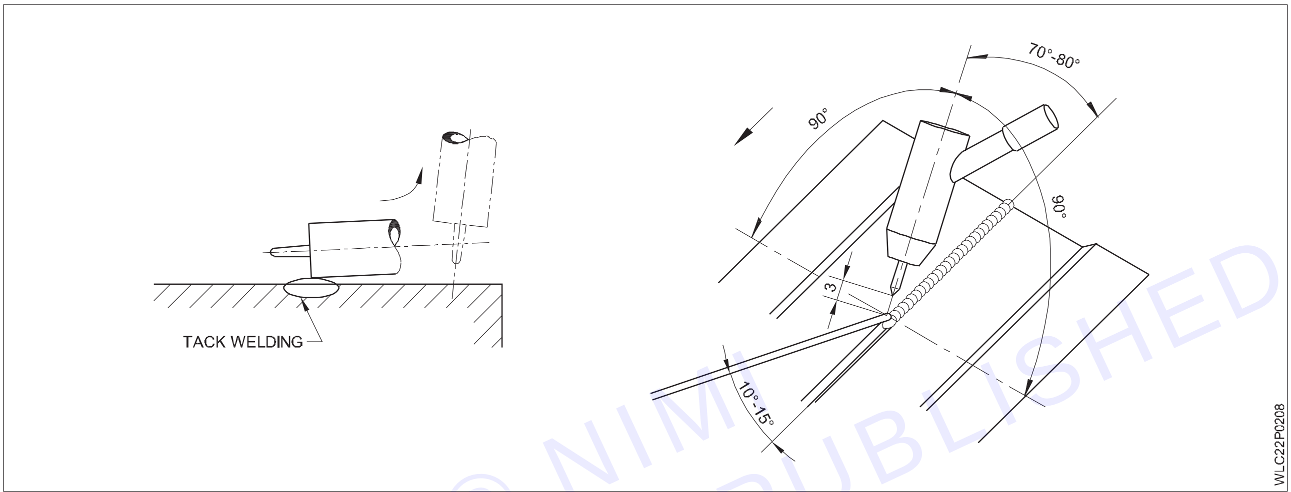


EXERCISE 63: Assess the Square butt joint on MS in down hand position by GTAW.

Objectives

At the end of this exercise you shall be able to

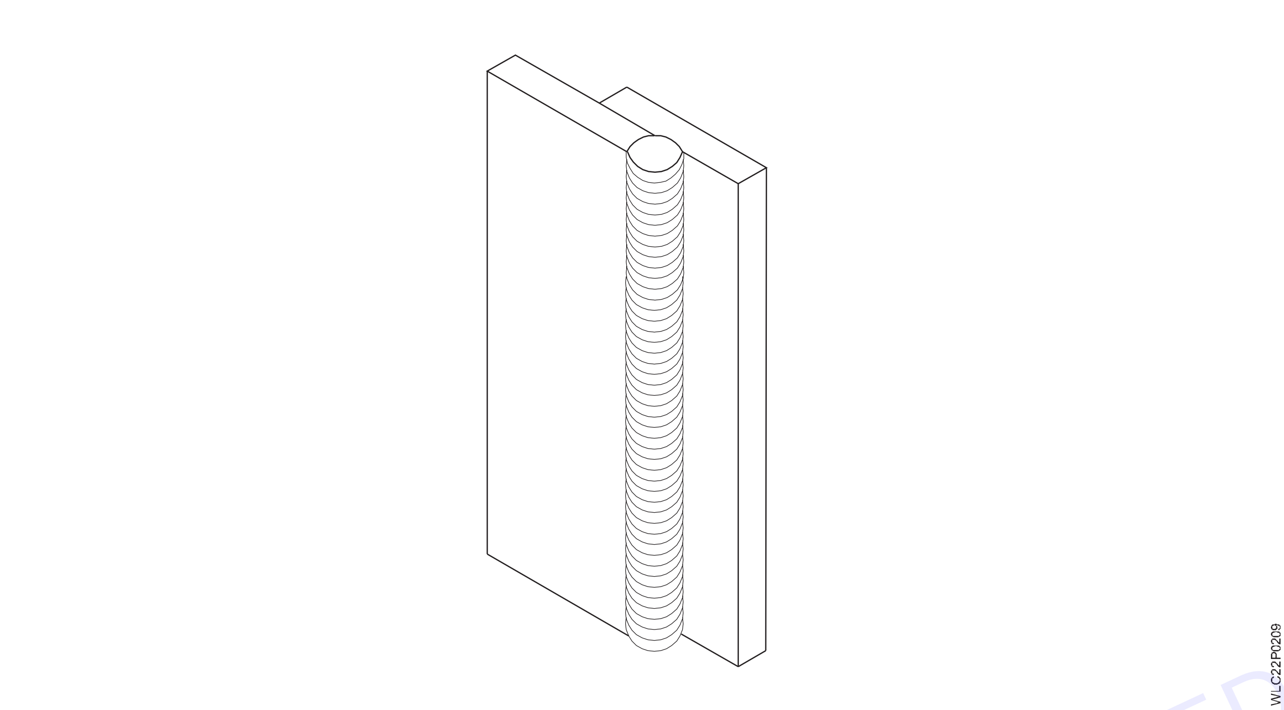
- select and set electrode size, filler rod, current, gas flow rate and polarity
- weld the joint using proper manipulation and angles for the torch and filler rod
- weld the joint without, weld defects.



Job Sequence

- Cut the plate by using hacksaw cutting as per drawing
- Set the sheets and tack weld in the form of a “Square butt” joint on the welding in flat position
- Fill the crater
- Manipulate the torch and filler rod in the correct position with respect job
- Stop the weld at the left-hand edge of the joint after filling up in the crater at the end of the weld
- The angular distortion between the vertical and horizontal sheets of the Tee joint is automatically controlled
- The current set is 10 to 15 ampere
- At the end of the welding perform the carter filler treatment by repeating the torch switch ON-OFF
- Cut the arc and hold at the finishing point unit molten metal solidifies
- Visual inspection: slight convexity ,uniform width ,uniform ripples And free from under cut at the toes of the weld indicate a smooth

Note : Wear protective clothing.

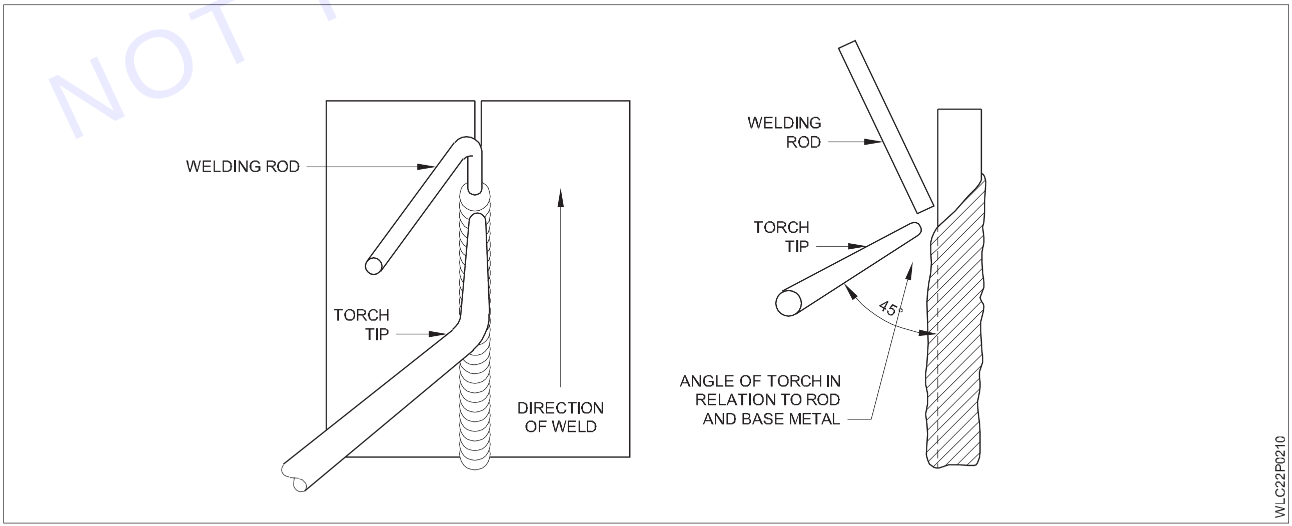


Skill Sequence

Assess the Square butt joint on MS in down hand position by GTAW

Objectives: At the end of this exercise you shall be able to
- assess the Square butt joint on MS in down hand position by GTAW.

Setting and tacking the lap joint (Fig 1)

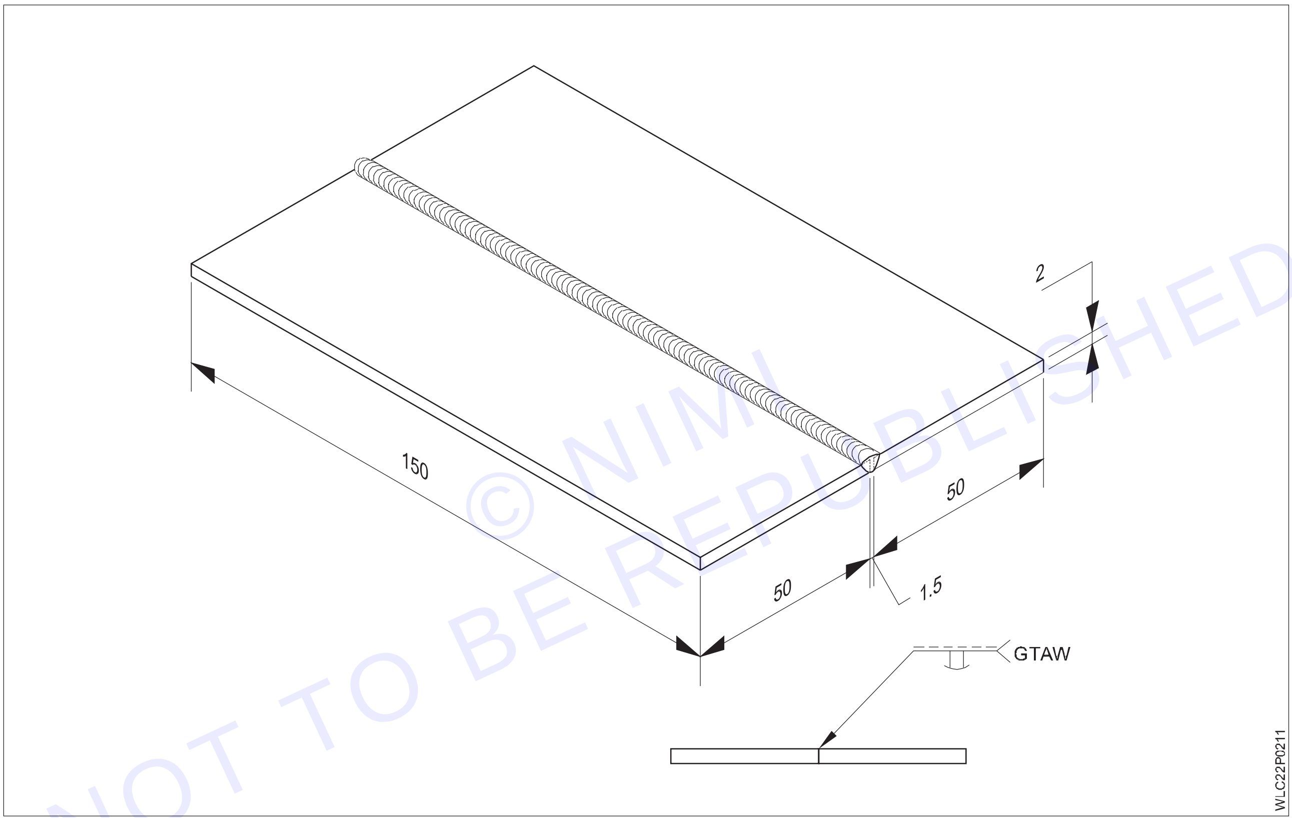


EXERCISE 64: Construct Lap joint on MS sheet 1.6 mm in Vertical position by GTAW.

Objectives

At the end of this exercise you shall be able to

- produce molten pool of required size by the manipulation of torch
- add filler metal at the required rate and place by manipulation the filler rod
- deposit fusion run with filler rod in flat position and maintain uniform arc travel speed
- clean and inspect the deposited beads for surface defects.



Job Sequence

- Cut the plate by using hacksaw cutting as per drawing
- Set the sheets and tack weld in the form of a "Square butt" joint on the welding in flat position
- Fill the crater
- Manipulate the torch and filler rod in the correct position with respect job
- Stop the weld at the left-hand edge of the joint after filling up in the crater at the end of the weld
- The angular distortion between the vertical and horizontal sheets of the Tee joint is automatically controlled
- The current set is 10 to 15 ampere
- At the end of the welding perform the carter filler treatment by repeating the torch switch ON-OFF
- Cut the arc and hold at the finishing point unit molten metal solidifies
- Visual inspection: slight convexity ,uniform width ,uniform ripples And free from under cut at the toes of the weld indicate a smooth

Skill Sequence

Construct Lap joint on MS sheet 1.6 mm in Vertical position by GTAW

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

- construct Lap joint on MS sheet 1.6 mm in Vertical position by GTAW.

Setting and tacking the lap joint

Set the lap joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly. Use a current for tacking.

Set the joint in a flat position using angle iron.

Welding the lap fillet joint in flat position

Deposit root run with a 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Note : Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run and 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note :Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

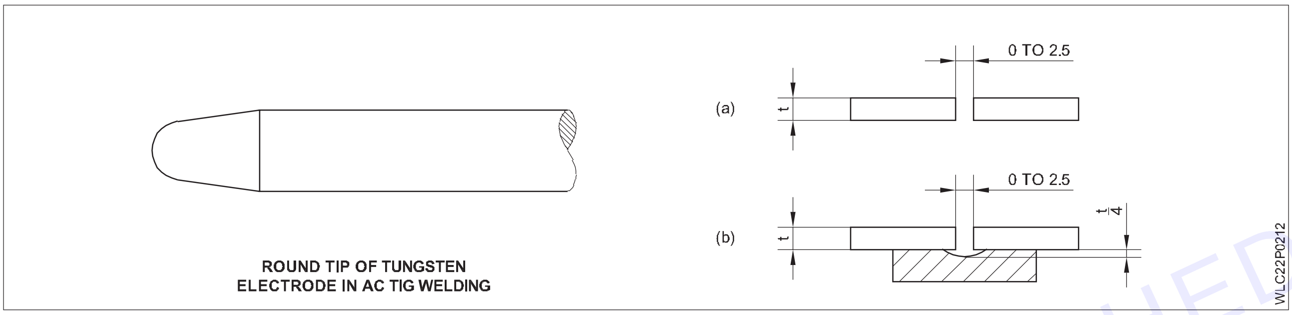
Inspect the lap fillet weld and ensure:

EXERCISE 65: Make Square butt joint on MS sheet 2 mm in Vertical position by GTAW.

Objectives

At the end of this exercise you shall be able to

- produce molten pool of required size by the manipulation of torch
- add filler metal at the required rate and place by manipulation the filler rod
- deposit fusion run with filler rod in flat position and maintain uniform arc travel speed
- clean and inspect the deposited beads for surface defects.



Job Sequence

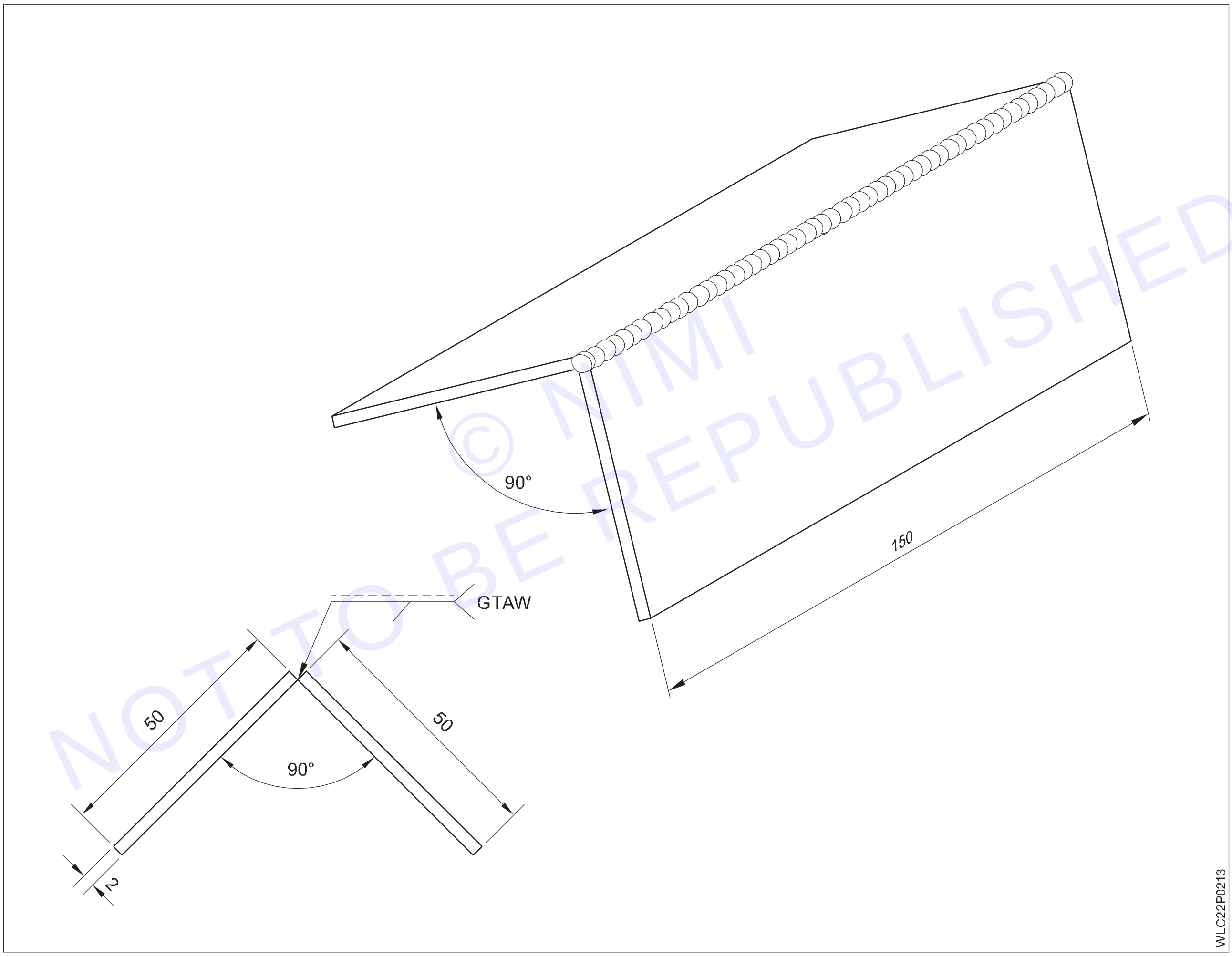
- Cut the plate by using hacksaw cutting as per drawing
- Set the sheets and tack weld in the form of a “Square butt” joint on the welding in flat position
- Fill the crater
- Manipulate the torch and filler rod in the correct position with respect job
- Stop the weld at the left-hand edge of the joint after filling up in the crater at the end of the weld
- The angular distortion between the vertical and horizontal sheets of the Butt joint is automatically controlled
- The current set is 10 to 15 ampere
- At the end of the welding perform the carter filler treatment by repeating the torch switch ON-OFF
- Cut the arc and hold at the finishing point unit molten metal solidifies
- Visual inspection: slight convexity ,uniform width ,uniform ripples And free from under cut at the toes of the weld indicate a smooth.

EXERCISE 66: Monitor Square butt joint on Aluminum sheet 3 mm thick in Flat position by GTAW

Objectives

At the end of this exercise you shall be able to

- weld square butt joint in Aluminum sheet 3mm thick using TIG welding process.
- add filler metal at the required rate and place by manipulation the filler rod
- deposit fusion run with filler rod in flat position and maintain uniform arc travel speed
- clean and inspect the deposited beads for surface defects.



Job Sequence

- Prepare aluminium sheets as per dimensions.
- Use Tungsten zirconium 3mm size electrode
- Clean the edges of the sheets
- Select the various parameters as given in the table 1and set them accordingly.
- Weld the joint in flat position using leftward technique.
- Fill the crater.

- Clean the weld area thoroughly.
- Inspect the job for free defects.
- **Visual inspection :** slight convexity, uniform width, uniform ripples And free from under cut at the toes of the weld indicate a smooth

Skill Sequence

Monitor Square butt joint on Aluminum sheet 3 mm thick in Flat position by GTAW

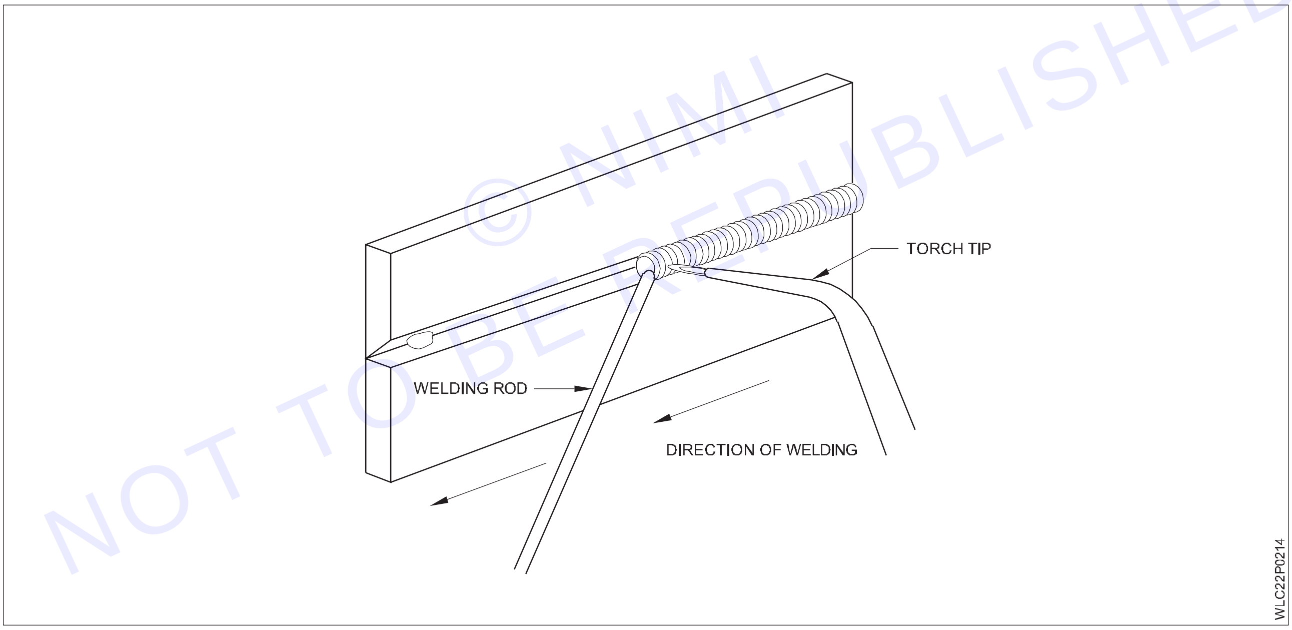
Objectives: At the end of this exercise you shall be able to

- monitor Square butt joint on Aluminum sheet 3 mm thick in Flat position by GTAW.

Setting and tacking the lap joint

Ensure setting of Butt joint as per drawing.

Tungsten electrode tip to be ground for AC welding-Aluminium.



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.

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.

TABLE 1

Guideline for Manual AC TIG welding of aluminium

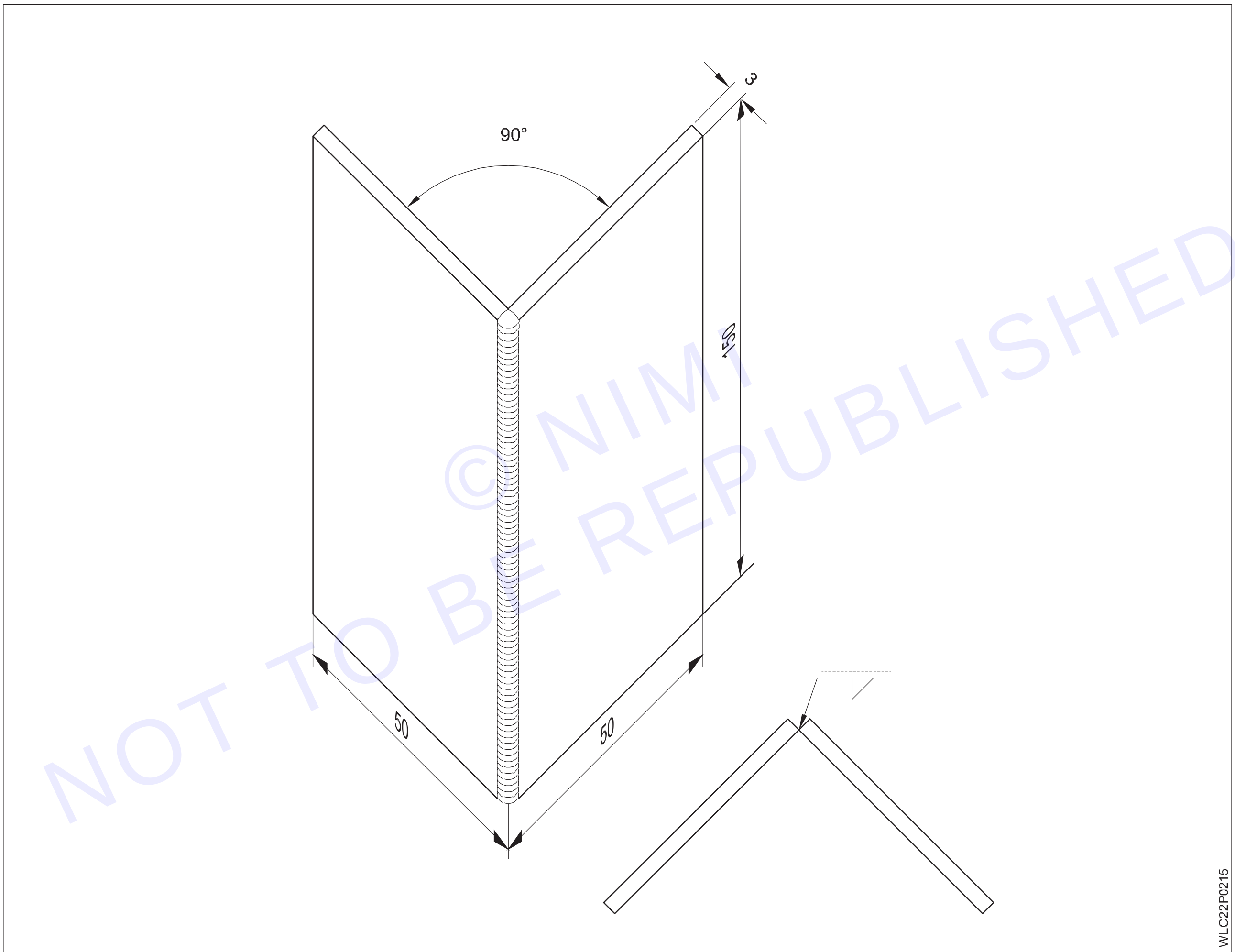
Plate thickness (mm)	Welding position	Joint type	Current AC (Amp)	Electrode Dia.(mm)	Nozzle size (10) mm (mm)	Argon flow Rate .LPM	Filler rod Dia. mm	Number of runs
1.6	F	Square butt	70 - 100	2.4	8.0	10	2.4	1
	H, V	Square butt	70 - 100	2.4	8.0	10	2.4	1
	O	Square butt	60 - 90	2.4	8.0	13	2.4	1
3.2	F	Square 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	60⁰ Single Vee	180 - 220	4.0	11	12	4.0	2
	H, V	60⁰ Single Vee	160 - 200	4.0	11	12	4.0	2
	O	60⁰ Single Vee	170 - 200	4.0	11	12	4.0	2
6.35	F	60⁰ Single Vee	220 - 240	4.8	12.7	15	4.0	2
	H, V	60⁰ Single Vee	220 - 240	4.8	12.7	15	4.0	2
	O	60⁰ Single Vee	210 - 250	4.8	12.7	18	4.0	2

EXERCISE 67: Assess Corner joint on Aluminum sheet 2 mm thick in down hand position by GTAW

Objectives

At the end of this exercise you shall be able to

- weld outside corner joint in aluminum sheet 2 mm thickness using TIG welding process
- add filler metal at the required rate and place by manipulation the filler rod
- deposit fusion run with filler rod in flat position and maintain uniform arc travel speed
- clean and inspect the deposited beads for surface defects.



Job Sequence

- Use pure aluminium filler wire/alluminium +5% silicon of 2.4mm.
- Use 2.4mm (Zirconium) tungsten electrode.
- AC power source with DC suppressor and high frequency units.
- Shielding gas argon.
- Prepare aluminium sheet as per dimensions.
- Clean the edges of the sheets.
- Use stainless steel wire brush for surface cleaning.

- Tack the set pieces at correct intervals and in correct alignment for an outside corner joint.
- Weld the joint in flat position.
- Make uniform size bead with correct penetration at the root in the outside corner joint.
- Clean the weld area thoroughly.
- Inspect the completed outside corner weld for weldment quality.

Skill Sequence

Assess Corner joint on Aluminum sheet 2 mm thick in down hand position by GTAW

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

- assess Corner joint on Aluminum sheet 2 mm thick in down hand position by GTAW.

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.

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

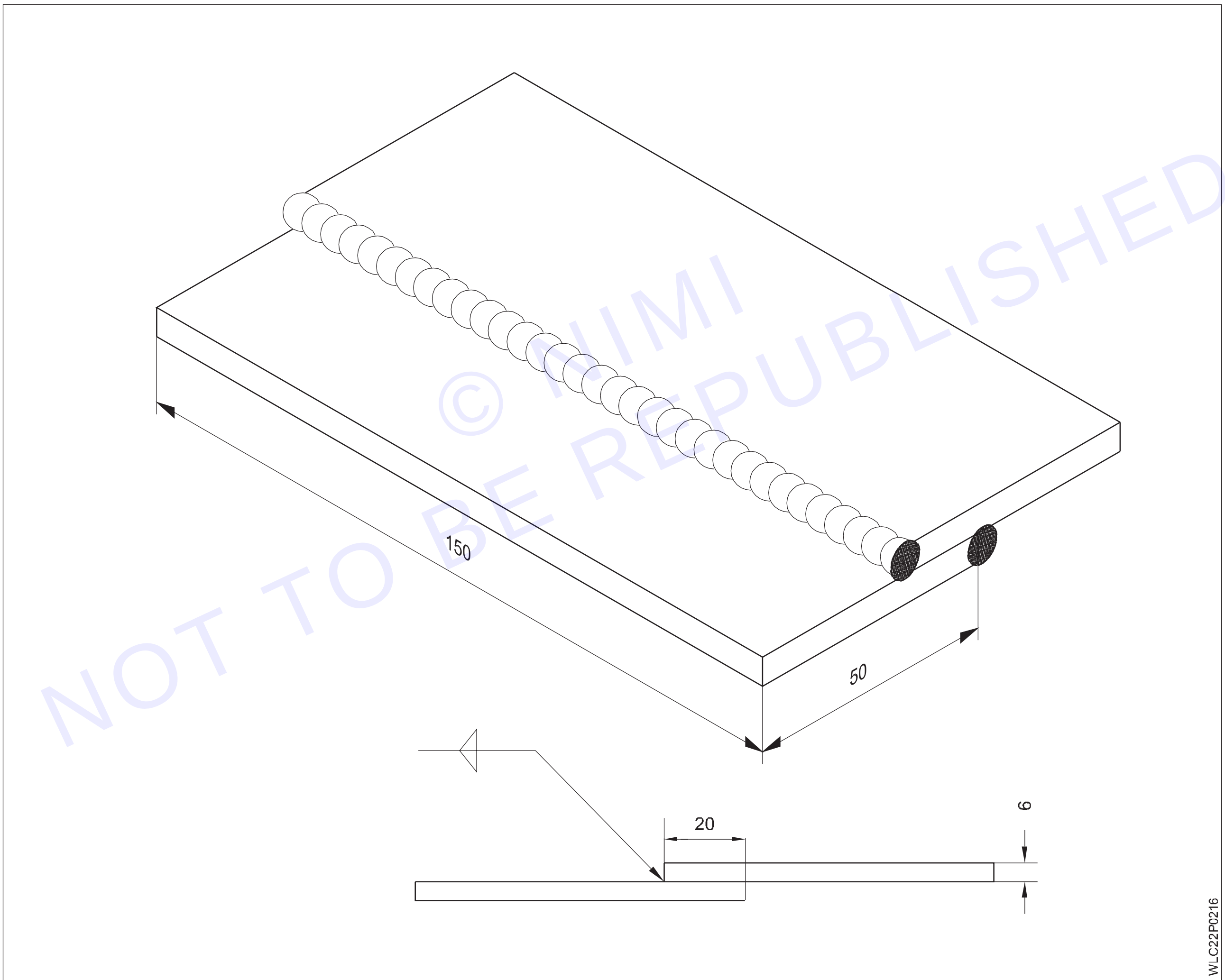
- correct alignment and uniformity of bead with correct penetration after cleaning the welded joint thoroughly.
- uniform ripples with equal width and height of bead.

EXERCISE 68: Construct Square butt joint on Aluminum sheet 2 mm thick in Horizontal positions by GTAW

Objectives

At the end of this exercise you shall be able to

- weld square butt joint in Aluminum sheet 3mm thick using TIG welding process.
- add filler metal at the required rate and place by manipulation the filler rod
- deposit fusion run with filler rod in flat position and maintain uniform arc travel speed
- clean and inspect the deposited beads for surface defects.



Job Sequence

- Prepare aluminium sheets as per dimensions.
- Use Tungsten (zirconium) 2.4 mm dia electrode.
- Clean the edges of the sheets.
- Use the stainless steel wire brush for surface cleaning.
- Set the square butt joint.

- Select the various parameters and set them accordingly.
- Weld the joint in flat position using leftward techniques.

Fill the crater

- Clean the weld area thoroughly.
- Inspect the job for free from defects.

Visual inspection : Slight convexity, uniform width, uniform ripples and free from under cut at the toes of the weld indicate a smooth.

Skill Sequence

Construct Square butt joint on Aluminum sheet 2 mm thick in Horizontal & Vertical positions by GTAW

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

- construct Square butt joint on Aluminum sheet 2 mm thick in Horizontal positions by GTAW.

Setting and tacking the lap joint

Set the butt joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly. Use a ∅ 2.4 Tungsten electrode with 160-amp current for tacking.

Set the joint in a Horizontal & vertical position using angle iron.

Welding the Butt fillet joint in flat position

Deposit root run with 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the Butt fillet weld and ensure :

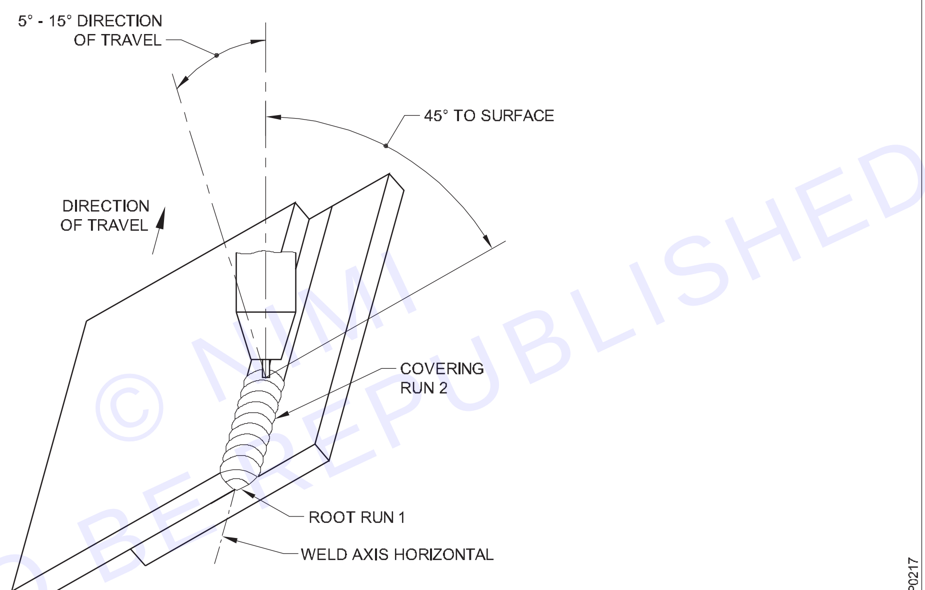
- It has equal leg length with slight convexity.
- The upper edge of the plate has not melted off.
- It is free from surface

EXERCISE 69 : Make Corner joint on Aluminium sheet 2 mm thick in down Vertical positions by GTAW

Objectives

At the end of this exercise you shall be able to

- weld outside corner joint in aluminum sheet 2 mm thickness using TIG welding process
- add filler metal at the required rate and place by manipulation the filler rod
- deposit fusion run with filler rod in flat position and maintain uniform arc travel speed
- clean and inspect the deposited beads for surface defects.



A FILLET WELD ON A LAP JOINT IN THE FLAT POSITION

Job Sequence

- Cut the sheet by shearing machine as per drawing.
- Grind and file the edges of sheets to square.
- Deburr and clean the surface of the plates by carbon steel wire brush and filling.
- Set the plate in the form of corner as per drawing.
- Wear protective clothes.
- Connect the torch to the positive terminal of the machine.
- Set 90-100A current/corresponding wire feed rate, 19 to 20 arc voltage and deposit the run using Dip transfer mode.
- Tack weld (min. 10mm length) on both ends of the corner joint
- Keep the tack welded job in vertical position on a weld positioner.
- Strike an arc and move the torch steady straight from the tor if the joint downwards
- Weld the corner joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique.
- Ensure good leg length and even fusion of plates.

- Avoid under cut
- Ensure the edges of the plate are not melted off due to excessive weaving.
- Ensure there is no undercut at the toe of the weld on plate
- **Visual inspection:** slight convexity, uniform width, uniform ripples and free from under cut at the toes of the weld indicate a smooth

Skill Sequence

Make Corner joint on Aluminium sheet 2 mm thick in down Vertical positions by GTAW

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

- make Corner joint on Aluminium sheet 2 mm thick in down Vertical positions by GTAW.

Set the lap joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly. Use ∅ 2.4 Tungsten electrode with 160-amp current for tacking.

Set the joint in a flat position using angle iron.

Welding the corner fillet joint in flat position

Deposit root run with ∅ 2.4 Tungsten electrode with 100-110 amp current

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Note : Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with a 4mmø medium coated MS electrode and 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note : Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

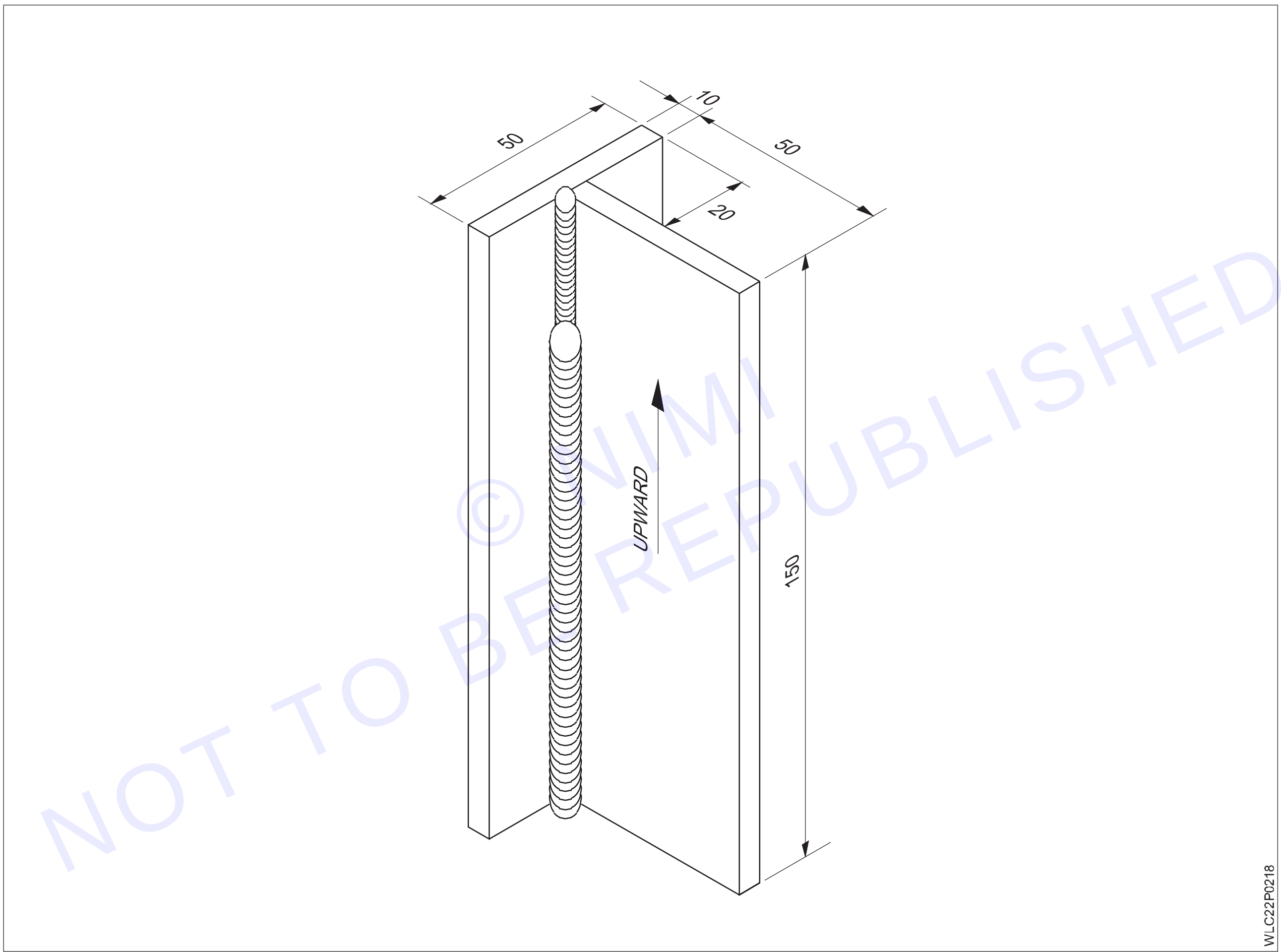
Inspect the Corner/fillet weld and ensure: comer

- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- It is free from surface defects.

Make Lap and Joint on Aluminium sheet 2mm thick in down Horizontal

Objectives

At the end of this exercise you shall be able to
- weld square butt joint on Aluminum sheet 3mm thick using TIG welding process.
- add filler metal at the required rate and place by manipulation the filler rod
- deposit fusion run with filler rod in flat position and maintain uniform arc travel speed
- clean and inspect the deposited beads for surface defects.



Job Sequence

- Cut the plate by using hacksaw cutting as per drawing
- Assess Lap joint on Aluminum sheet 2 mm thick in down hand position by GTAW
- Fill the crater
- Manipulate the torch and filler rod in the correct position with respect job
- Stop the weld at the left-hand edge of the joint after filling up in the crater at the end of the weld
- The angular distortion between the vertical and horizontal sheets of the Tee joint is automatically controlled.
- The current set is 10 to 15 ampere.
- At the end of the welding perform the centre filler treatment by repeating the torch switch ON-OFF.

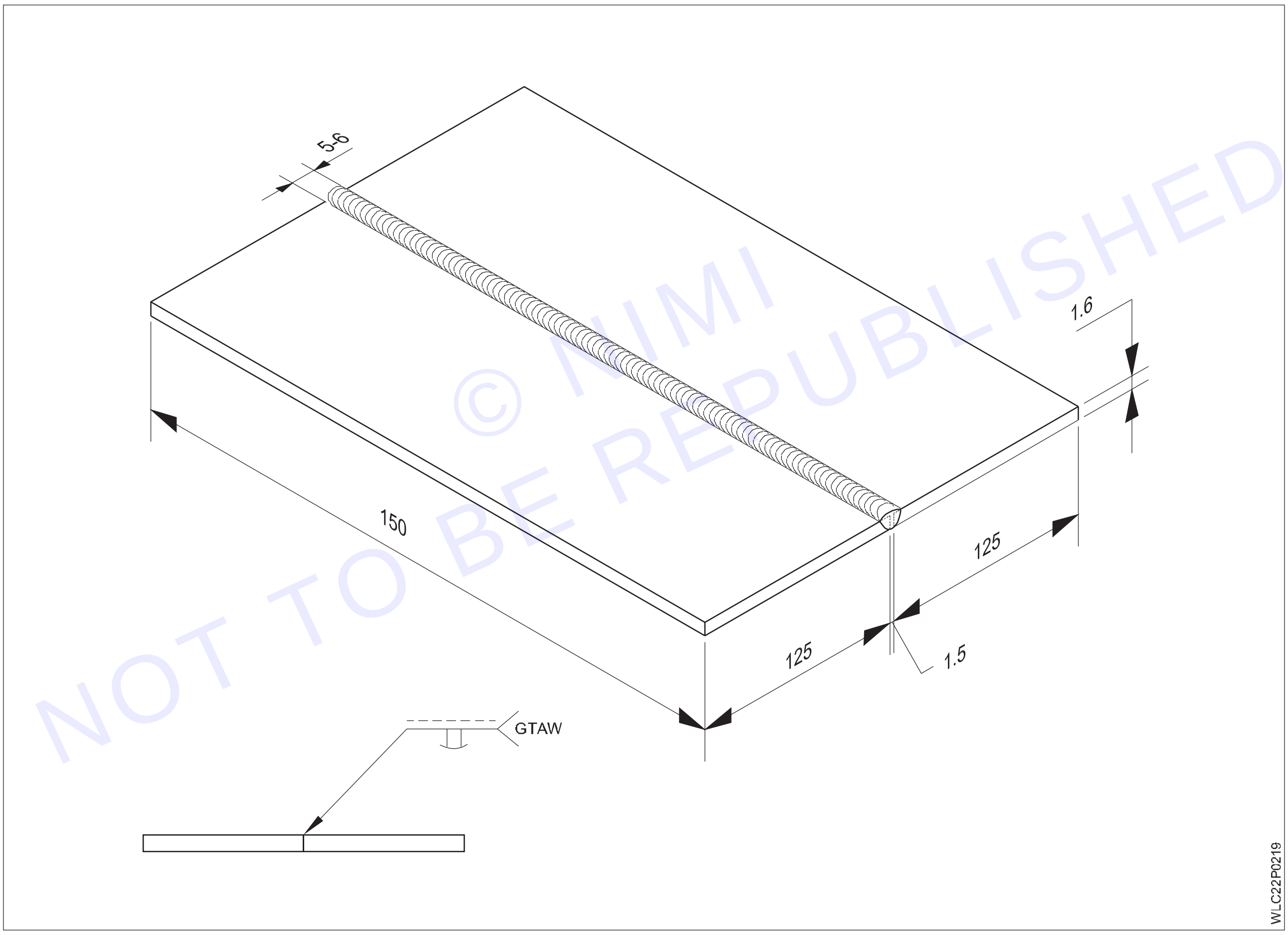
- Cut the arc and held at the finishing point unit molten metal solidifies.
- **Visual Inspection :** Slight convexity, uniform width, uniform ripples. And free from under cut at the toes of the weld indicate a smooth.

Skill Sequence

Make Lap and Joint on Aluminium sheet 2mm thick in down Horizontal

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

- make Lap and Joint on Aluminium sheet 2mm thick in down Horizontal.



Setting and tacking the lap joint.

Set the lap joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly. Use ∅ 2.4 Tungsten electrode with 160-amp current for tacking.

Set the joint in a flat position using angle iron.

Welding the lap fillet joint in flat position

Deposit root run with a 100-110 amp current

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Note : Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run and 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note : Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the Corner/fillet weld and ensure: comer

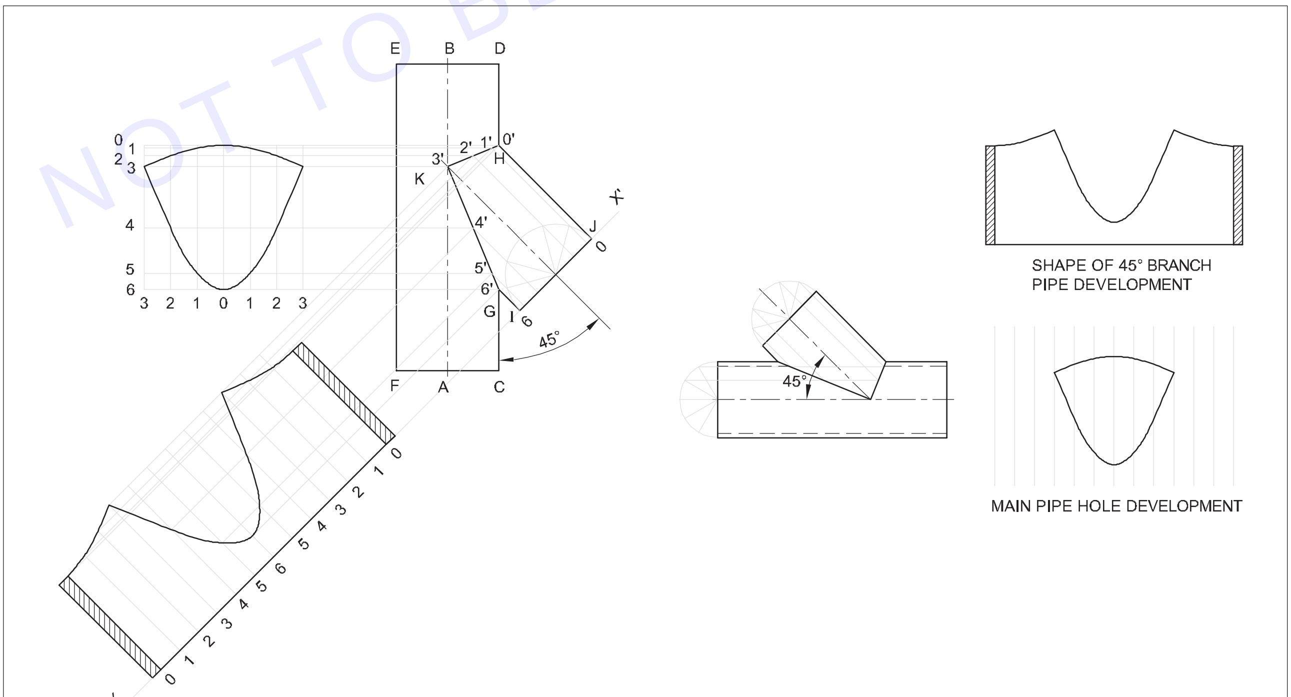
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- It is free from surface defects.

Make Tee Joint on Aluminium sheet 2mm thick in down vertical positions by GTAW

Objectives

At the end of this exercise you shall be able to

- weld a Tee joint using 5% silicon aluminium filler wire in flat position by TIG welding process
- add filler metal at the required rate and place by manipulation the filler rod
- deposit fusion run with filler rod in flat position and maintain uniform arc travel speed
- clean and inspect the deposited beads for surface defects.



DEVELOPMENT FOR 45° BRANCH JOINT "50 mm OD PIPES"

Job Sequence

- Prepare the plates to size (i.e 150 x 50 x 10mm) using gas cutting, grinding and filing.
- Clean the base metal surface along the welding line with a carbon steel wire brush.
- Set the plates in the form of an inverted “T”.
- Wear all protective devices.
- Tack weld the 2 plates, keeping the T joint in horizontal position.
- Set the welding parameters as done in earlier exercises.
- Strike the arc keeping proper angles for the torch.
- Deposit the root run without weaving and ensure proper penetration and fill the crater.
- Check for defects like overlap, undercut, porosity and check for correct leg size and throat thickness.
- **Visual inspection:** slight convexity, uniform width, uniform ripples and free from under cut at the toes of the weld indicate a smooth

Skill Sequence

Make Tee Joint on Aluminium sheet 2mm thick in down vertical positions by GTAW

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

- make Tee Joint on Aluminium sheet 2mm thick in down vertical positions by GTAW.

Setting and tacking the lap joint.

Set the lap joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly. Use ∅ 2.4 Tungsten electrode with 160-amp current for tacking.

Set the joint in a flat position using angle iron.

Welding the lap fillet joint in flat position

Deposit root run with a 100-110 amp current

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Note : Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run and 160 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note : Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the Corner/fillet weld and ensure: comer

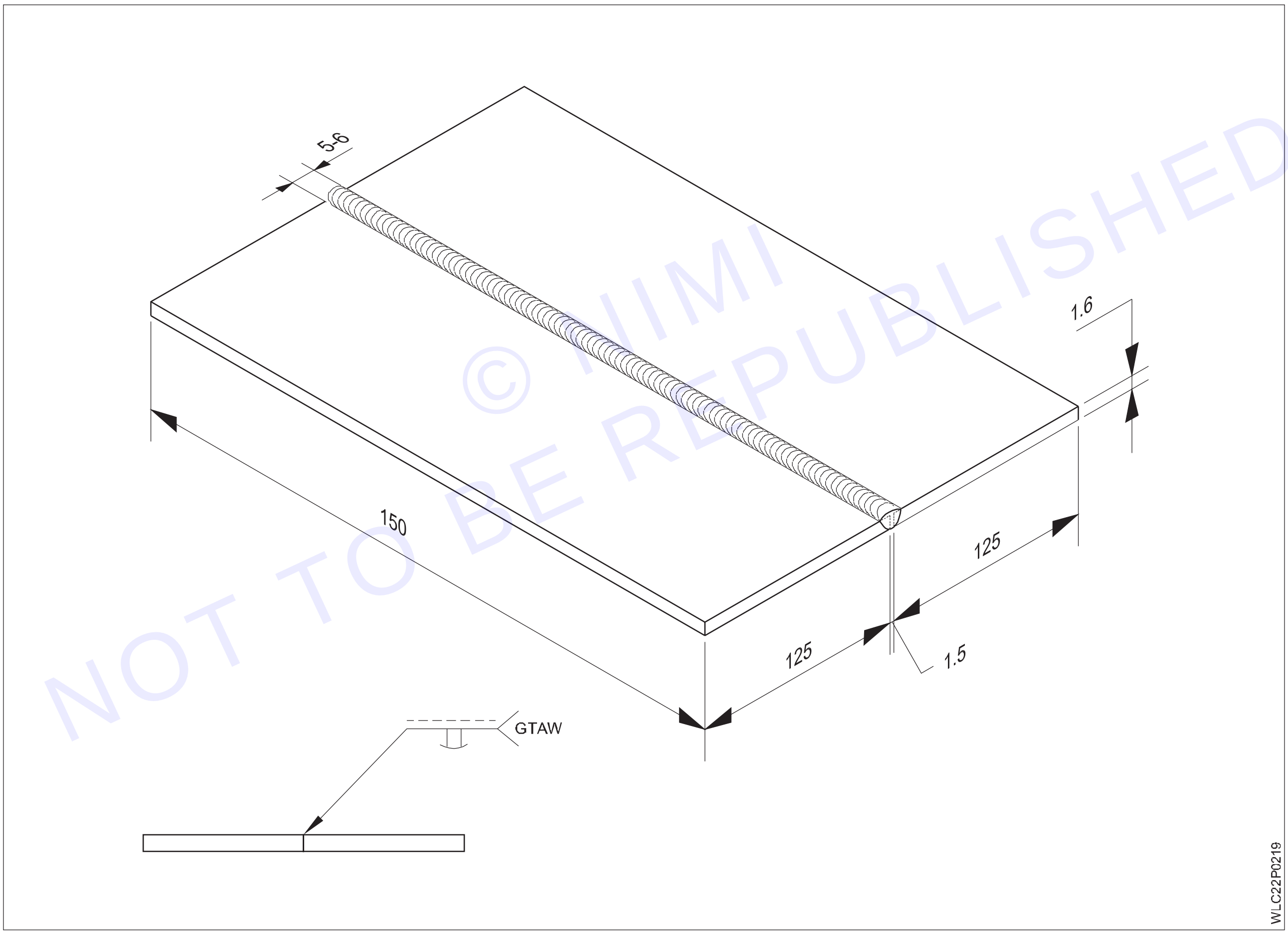
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- It is free from surface defects.

EXERCISE 70: Monitor the fabrication of Square butt joint on S.S sheet 1.6 mm thick in Flat position by GTAW

Objectives

At the end of this exercise you shall be able to

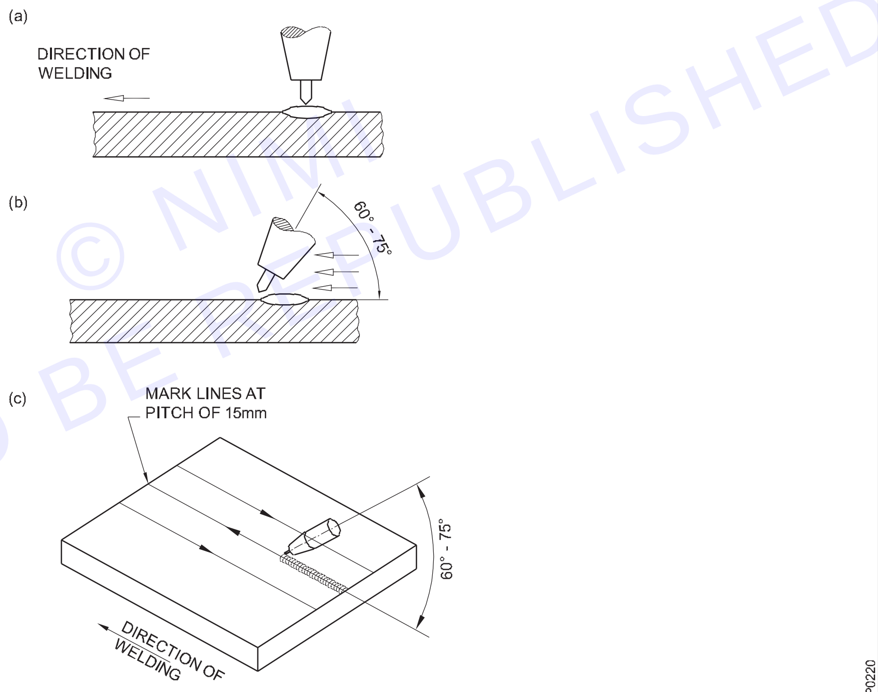
- weld square butt joint on stainless steel sheet-1.6mm thick flat position
- weld the joint using proper manipulation and angles for the torch and filler rod
- deposit fusion run with filler rod in flat position and maintain uniform arc travel speed
- clean and inspect the deposited beads for surface defects.



Job Sequence

- Clean the base metal surface with the S.S wire brush.
- Clean the base metal surface with alcohol.
- Adjust the current to about 80 to 90A.
- Adjust the gas flow rate to 6-8 LPM.
- Set the root gap to 1.5mm.
- Fix the base metal with the jig.
- Flow the back shielding gas by 4LPM.
- Tack weld at 10mm inside from both ends of the joint.
- Stop the back shielding gas.
- Remove the base metal from the jig.
- Check if the joint has good alignment.
- Fasten the base metal securely to the jig.
- Polish the base metal with the ss wire brush.

Fig 1



MAKING A STINGER BEAD
WITHOUT FILLER ROD

Visual inspection: Slight convexity, uniform width, uniform ripples and free from under cut at the toes of the indicate a smooth

Skill Sequence

Square butt joint on S.S sheet 1.6mm thick in Flat position by GTAW

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

- square butt joint on S.S sheet 1.6 mm thick in Flat position by GTAW.

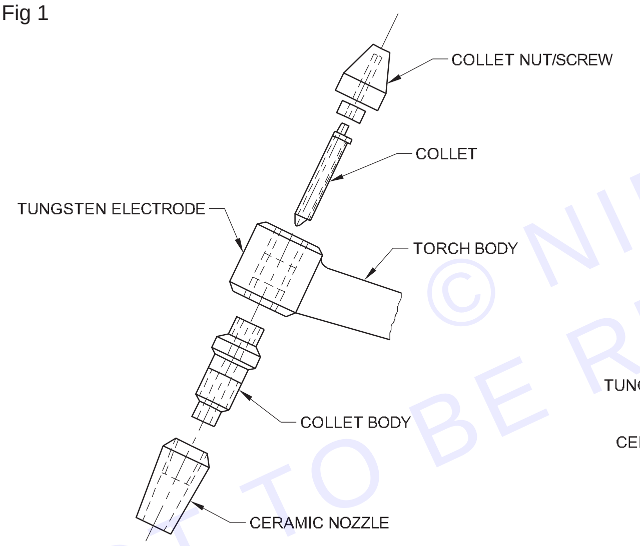
Select a Tungsten electrode of a proper f and give a proper angle to its tip 600 normally.

Set the torch (Figs 1,2,3& 4) with proper electrode extension.

Set the water line. Connect the gas and water hoses of the torch to the gas and water lines properly and check for water and gas leakage. Connect the power lead of the torch to the negative terminal of the power source and workpiece of the positive terminal of the power source. Check the connections for tightness.

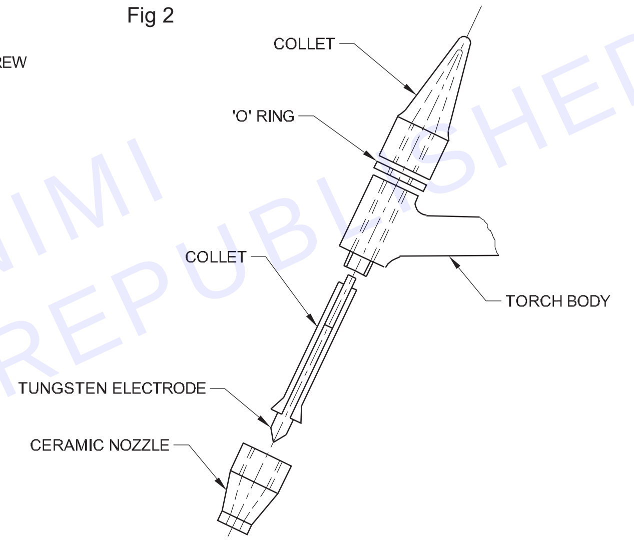
The electrode should be ground to have the tip with proper angles. Blunt tipped electrodes must be ground as shown in Fig. A properly ground electrode tip provides confined and stable arc which gives better penetration during welding. Special grinding machines are available to grind the tungsten electrodes.

Fig 1



COMPONENTS OF A WATER COOLED GTAW TORCH

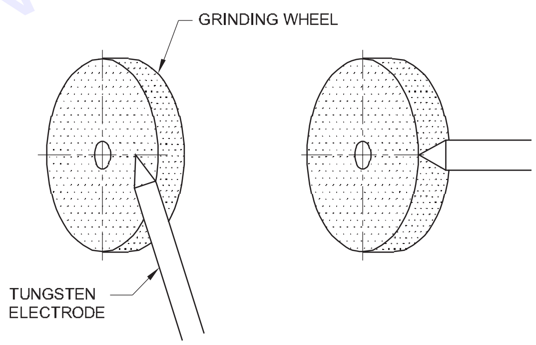
Fig 2



COMPONENTS OF A GAS COOLED GTAW TORCH

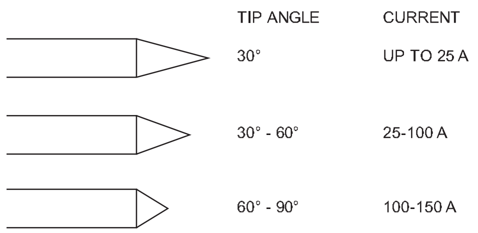
WLC22P0221

Fig 3



ELECTRODE POSITION FOR GRINDING

Fig 4



TUNGSTEN TIP CONFIGURATION

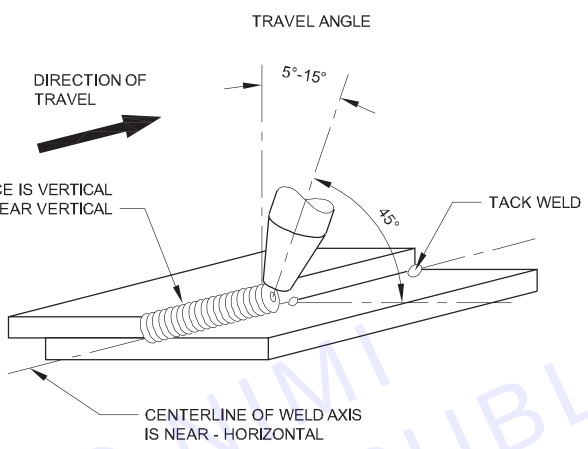
WLC22P0222

EXERCISE 71: Lap joint on S.S sheet 1.6 mm thick in Flat position by GTAW

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
- deposited the bead with or without weaving
- clean and inspect the weld.



Job Sequence

- Prepare the job to size as per drawing.
- Clean the job surface with stainless steel wire brush.
- Mark parallel lines on the job surface as per drawing and punch the lines.
- Set the work piece (job) on the work table in flat position.
- 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.
- Start the welding machine. Connect the torch to the positive (DC +ve) terminal (DCRP) of the machine.
- Open the argon gas flow before striking the arc.
- Set the arc voltage at 19-21 volt as required for dip transfer mode.
- Set the Gas Flow Rate at 8-10 LPM (Litres Per Minute)
- Set the wire feed rate so as to get 90-100 Amp by striking the arc on a scrap plate.
- Use DIN 11 or 12 black/green filter glass on Hand Shield/Helmet for above current setting.
- **Visual inspection:** slight convexity, uniform width, uniform ripples and free from under cut at the toes of the weld indicate a smooth

Skill Sequence

Lap joint on S.S sheet 1.6 mm thick in Flat position by GTAW

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

- lap joint on S.S sheet 1.6 mm thick in flat position by GTAW.

Setting and tacking the lap joint.

Set the lap joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly.

Set the joint in a flat position using angle iron.

Welding the lap fillet joint in flat position

Deposit root run with 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with 90 - 110 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld and ensure:

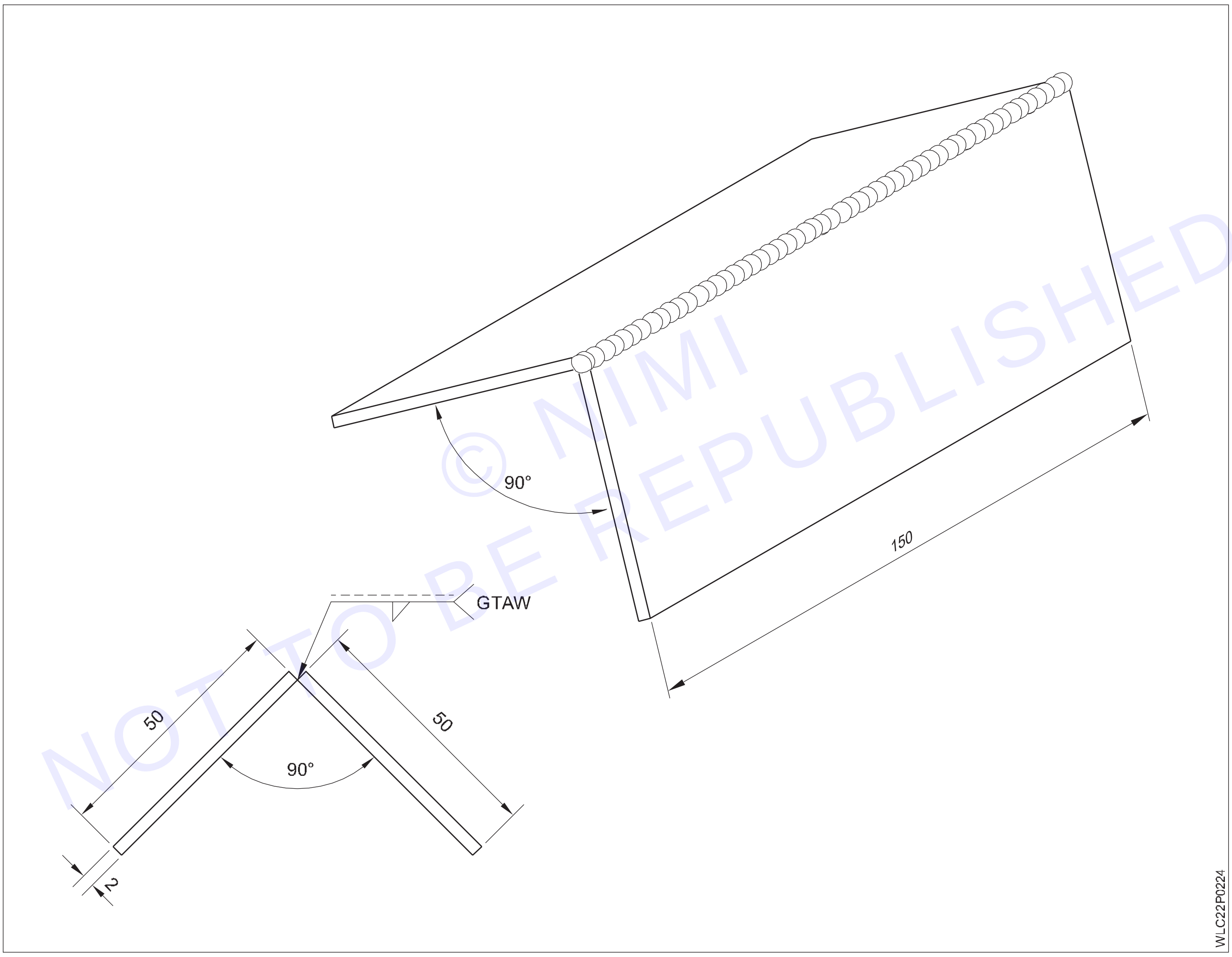
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- it is free from surface defects.

Corner joint on S.S sheet 1.6 mm thick in flat position by GTAW

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
- deposited the bead with or without weaving
- clean and inspect the weld.



Job Sequence

- Prepare the job to size as per drawing.
- Clean the job surface with stainless steel wire brush.
- Mark parallel lines on the job surface as per drawing and punch the lines.
- Set the workpiece (job) on the work table in flat position.
- 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.
- Start the welding machine. Connect the torch to the positive (DC +ve) terminal (DCRP) of the machine.
- Open the argon gas flow before striking the arc.
- Set the arc voltage at 19-21 volt as required for dip transfer mode.
- Set the Gas Flow Rate at 8-10 LPM (Liters Per Minute)
- Set the wire feed rate so as to get 90-100 Amp by striking the arc on a scrap plate.
- Use DIN 11 or 12 black/green filter glass on Hand Shield/Helmet for above current setting.
- Wear the protective clothing as required

Note: Wear protective clothing.

Skill Sequence

Corner joint on S.S sheet 1.6 mm thick in flat position by GTAW

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

- corner joint on S.S sheet 1.6 mm thick in flat position by GTAW.

Setting and tacking the lap joint

Set the corner joint with an overlap of 25mm.

The may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly. current for tacking.

Set the joint in a flat position using angle iron.

Welding the lap fillet joint in flat position

Deposit root run with with 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with 120 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the corner fillet weld and ensure:

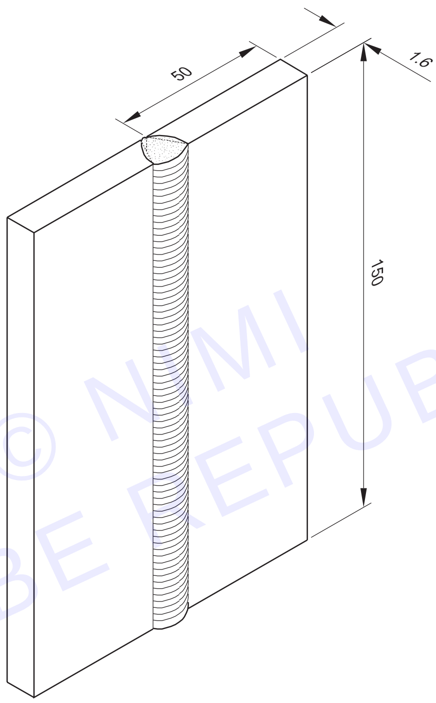
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- it is free from surface defects.

EXERCISE 72: Plan & make Square butt joint on S.S sheet 1.6 mm thick in Vertical position by GTAW

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
- deposited the bead with or without weaving
- clean and inspect the weld.



WLC22P0225

Job Sequence

- Prepare the job to size as per drawing.
- Clean the job surface with stainless steel wire brush.
- Mark parallel lines on the job surface as per drawing and punch the lines.
- Set the workpiece (job) on the work table in flat position.
- 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.
- Start the welding machine. Connect the torch to the positive (DC +ve) terminal (DCRP) of the machine.
- Open the argon gas flow before striking the arc.
- Set the arc voltage at 19-21 volt as required for dip transfer mode.
- Set the Gas Flow Rate at 8-10 LPM (Litres Per Minute)
- Set the wire feed rate so as to get 90-100 Amp by striking the arc on a scrap plate.
- Use DIN 11 or 12 black/green filter glass on Hand Shield/Helmet for above current setting.
- Wear the protective clothing as required

Skill Sequence

Plan & make Square butt joint on S.S sheet 1.6 mm thick in Vertical position by GTAW

Objectives: At the end of this exercise you shall be able to
- plan & make square butt joint on S.S sheet 1.6 Mm thick in vertical position by GTAW.

Setting and tacking the lap joint

Set the square butt joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly.

Set the joint in a flat position using angle iron.

Welding the lap fillet joint in flat position

Deposit root run with 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.)

Maintain a short arc to get uniform fusion and root penetration.

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with 120 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld and ensure:

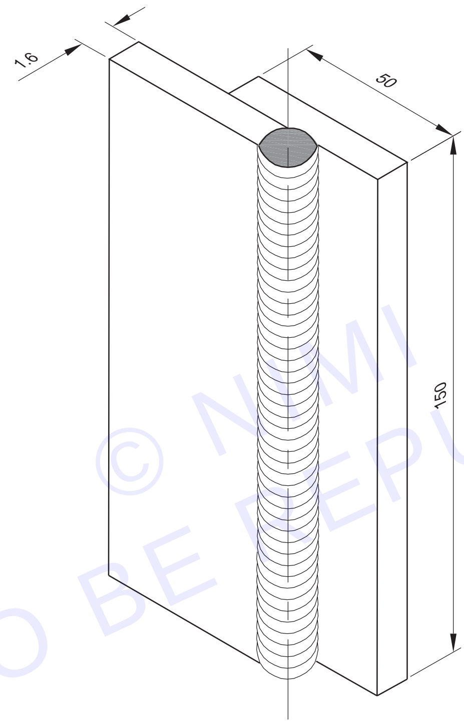
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- it is free from surface defects.

EXERCISE 73: Construct Lap joint on MS sheet 1.6 mm in Vertical position by GTAW

Objectives

At the end of this exercise you shall be able to

- produce molten pool of required size by the manipulation of torch
- add filler metal at the required rate and place by manipulation the filler rod
- deposit fusion run with filler rod in flat position and maintain uniform arc travel speed
- clean and inspect the deposited beads for surface defects.



Job Sequence

- Cut the plate by using hacksaw cutting as per drawing
- Construct Lap joint on MS sheet 1.6 mm in Vertical position by GTAW
- Fill the crater
- Manipulate the torch and filler rod in the correct position with respect job
- Stop the weld at the left-hand edge of the joint after filling up in the crater at the end of the weld
- The angular distortion between the vertical and horizontal sheets of the lap is automatically controlled
- The current set is 10 to 15 amperes
- At the end of the welding perform the carter filler treatment by repeating the torch switch ON-OFF
- Cut the arc and hold at the finishing point unit molten metal solidifies

Skill Sequence

Construct Lap joint on MS sheet 1.6 mm in Vertical position by GTAW

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

- Plan & make Square butt joint on S.S sheet 1.6 mm thick in Vertical position by GTAW.

Setting and tacking the lap joint

Set the lap joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly.

Set the joint in a flat position using angle iron.

Welding the lap fillet joint in flat position

Deposit root run with 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with and 120 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld and ensure:

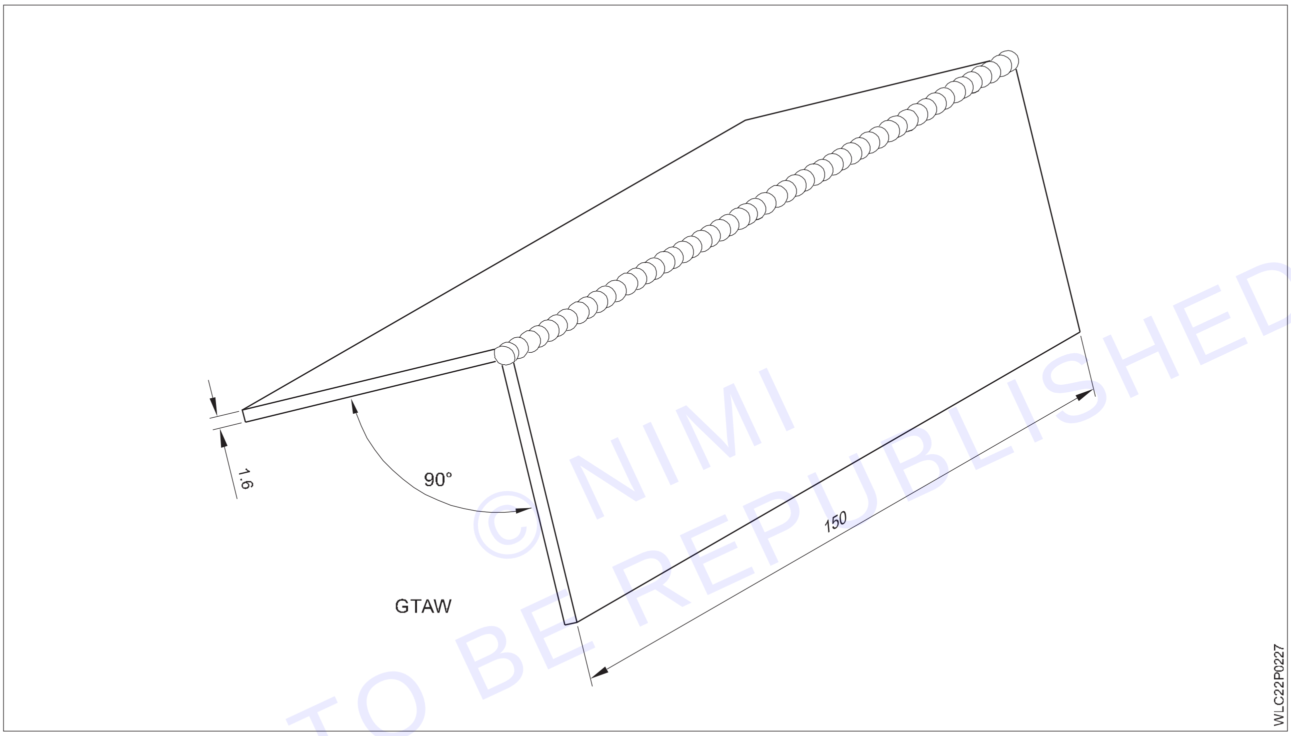
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- it is free from surface defects.

Construct Corner joint on MS sheet 1.6 mm in Vertical position by GTAW

Objectives

At the end of this exercise you shall be able to

- produce molten pool of required size by the manipulation of torch
- add filler metal at the required rate and place by manipulation the filler rod
- deposit fusion run with filler rod in flat position and maintain uniform arc travel speed
- clean and inspect the deposited beads for surface defects.



Job Sequence

- Cut the plate by using hacksaw cutting as per drawing
- Construct Lap joint on MS sheet 1.6 mm in Vertical position by GTAW
- Fill the crater
- Manipulate the torch and filler rod in the correct position with respect job
- Stop the weld at the left-hand edge of the joint after filling up in the crater at the end of the weld
- The angular distortion between the vertical and horizontal sheets of the Tee joint is automatically controlled
- The current set is 10 to 15 amperes
- At the end of the welding perform the carter filler treatment by repeating the torch switch ON-OFF
- Cut the arc and hold at the finishing point unit molten metal solidifies
- **Visual inspection:** slight convexity, uniform width, uniform ripples and free from under cut at the toes of the weld indicate a smooth

Skill Sequence

Construct Corner joint on MS sheet 1.6 mm in Vertical position by GTAW

Objectives: At the end of this exercise you shall be able to
- construct Corner joint on MS sheet 1.6 mm in Vertical position by GTAW.

Setting and tacking the lap joint

Set the lap joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly. Use a current for tacking.

Set the joint in a flat position using angle iron .

Set the joint in a flat position using angle iron.

Welding the lap fillet joint in flat position

Deposit root run with 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with 120 - 140 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld and ensure:

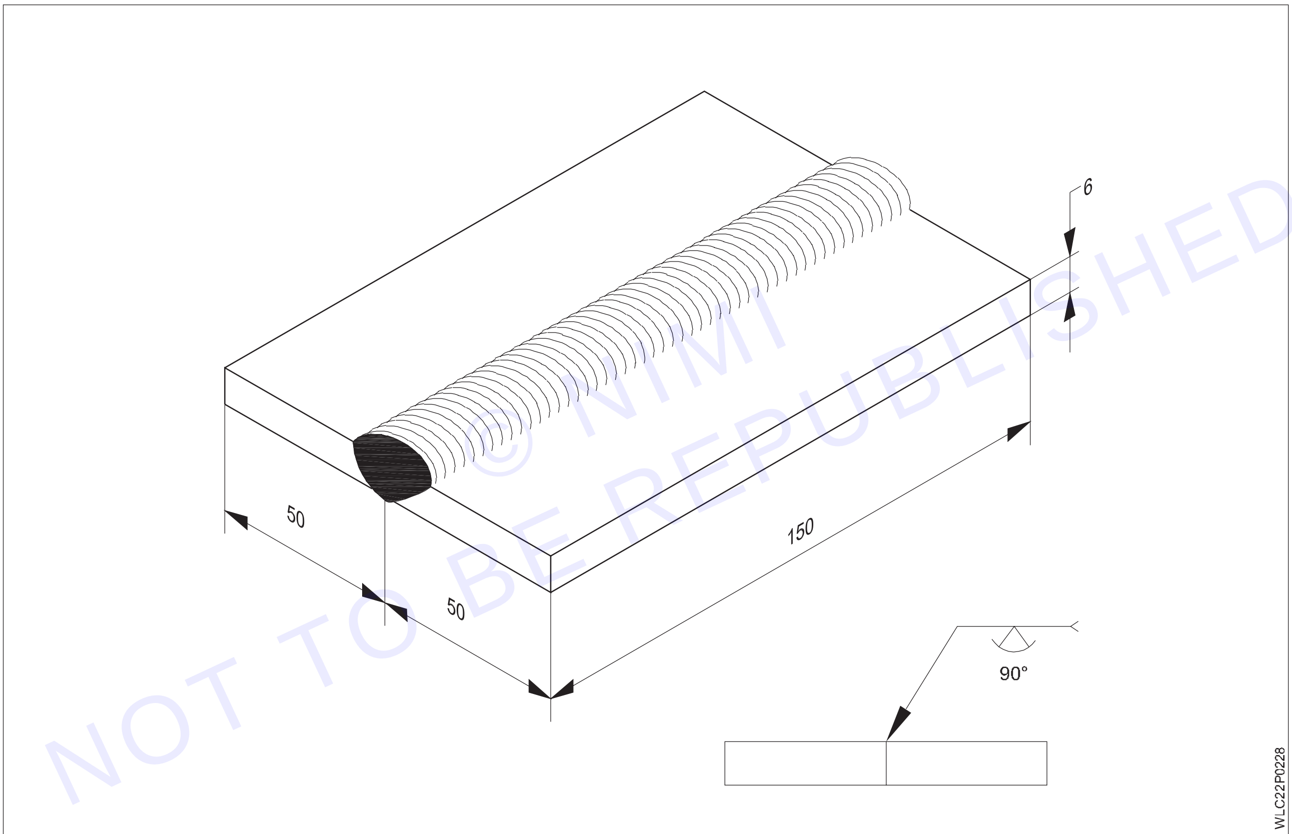
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- it is free from surface defects.

EXERCISE 74: Monitor the formation of Single V butt joint on Aluminum sheet 6 mm thick by GTAW in down hand

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.



Job Sequence

- Prepare aluminium sheets as per dimensions.
- Use Tungsten (zirconium) 2.4mm dia electrode.
- Clean the edges of the sheets.
- Use the stainless-steel wire brush for surface cleaning.
- Set the square butt joint
- Select the various parameters as given in the Table 1 and set them accordingly.
- Weld the joint in flat position using leftward technique.
- Fill the crater.
- Clean the weld area thoroughly.

- inspect the job for free from defects

Note: Wear protective clothing.

Skill Sequence

Monitor the formation of Single V butt joint on Aluminum sheet 6 mm thick by GTAW in down hand position

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

- monitor the formation of Single V butt joint on Aluminum sheet 6 mm thick by GTAW in down hand position.

Setting and tacking the lap joint

Set the butt joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly.

Set the joint in a flat position using angle iron.

Welding the lap fillet joint in flat position

Deposit root run with 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with 120 - 140 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld and ensure:

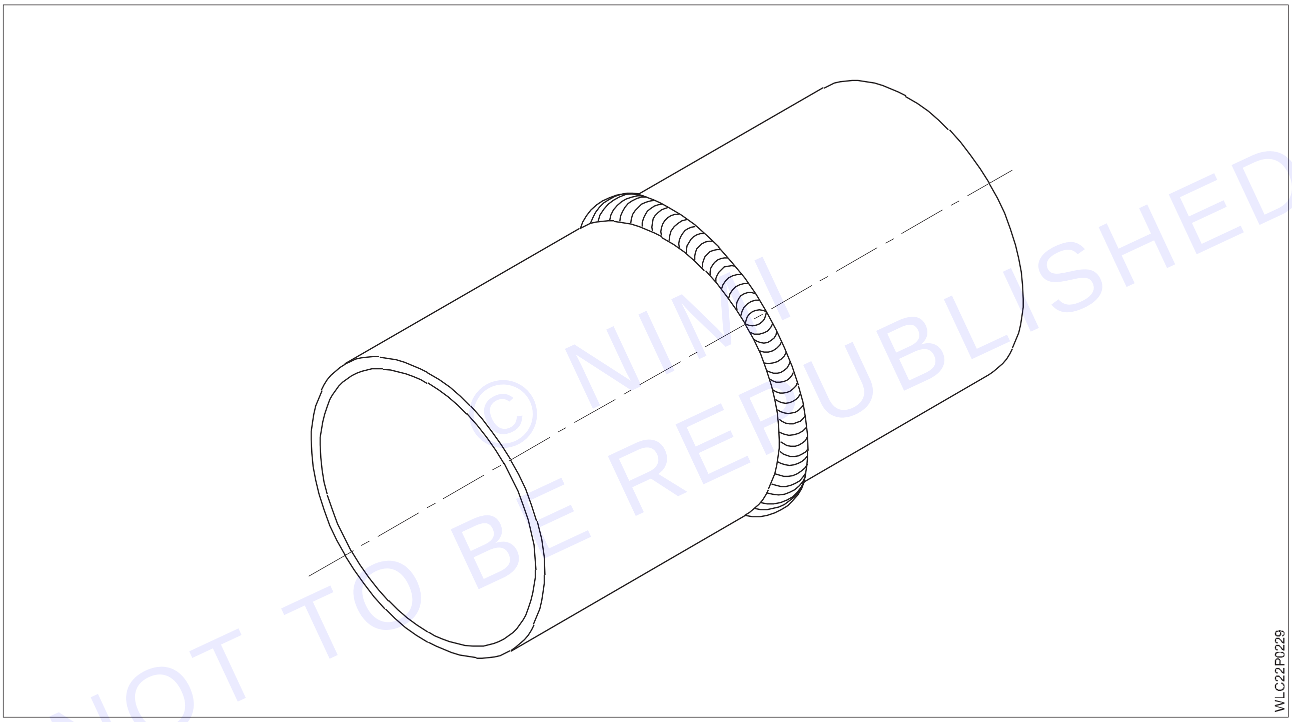
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- it is free from surface defects.

EXERCISE 75: Make Square butt joint on Tube welding on M.S. tube metals in rolled position by GTAW

Objectives

At the end of this exercise you shall be able to

- prepare plate pieces by gas cutting and by grinding to size
- set plates as a lap joint and tack weld at both ends
- place the lap joint in a flat position for welding
- deposit root run of proper size and ensure penetration
- deposit the final covering run in the lap joint of proper leg size
- clean and inspect the lap fillet weld for surface defects.



Job Sequence

- Welding is a fabrication process that joins materials
- usually metals or thermoplastics, by using high heat to melt the parts together and allowing them to cool, causing fusion
- Welding is distinct from lower temperature techniques such as brazing and soldering, which do not melt the base metal (parent metal).
- In addition to melting the base metal, a filler material is typically added to the joint to form a pool of molten material (the weld pool) that cools to form a joint that, based on weld configuration (butt, full penetration, fillet, etc.),
- can be stronger than the base material Pressure may also be used in conjunction with heat or by itself to produce a weld.
- lding also requires a form of shield to protect the filler metals or melted metals from being contaminated or oxidized

- Many different energy sources can be used for welding including a gas flame (chemical), an electric arc (electrical), a laser, an electron beam, friction, and ultrasound.
- While often an industrial process, welding may be performed in many different environments including in open air under water, and in outer space
- Welding is a hazardous undertaking and precautions are required to avoid burns, electric shock. vision damage, inhalation of poisonous gases and fumes, and exposure to intense ultraviolet radiation.

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by using a 2.4 mm dia. Tungsten electrode with 60 90 amps current.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion coated M.S. electrode with150-160amps welding current.

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.

Skill Sequence

Make Square butt joint on Tube welding on M.S. tube metals in rolled position by GTAW and monitor the same

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

- make Square butt joint on Tube welding on M.S. tube metals in rolled position by GTAW and monitor the same.

Setting and tacking the lap joint

Set the butt joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. Ensure the 2 lapping sur-faces are perfectly cleaned and they contact each other properly.

Set the joint in a flat position using angle iron.

Welding the butt fillet joint in flat position

Deposit root run with 100-110 amp current.

Maintain 80° angle to the line of the weld and 45° between the weld faces.

Maintain a short arc to get uniform fusion and root penetration.

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with and 120 - 140 amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the butt fillet weld and ensure:

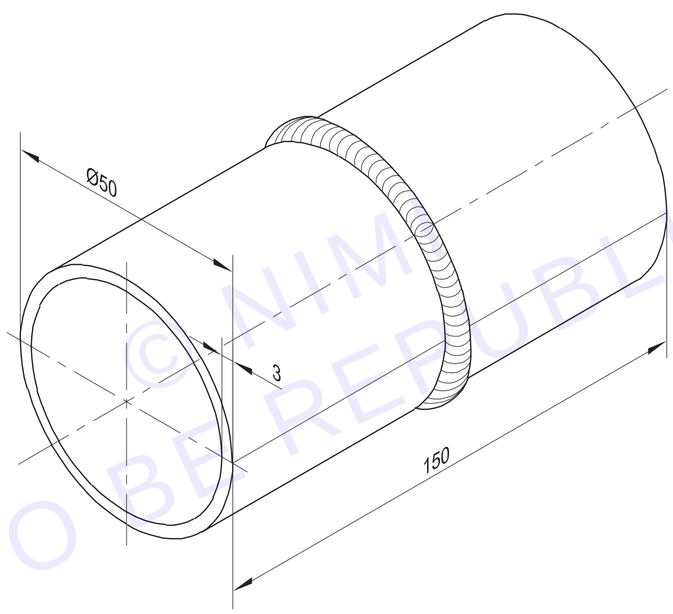
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- it is free from surface defects.

EXERCISE 76: Plan & perform Root pass welding of M. S schedule 40pipes by GTA Welding up to 6G Positions

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
- deposit the bead with or without weaving
- clean and inspect the weld.



Job Sequence

- Cut and prepare the aluminium pipe as per the dimensions given.
- Align the pipes in flat position (butt) for tack weld with the help of a Vee Block-angle iron.
- Tack the joints at 120°C by rotation and complete the tacking.
- Use the roller stand to maintain the downward welding position
- Rotate the pipe at uniform speed for good weld result.
- Further welding is done by rotating the pipe as shown in to the next segment and completed.
- Repeat the above procedure till the joint is completely welded.
- Remove the work piece from the rotating fixture.
- Clean the weld bead and inspect

Note: Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.

Note: Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the final covering run with a weave motion using coated M.S. electrode with150-160amps welding current.

Note: Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Note: Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.

Skill Sequence

Plan & perform Root pass welding of M. S schedule 40pipes by GTA Welding up to 6G Positions

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

- plan & perform Root pass welding of M. S schedule 40pipes by GTA Welding up to 6G Positions.

Setting and tacking the butt joint (Fig 1)
Set the butt joint with an overlap of 25mm.
The overlap may vary based on the plate thickness.
Tack-weld on both ends. (Fig 1) Ensure the adjacent sur-faces are perfectly cleaned and they contact each other properly. Use a 120-amp current for tacking.
Set the joint in a flat position using angle iron (Fig 2).

Welding the lap fillet joint in flat position

Deposit root run with with 100-110 amp current.
Maintain 80° angle to the line of the weld and 45° between the weld faces. (Fig 2)
Maintain a short arc to get uniform fusion and root penetration.

Note: Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.
Deposit the final covering run with and 160 amp current.
Give side-to-side movement to the electrode not more than 2.5 times its dia.
Use the same electrode angle as was used for the root bead.

Note: Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

Remove the slag with a chipping hammer.
Clean the weld with a steel wire brush.
Inspect the butt fillet weld (Fig 3) and ensure:

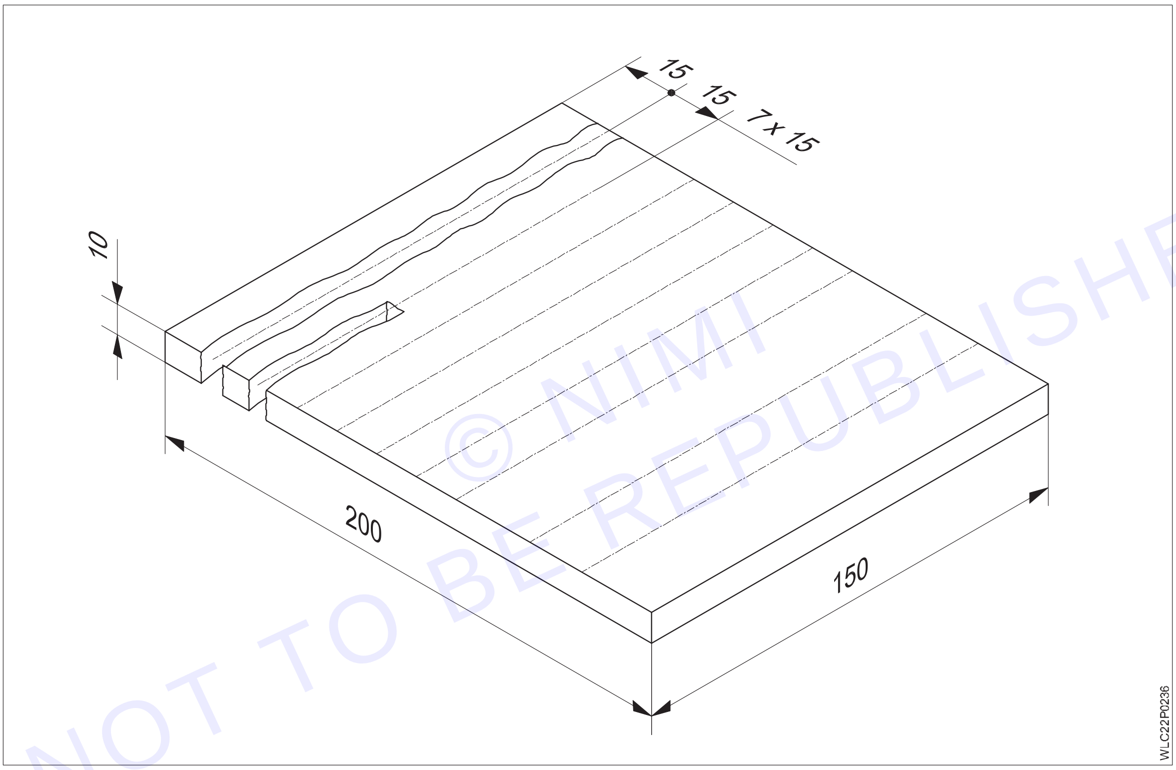
- It has equal leg length with slight convexity
- The upper edge of the plate has not melted off
- it is free from surface defects.

EXERCISE 77(A): Plan & monitor Plasma cutting of SS sheets plates

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 Clean and inspect the weld.



Job Sequence

- Begin cutting by placing the torch as close as possible to the edge of the base metal.
- Pull the trigger to ignite the pilot arc.
- Move the torch near the work piece to ignite the cutting arc 4
- Wait for the arc to penetrate through the bottom of the work piece.
- Start moving the torch slowly, perpendicular to the work piece. Watch sparks leaving the bottom of the work piece 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.
- At the end of a cut, angle the torch slightly or pause briefly to completely finish the cut systems.
- 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.
- To maximize cutting speeds, it is recommended to turn your power source to full output for S.S material thicknesses.

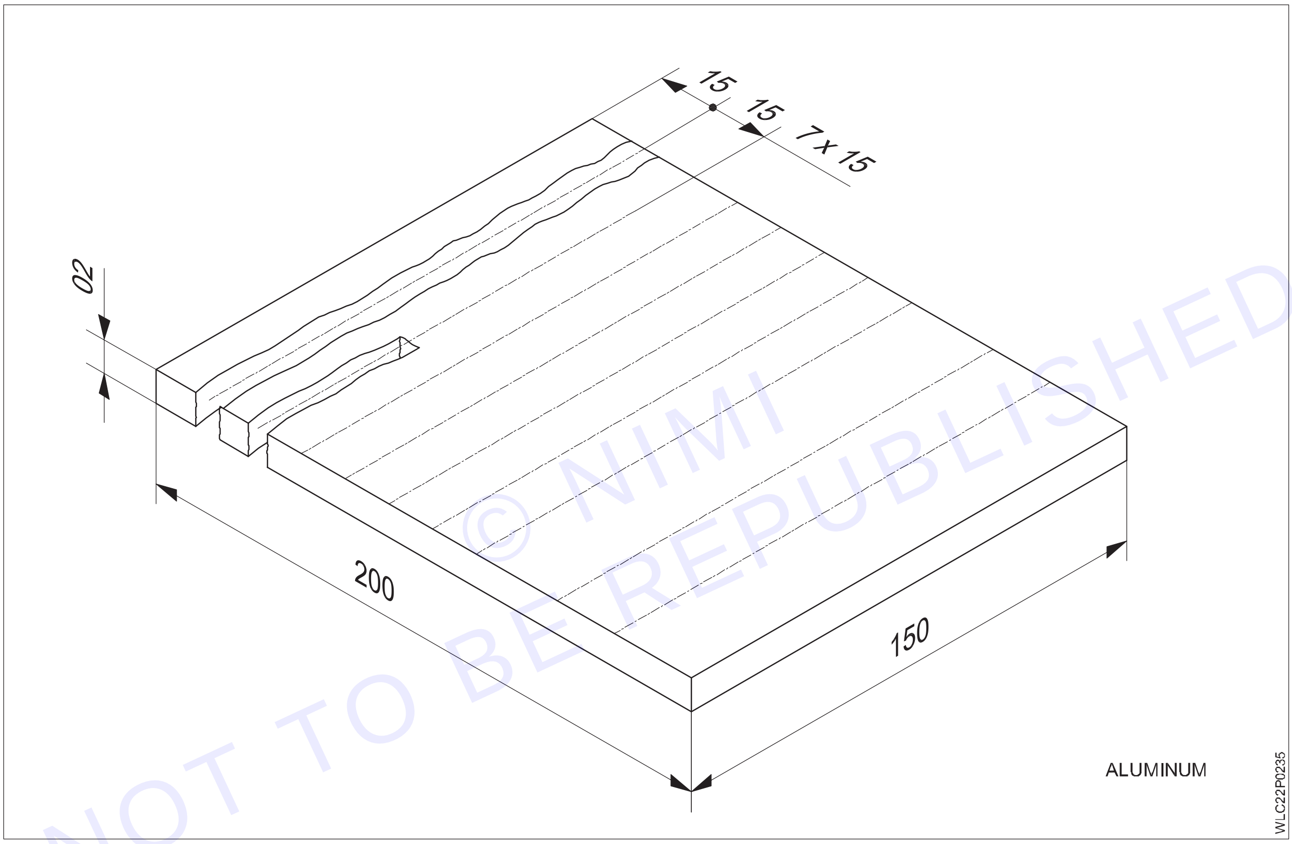
Note: Wear protective clothing.

EXERCISE 77(B): Plan & monitor Plasma cutting of Aluminum

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.



Job Sequence

- Begin cutting by placing the torch as close as possible to the edge of the base metal.
- Pull the trigger to ignite the pilot arc.
- Move the torch near the work piece to ignite the cutting arc 4
- Wait for the arc to penetrate through the bottom of the work piece.
- Start moving the torch slowly, perpendicular to the work piece. Watch sparks leaving the bottom of the work piece 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.
- At the end of a cut, angle the torch slightly or pause briefly to completely finish the cut systems.
- 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.
- To maximize cutting speeds, it is recommended to turn your power source to full output for aluminium0 material thicknesses.

EXERCISE 78: CNC profile cutting practice using air plasma torcah

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
- deposit the bead with or without weaving
- clean and inspect the weld.

Job Sequence

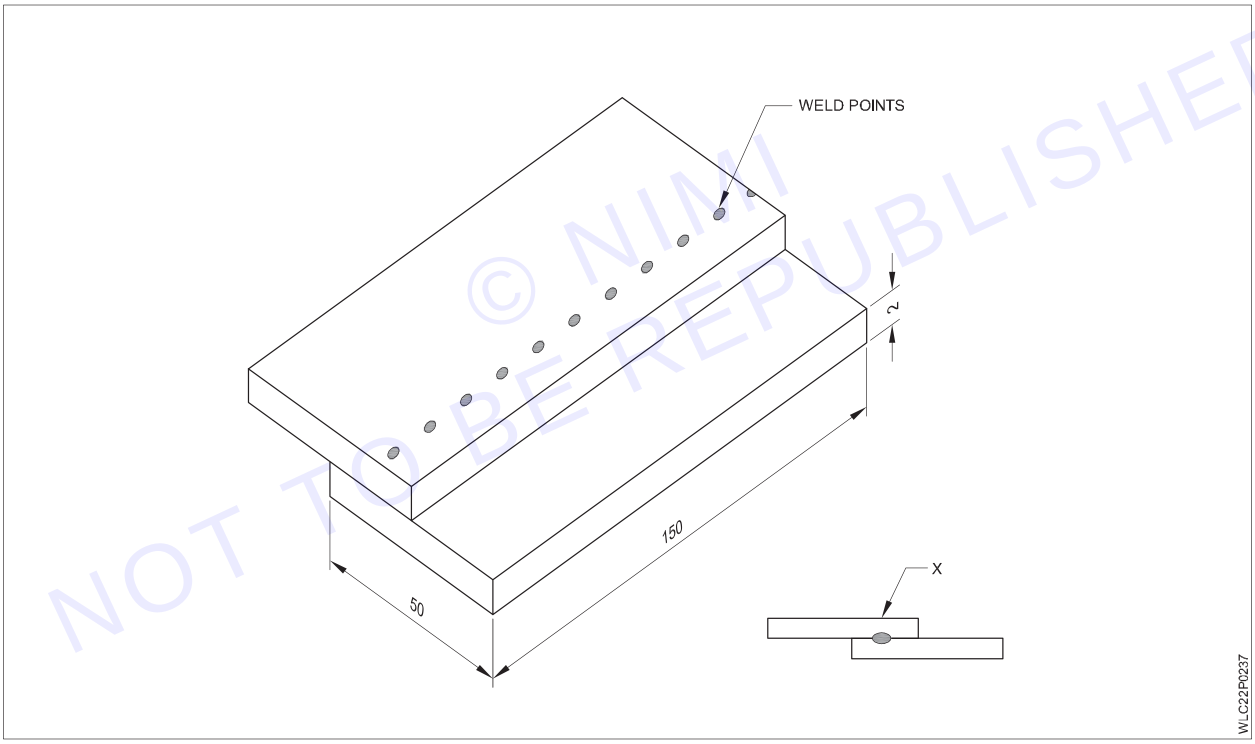
- Plasma cutting (plasma arc cutting) is a melting process in which a jet of ionized gas at temperatures above 20,000°C is used to melt and expel material from the cut.
- During the process, an electric arc is struck between an electrode (cathode) and the workpiece (anode).
- The electrode is recessed in a water- or air-cooled gas nozzle which constricts the arc causing the narrow, high temperature, high velocity plasma jet to form.
- When the plasma jet hits the workpiece, recombination takes place and the gas reverts to its normal state, emitting intense heat as it does so.
- This heat melts the metal and the gas flow ejects it from the cut. Plasma gases are usually argon, argon/ hydrogen or nitrogen.
- These inert gases can be replaced by air but this requires a special electrode of hafnium or zirconium.
- Use of compressed air makes this variant of the plasma process highly competitive with the oxy-fuel process for cutting carbon-manganese and stainless steels up to 20mm thick.
- Inert gases are preferred for high quality cuts in reactive alloys.
- Plasma arc can cut a very wide range of electrically conductive alloys including plain carbon and stainless steels, aluminum and its alloys, nickel alloys and titanium.

Note: Wear protective clothing.

EXERCISE 79: Make Lap joint on Stainless steel sheet by Resistance Spot welding MS sheets joining 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 Sequence

- Cut the plates by gas cutting as per drawing.
- Set the pieces in the form of corner joint as per drawing.
- Tack weld on both ends of the corner joint.
- Set the joint on the welding table in flat position .
- Connect the torch to the positive terminal of the machine.
- Set 90-100A current/corresponding wire feed rate,19 to 20 arc voltage and deposit the run using Dip transfer mode.

- Deposit run in the joint by forming a key hole and obtain complete penetration and even fusion of plates.
- Ensure good leg length and even fusion of plates.
- Select dia 1.mm m.s electrode
- Set 90 to 100 amps current
- Ensure proper root penetration and even fusion.
- Wide and weaving motion the side of corner joints.

Note: Wear protective clothing.

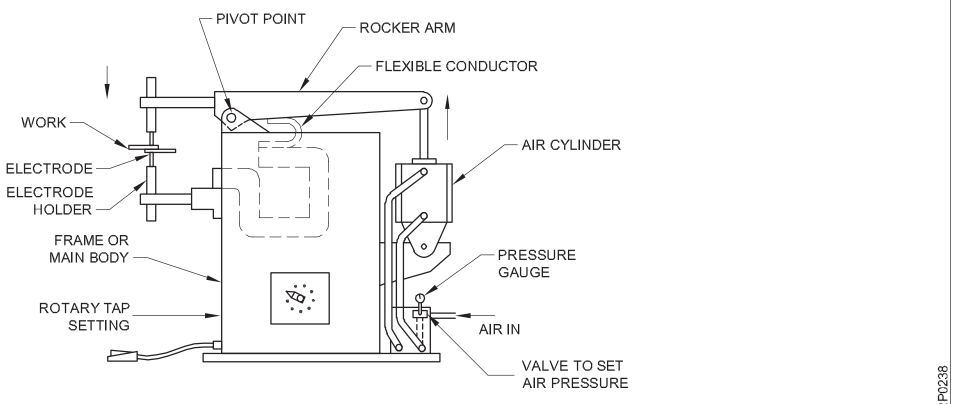
Skill Sequence

Make Lap joint on Stainless steel sheet by Resistance Spot welding MS sheets joining by Resistance Spot welding

Objectives: At the end of this exercise you shall be able to
- make lap joint on stainless steel sheet by resistance spot welding ms sheets joining by resistance spot welding.

1 Set the pieces in the form of lap joint.
2 Select proper spot welding machine as Fig 1.
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.

Fig 1

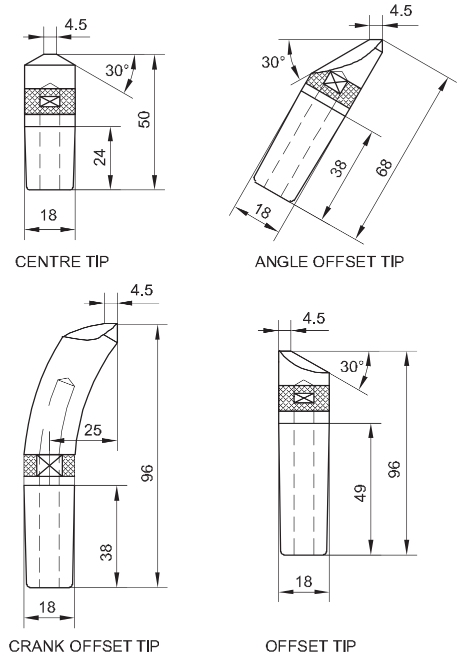


ROCKER ARM TYPE RESISTANCE WELDING MACHINE

7 Complete the welding(Wled nugget) carefully.

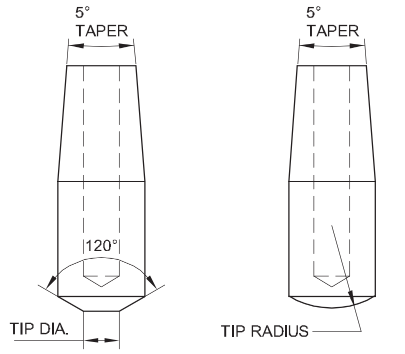
8 Clean and inspect the defects.

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

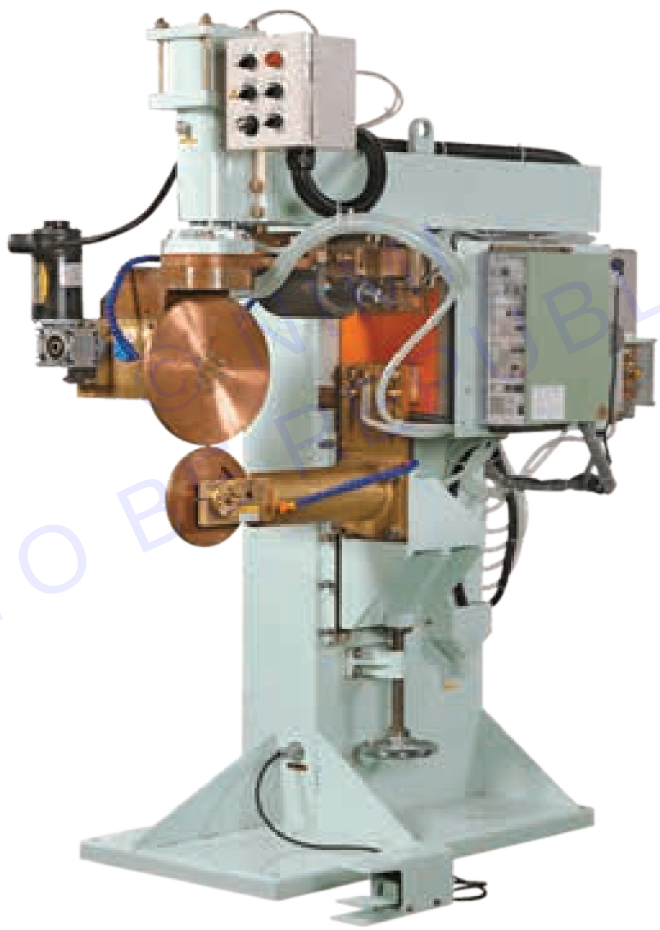
WLC22P0239

EXERCISE 80: Practice on Seam welding machine

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
- deposit the bead with or without weaving
- clean and inspect the weld.



Job Sequence

- Seam welding can generate large amounts of heat
- Especially when making a liquid tight continuous weld.
- This heat is very visible at the actual weld joint.
- You stated that you are using cooling water as specified by the machine manufacturer at 20 l per minute.
- This may be adequate for the machine under normal operation.
- It does not mean that at the weld area the cooling is adequate.
- Heat can be a suspect to address.
- The machine produces good welds for 300 meters.
- Then cracks appear
- After stopping for a period of time the machine is cooled down.
- A restart produces good product for another 300 meters.
- If the hub cooling of the wheel cannot adequately cool the wheel to keep the wheel rim face at a steady heat condition, the rim face heat will build up and gradually get hotter.
- The part will not cool as quickly and the process will change.
- Apparently, CRACKING results.

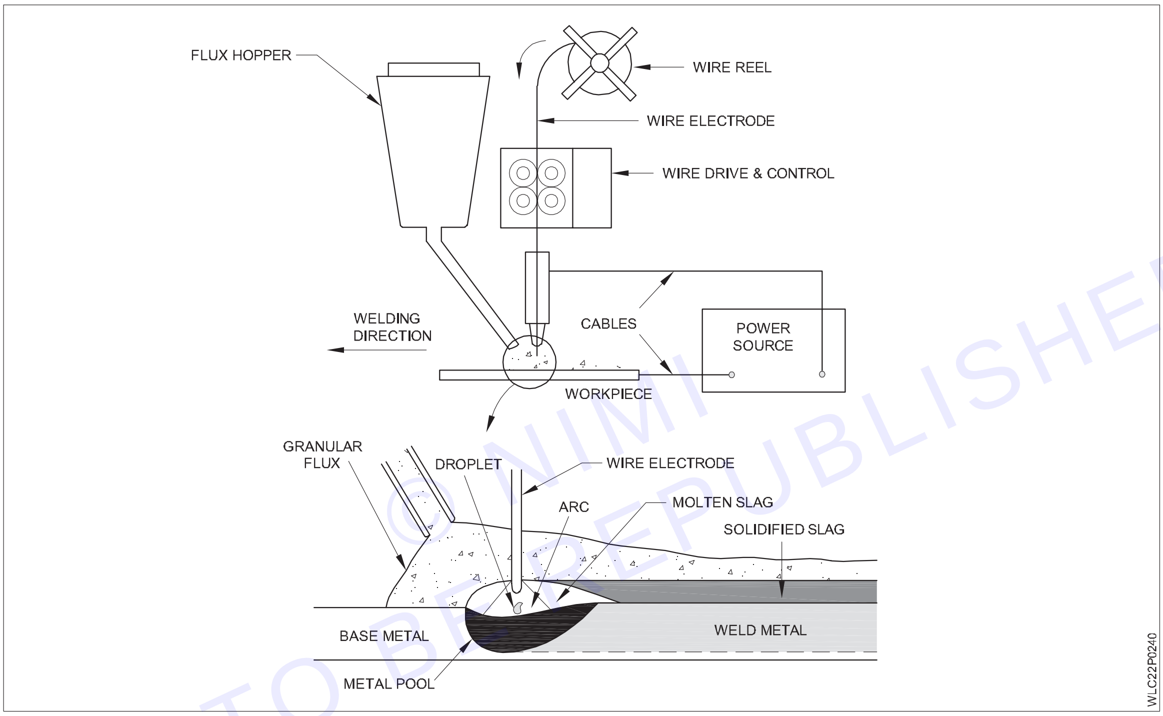
Note: Wear protective clothing.

EXERCISE 81: Practice on Automatic Submerged Arc Welding machine

Objectives

At the end of this exercise you shall be able to

- mark and set the plate as per drawing
- deposit the bead with or without weaving
- clean and inspect the weld.



Job Sequence

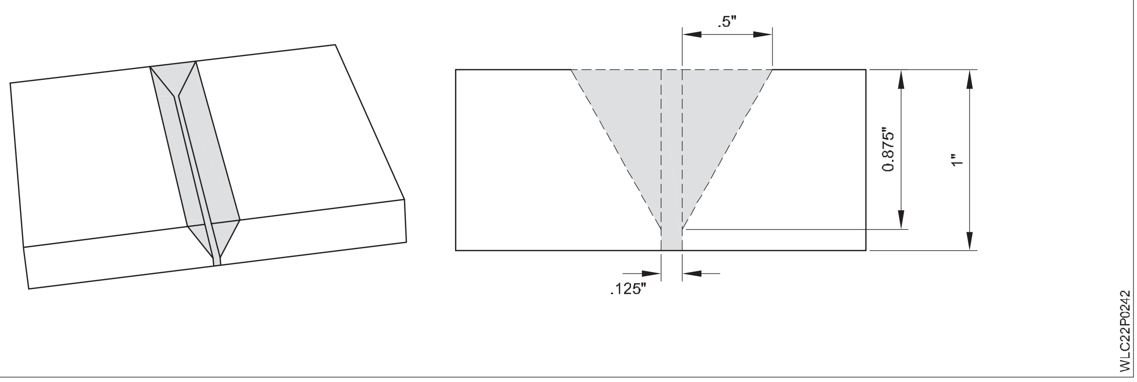
- As can be seen from the arc is "submerged" beneath a blanket of flux and is, therefore, not usually visible during the welding operation itself.
- These facts make the process advantageous from a health and safety viewpoint as there is no arc to promote "arc eye" and very little fume.
- There are two welding consumables involved in the process, the electrode and the flux.
- The electrode can be a solid wire, a cored wire, or a strip.
- The flux, made from a variety of minerals and compounds can be rather complex and can be produced in a number of forms.
- Submerged arc welding is viewed as a high productivity process and is usually automated/mechanized in its form.
- The simplest application of the process uses a single wire.
- Electing the correct wire diameter for a welded joint depends on many factors and the size of the available power source usually limits the diameter of the wire that can be used.
- While most power sources for this process are 1,000 amps, smaller power source may be used.
- A 3/32-in.-dia. wire through to a 5/32-in.-dia.
- Wire will run in the 300 to 900 amps range using direct current and with the electrode positive (DC+) Note: Wear protective clothing.

EXERCISE 82: Demonstrate butt joint Robot Welding

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
- deposit the bead with or without weaving
- clean and inspect the weld.



Job Sequence

- The first step is to provide an accurate joint mapping method with enough resolution for your application.
- With the joint mapping process, before welding the robot searches and maps out the joint, determining accurate positioning of the weld joint and volume information so that the welding parameters can be adjusted accordingly.
- Specialized algorithms are also created that use the joint measurements to determine if the weld passes and layer sequence have to change with the changing groove dimensions.
- Algorithms are also created that prevent cold lap between layers.
- Also, all collected joint mapping data can be used for quality control purposes if required.
- Joint analysis is the next step.
- As mentioned previously, one of the problems with welding these joints with traditional robotic methods is that when the joint is searched properly and the location can be found repeatedly, the search simply provides an offset so the robot welds in the right location.
- If the joint fit-up is in a condition that should not be welded, the robot will weld it regardless.
- Joint analysis provides a means of checking and verifying against a set of acceptable tolerances. With joint analysis, the robot analyzes the joint and then makes a decision whether to weld or stop, depending on the configuration.

Note: Wear protective clothing.

EXERCISE 83 : Perform & review Hardness Testing

Objectives

At the end of this exercise, you will be able to:

- prepare the surface
- inspect the defect
- check strength
- check Microstructure of a known material.

Job Sequence

- The application of hardness testing enables you to evaluate a material's properties, such as strength, ductility and wear resistance, and so helps you determine whether a material or material treatment is suitable for the purpose you require.
- The definition of hardness testing is 'a test to determine the resistance a material exhibits to permanent deformation by penetration of another harder material.'
- However, hardness is not a fundamental property of a material.
- Therefore, when drawing conclusions of a hardness test you should always evaluate the quantitative value in relation to the given load on the indenter the given load duration and the specific indenter geometry.
- A hardness test is typically performed by pressing a specifically dimensioned and loaded object (indenter) into the surface of the material you are testing.
- The hardness is determined by measuring the depth of indenter penetration or by measuring the size of the impression left by an indenter.
- Hardness tests that measure the depth of indenter penetration include: Rockwell, Instrumented Indentation Testing, and Ball Indentation Hardness.
- Hardness tests that measure the size of the impression left by the indenter include: Vickers, Knoop, and Brinell.

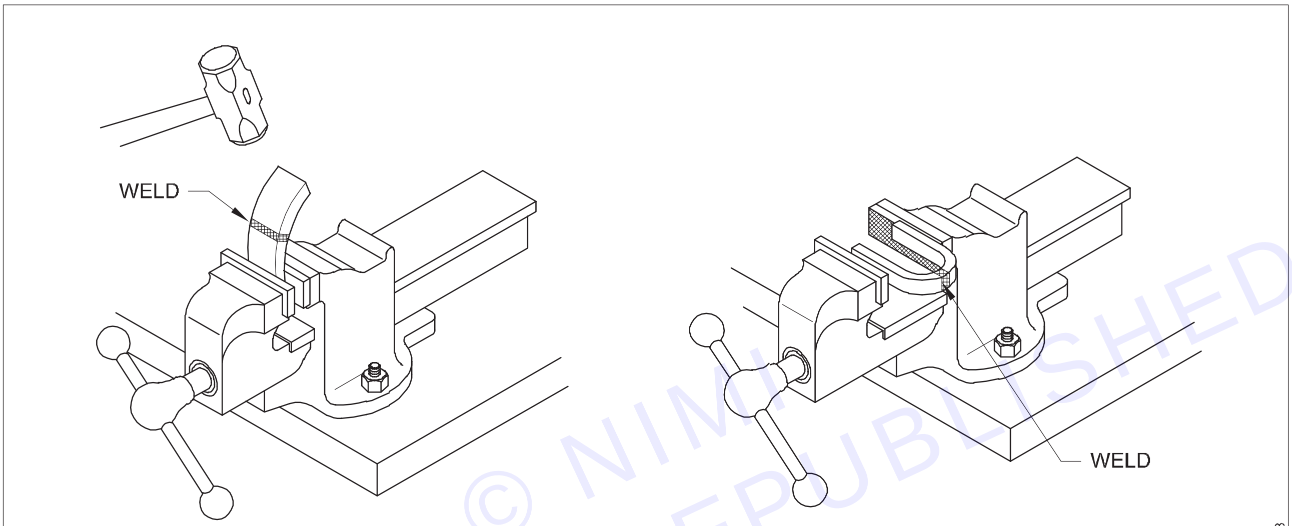
Wear protective clothing.

EXERCISE 84 : Plan Bend Testing of Weldments

Objectives

At the end of this exercise, you will be able to:

- fix the job in vice
- apply the force on job to bend
- use guided machine
- rectify the defects.



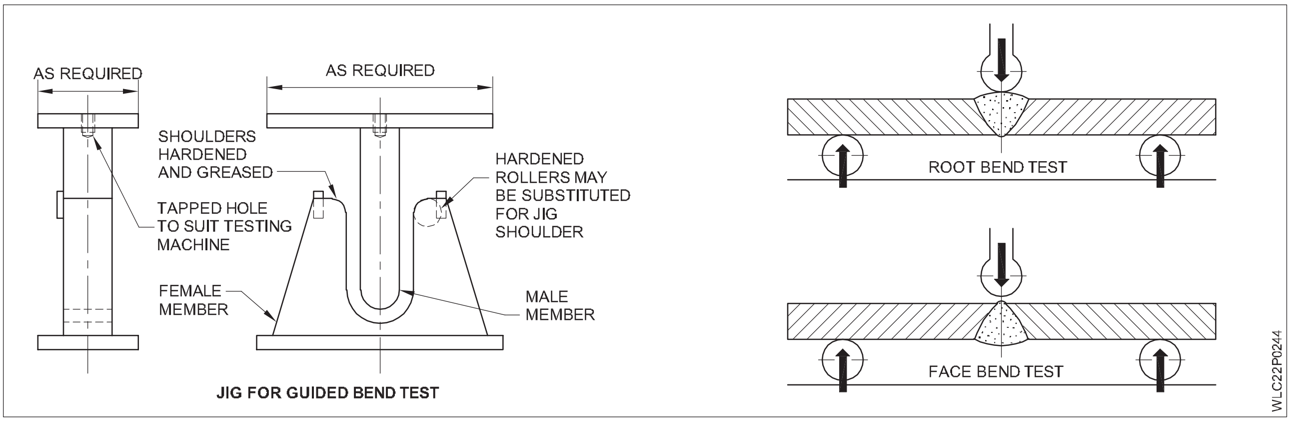
THIS IS ONE WAY THE INITIAL BEND CAN BE MADE

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

Job Sequence

- 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 is bent to 180° through a bend testing
- There are two types of specimens prepared for this-one for face bend and the other for root bend.
- 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.

Wear protective clothing.

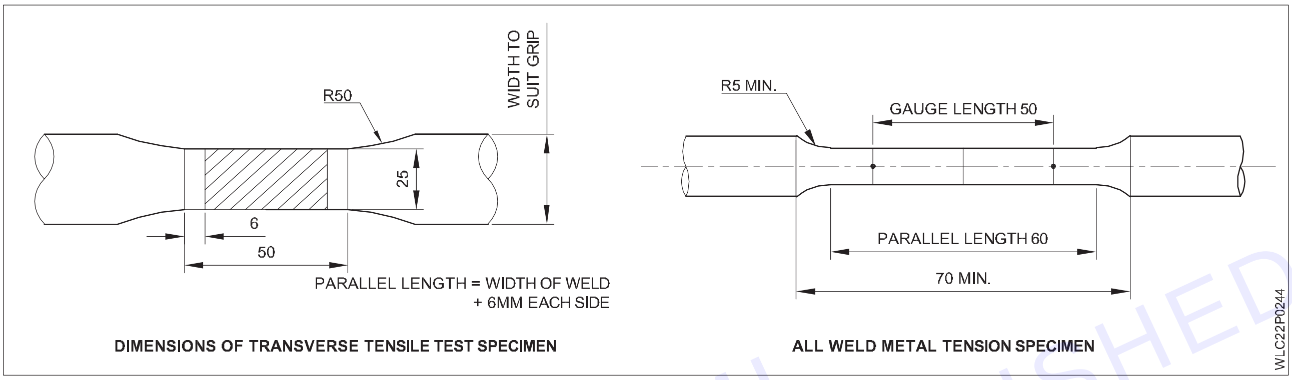

AS REQUIRED
AS REQUIRED
SHOULDERS HARDENED AND GREASED
TAPPED HOLE TO SUIT TESTING MACHINE
HARDENED ROLLERS MAY BE SUBSTITUTED FOR JIG SHOULDER
FEMALE MEMBER
MALE MEMBER
JIG FOR GUIDED BEND TEST
ROOT BEND TEST
FACE BEND TEST
WLC22P0244

EXERCISE 85 : Perform tensile testing

Objectives

At the end of this exercise, you will be able to:

- explain the necessity for destructive tests
- explain the different methods of destructive test of weldments
- explain the advantages and limitations of workshop and laboratory tests
- identify the specimen for destructive tests.



Job Sequence

- A tensile test is conducted to know the tensile strength and ductility. (i.e.elongation) of a weld. Two types of test specimens are prepared for the tensile test.
- The tensile test gives the values of the tensile strength of the weld and the percentage of elongation of the weld.
- They are – transverse tensile test specimen.
- This reveals the suitability of a joint welded with certain electrodes and base metals for a particular service condition.

Wear protective clothing.

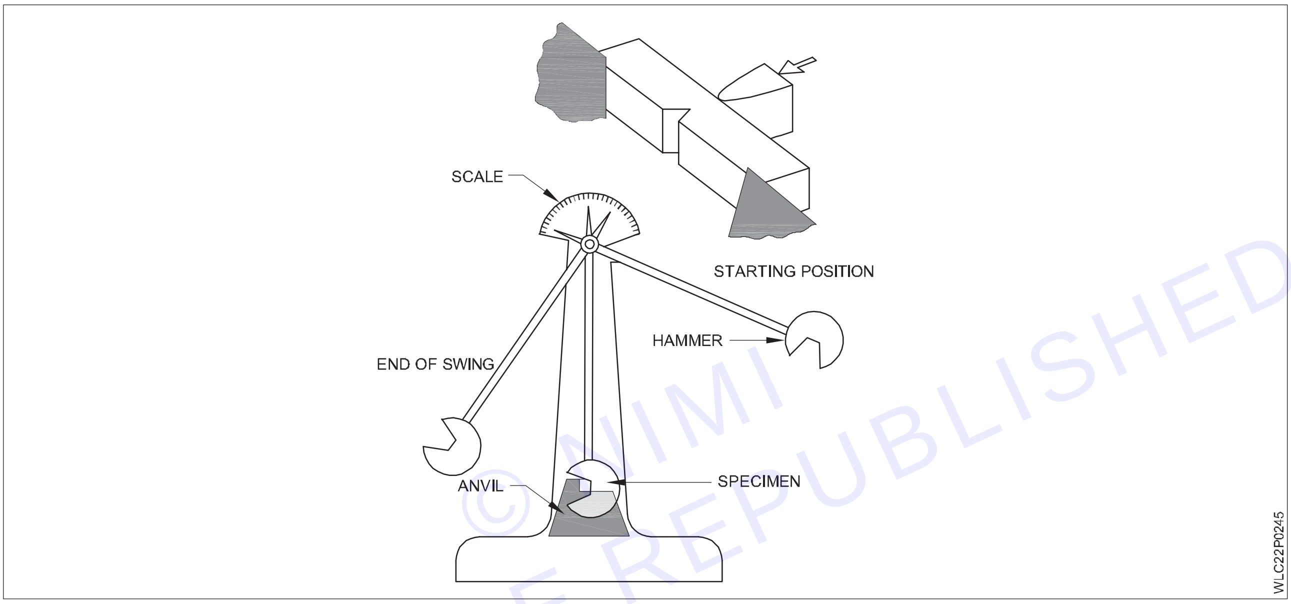
- The basic idea of a tensile is to place a sample of a material between two fixeres called “grips” which clamp the material has known dimensions, like length and cross sectional area we then begin to apply weight to the material gripped at one and white the other end is fixed.

EXERCISE 86 : Conduct Impact Testing

Objectives

At the end of this exercise, you will be able to:

- explain the necessity for destructive tests
- explain the different methods of destructive test of weldments
- explain the advantages and limitations of workshop and laboratory tests
- identify the specimen for destructive tests.



Job Sequence

- There are two main forms of impact test, the IZAD test and the chary test. Both involve striking a standard specimen with a controlled weight pendulum travelling at a set speed. The amount of energy absorbed in fracturing the test piece is measured and this gives an indication of the notch toughness of the test material.
- The impact testing method is pivotal for determining a materials ductile to brittle transition temperature and it is ability to resist deformation due to impact loads. The charpy and IZAD test quantify the energy observed by a material upon impact, while drop-weight and dynamic tear test provide additional data on material resistance to impacts of varying intensities.

EXERCISE 87 : Inspect dimensional weldments using weld gauge

Objectives

At the end of this exercise, you will be able to:

- height of flat weld
- height of fillet weld bead
- thickness of fillet weld
- bevel angle of weldment
- vertical misalignment.

Job Sequence

- There are several types of gauges used in measuring welds and welding defects including but not limited to porosity, undercut, under fill and concavity.
- The two most used kinds are the Standard Fillet Weld Gauge and AWS Gauge Automatic Weld Size Gauge.
- This article will show you how to use both gauges properly.
- The Fillet Weld Gauge is one of the easiest gauges to use and is helpful to check welds for fillet size and concavity.
- We always want our welds to be from flat to slightly convex.
- The Fillet Weld Gauge will let you know if your weld is concave.
- This type of gauge will typically include 7 or more pieces.
- For example, here are some instructions on how to use a 1/2″ fillet weld:
- Simply slide the gauge and have the top end rest against the vertical piece.
- This end should be exactly at the top edge of the weld to be a 1/2″ fillet. If you have space between the gauge and the toe of the weld, then the weld is undersized.
- The bottom edge of the fillet has more room, which allows for a larger leg size.
- This is particularly useful with big fillet welds where gravity tends to make the bottom leg larger.
- The vertical line will show where the bottom toe should be.

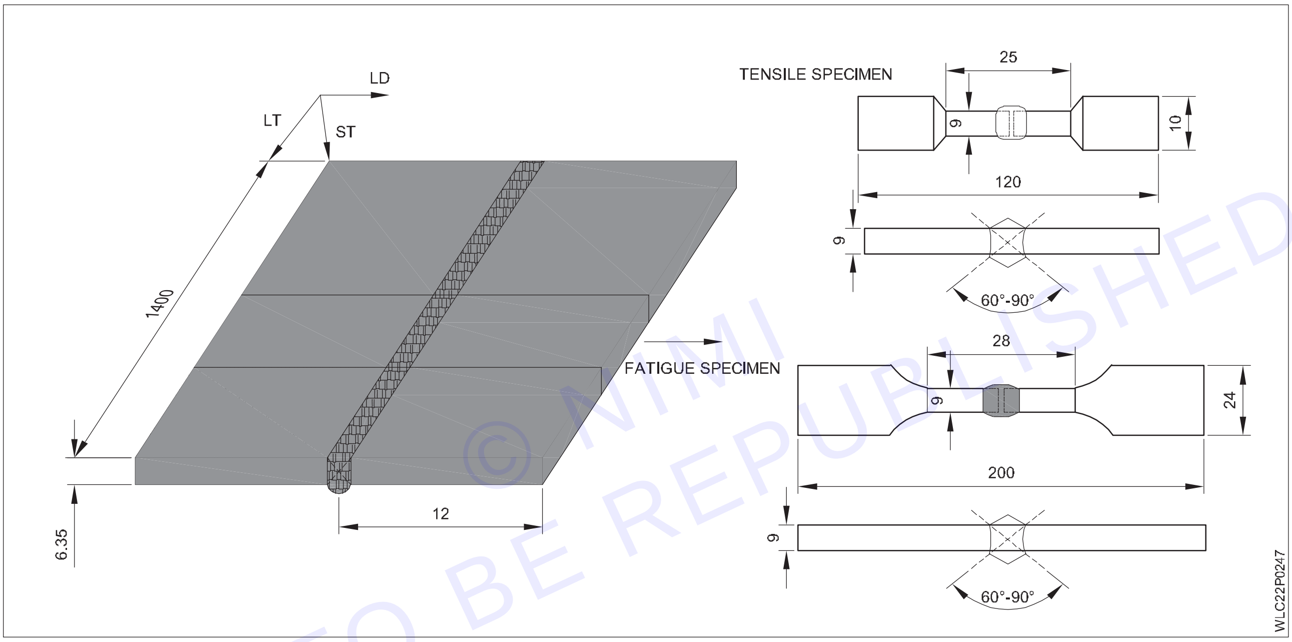
Wear protective clothing.

EXERCISE 88 : Plan & prepare Weld test specimen

Objectives

At the end of this exercise, you will be able to:

- mark the location of the specimens on the test assembly
- remove the discard from each end of the test assembly
- remove the entire backing bar, if present, ensuring that none of the base metal is removed
- straighten the test assembly
- remove the weld reinforcement until it is flush with the parent plate.



Job Sequence

- All test specimens were machined transverse to the welding direction. The 20mm thick slices taken from each weldment are shown in Figure 3, with the respective test specimen locations also indicated.
- Samples approximately 25mmx25mm x 25mm were taken from the mid-thickness of the plate from the parent metal, TB-repair and fabrication weld metals.
- These were then chemically analyzed to determine the chemical composition in terms of average weight %. Replicas were taken of the parent metal, both HAZs (either side of the weld metal) and weld metal for the respective weldments investigated.
- These were then examined under light optical microscopy (LOM). Prior to preparation of the destructive through-wall metallographic samples, replicas were also taken on the through-wall thickness of the plate.
- Again, these were performed on the parent metal, both HAZs (either side of the weld metal) and weld metal for both weldments investigated. This was an additional measure taken to verify the presence of any creep damage that may have been overlooked in the surface replications.
- Three through-wall samples (10mm cube) were taken from the outer-wall, mid-wall and inner-wall regions of the plate respectively. These were taken for the parent, weld metal and one HAZ, for each weldment supplied the samples were then mounted and metallographic ally prepared for microstructural analysis.

- These samples were oriented in the transverse direction, perpendicular to the welding direction.
- Additionally, four samples were also prepared the longitudinal direction to examine the microstructure for the presence of inclusion stringers in this orientation.
- Post-test creep-rupture and miniature-sample tensile test specimens were prepared for fractography.
- This simple technique allows topographical examination of the fracture face under the scanning electron microscope (SEM). This was performed for both test specimens.
- Miniature sample tensile specimens were tested with a 24 mm gauge length (GL) and 3 mm diameter. Specimens were machined from parent and weld metal regions in the transverse orientation.
- The tests were performed at room temperature (RT) and elevated temperature.
- Due to the smaller size test specimens utilized in these testing, minor modifications to the test methodologies specified had to be implemented.

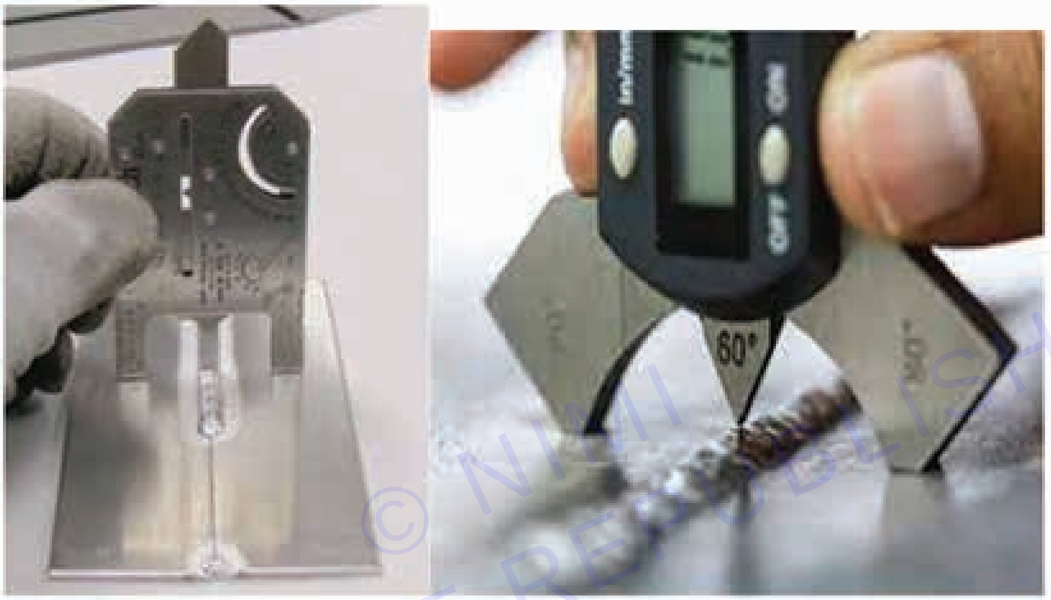
Wear protective clothing.

EXERCISE 89 : Conduct Visual inspection of weldments

Objectives

At the end of this exercise, you will be able to:

- all work completed weld face plus ½ inch on both side of weld shall be visually inspected for the entire length of the weld
- how distance and angle the inspector's eyes should be within 24 inches of the surface to be inspected and b at an angle of at least 30 degrees to the surface being inspected.



Job Sequence

- Visual inspection is a non-destructive testing (NDT) weld quality check process.
- During the testing method, the weld is examined visually through the eyes to determine surface discontinuities.
- The process must be conducted by an experienced welding inspector.
- Visual inspection of welded connections is the most common weld quality testing methods.
- This type of inspection is probably the most underrated and often misused, method of welding inspection.
- Because of its simplicity, and the absence of sophisticated equipment, the potential of this method of inspection is quite often underestimated.
- Visual inspection of welding can often be the easiest to perform and is usually the least expensive to conduct.
- If carried out correctly, this type of inspection can often be an extremely effective method of maintaining acceptable welding quality and preventing welding problems.
- There are many areas within the welding operation that can be verified and evaluated by this method of inspection.
- When designing an inspection plan, we need to establish the most appropriate areas to apply our inspection. We need to consider the possibility of preventing welding-related problems, rather than finding problems that may have already occurred.
- Non- destructive testing (NDT), which is typically used for the inspection of completed welds, is usually designed, and conducted to find welding problems after the fact when the weld is completed. Visual inspection can often be utilized to prevent welding problems from happening in the first place.

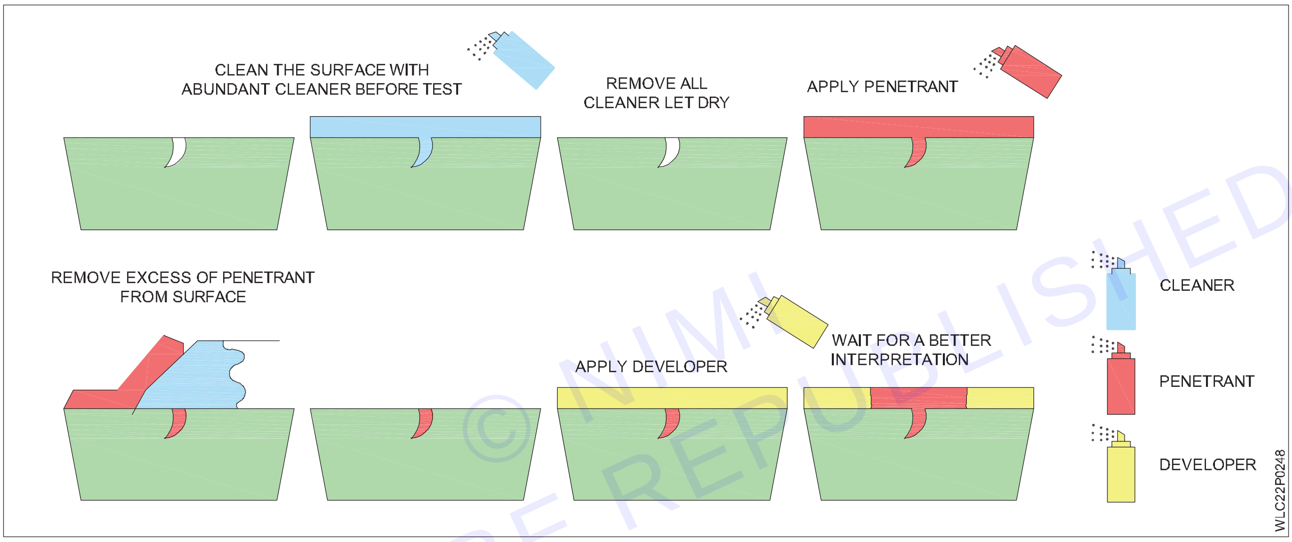
Wear protective clothing.

EXERCISE 90: Evaluate welding defects using Dye penetrant

Objectives

At the end of this exercise, you will be able to:

- Kit spray penetrating stains (penetrant, cleaner, developer) to solvent removal technique visible agent (Type II, Method C)
- Luxmeter
- Gloves and masks
- Industrial rag.



Job Sequence

- Liquid penetrant processes are non-destructive testing methods for detecting discontinuities that are open to surface.
- They may be effectively used in the inspection of both ferrous and non-ferrous metals and on non-porous, non-metallic materials, such as ceramics, plastics and glass.
- Surface discontinuities, such as cracks, seams, laps, cold shuts and laminations are indicated by these methods.
- Flaw detection with the help of liquid penetrant is being increasingly used in various industries in the country and recommendations of general character providing guidance on the applications of these methods are considered necessary.
- Surface Cleanser, Developer and Penetrant.
- A suitable liquid penetrant is applied to the surface of the component under examination and is permitted to remain there for sufficient time to allow the liquid to penetrant into any defects open at the surface.
- After the penetrant time, the excess penetrant, which remains on the surface, is removed.
- Then a light colored, powder absorbent called a developer is applied to the surface.
- This developer acts as a blotter and draws out a portion of the penetrant which had previously seeped into the surface openings.
- As the penetrant is drawn out, it diffuses into the coating of the developer, forming indications of the surface discontinuities or flaws.

Wear protective clothing.

EXERCISE 91 : Evaluate welding defects using cleaners and perform Magnetic Particle Testing

Objectives

At the end of this exercise, you will be able to:

- Magnetize the object. Run a magnetic current through the material
- If defects are present, they will create a secondary magnetic field, or flux leakage field. Spread metal particles on the object
- Spread metal particles over the material or object in the form of a powder or liquid.

Job Sequence

- Magnetic particle inspection is an inspection method used to identify defects on the surface of ferromagnetic materials by running a magnetic current through it.
- It can also be used to detect defects just beneath the surface of materials.
- The types of defects it can detect include cracks, pores, cold lap, and the lack of sidewall fusion in welds.
- Magnetic particle inspection (MPI) is also commonly called magnetic particle testing (MT), magnetic testing, or particle inspection.
- In this guide, we will use the terms magnetic particle inspection and magnetic particle testing and other permutations like magnetic particle inspection test interchangeably, following the alternate terms listed above.
- Magnetic particle inspections work by running a magnetic current through the material that is being inspected.
- When the current is interrupted by a defect magnetism spreads out from that point, indicating its presence and allowing inspectors to identify its location in the material.
- Magnetic testing is one of the more commonly used non-destructive testing (NDT) methods because it is quick and relatively inexpensive.
- However, it only works on materials that can be magnetized—called ferromagnetic materials—so its applications are somewhat limited.
- Some examples of ferromagnetic materials include steel, cobalt, iron, and nickel.

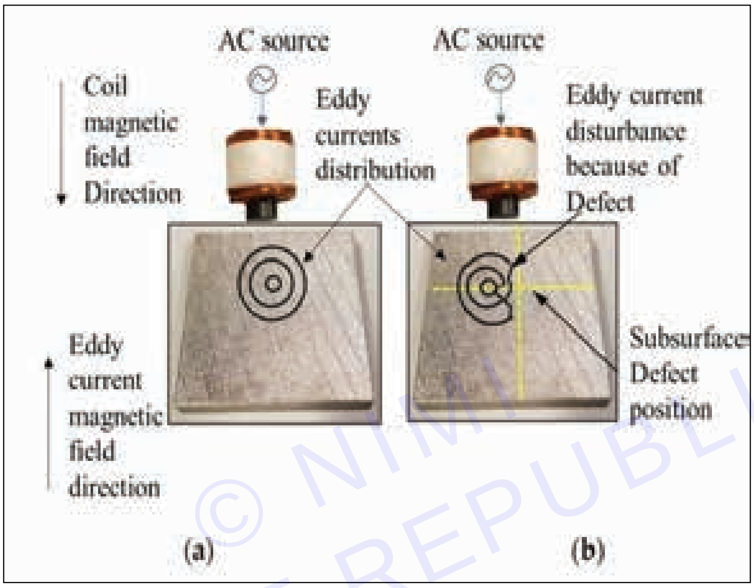
Wear protective clothing.

EXERCISE 92 : Evaluation of defects Eddy current testing

Objectives

At the end of this exercise, you will be able to

- susceptible to magnetic permeability changes
- small changes in permeability can make testing of welds and other ferromagnetic materials difficult
- only effective on conductive materials
- eddy current can only be used to measure materials that support the flow of electrical current.



Job Sequence

- The product is passed through or adjacent to an electrical test coil, which has been excited by an alternating current.
- This induces a flow of eddy currents around the test material or in the case of a sector coil in the area under the coil.
- Short, intermittent anomalies or flaws cause a variation in the eddy current pattern, which the instrument detects.
- The product moves longitudinally through the rotating test probes resulting in a helical search pattern.
- As the probe passes over a defect, variations in the induced Eddy Current pattern are detected.
- The minimum flaw length, which can be consistently detected, is a function of the rotary speed of the probe and the throughput speed of the material.
- Rotary testing is the method of choice for detecting seam type surface defects in non-magnetic and magnetic grades of wire and bar.
- Detect short surface and some subsurface defects, on or off-line, in magnetic and non-magnetic wire, bar and tube.
- Inspect welded tube for short ID or OD defects in the weld zone or on the full circumference.
- Test uniform cross sectional material, including squares, rectangles, hex and round.
- Inspect small diameter wire or tube for short defects.
- Check continuity and locate welds in single and multi-conductor insulated wire and cable.

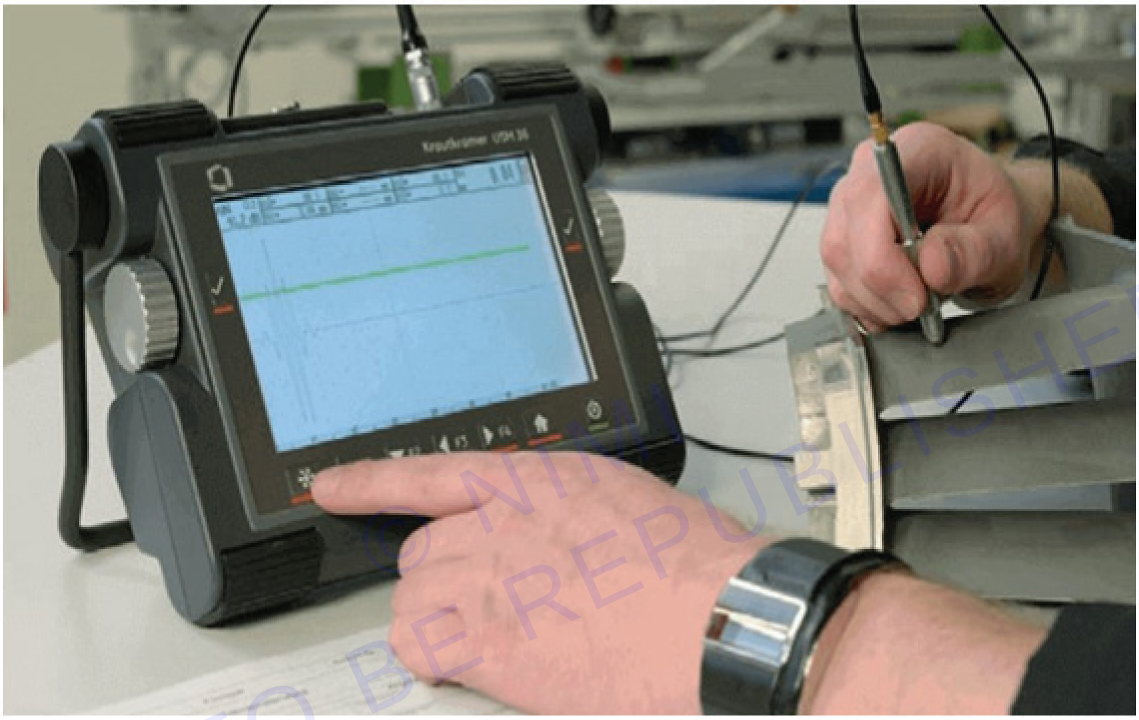
Wear protective clothing.

EXERCISE 93 : Set & Calibrate Ultrasonic Flaw detector

Objectives

At the end of this exercise, you will be able to

- following steps are used to calibrate ultrasonic flaw detectors
- firstly, set probe in position A with the right coupling
- ensure the test range is twice the workpiece's thickness and greater than 200mm
- also, set the sound velocity to 5920m/s and gain to the correct value.



Job Sequence

- Zero Offset Calibration – This setup considers the time elapsed during the wave travel before entering the test sample and then equates it to the time elapsed as it travels through a layer of the test sample. This time is often designated as t0.
- Material Velocity Calibration – Also known as the ultrasonic velocity setup, this calibration method depends primarily on the material to be inspected and the ambient temperature obtainable during the setup. However, it expects some basic assumptions to be in place before commencing the calibration. These assumptions include an elastic material, a frequency lower than the dimensions obtainable in the test sample but high enough to establish a wavelength, a constant atmospheric temperature and pressure, and a non-diffusive material.
- Auto Calibration – This method requires that specific settings be in place before calibration. These settings include using the ultrasonic velocity tables to adjust the material velocity values to be closer to the real values as much as possible. Also, the delay and zero offset values need to be set to zero. This method considers the speed of two similar signal reflectors sending two separate signals from different distances.

Velocity/Zero calibration

- Converting time to distance measurements using the speed of sound in test materials to program the flaw detector is often referred to as the velocity/zero calibration. Also, the zero offset setting's echo shape or transducer type requirements are critical. This type of calibration often considers the dimensions measured by the flaw detector, including the distance and thickness of the material, using precisely timed echoes. The ultrasonic flaw detector's accuracy depends on the careful measures taken during this calibration exercise, and errors might occur in the readings if the calibration is not carefully and correctly done. Thankfully, the calibration process is pretty straightforward and with the possibility of storing different material calibrations in the memory of the device.

Reference calibration

- Using similar materials or test blocks as reference standards to set up a testing operation is often referred to as reference calibration. However, for ultrasonic flaw detectors, the signal's amplitude received from standard references is usually the benchmark utilized for this type of calibration. User-defined procedures often give the details required for reference calibration used for specific tests.

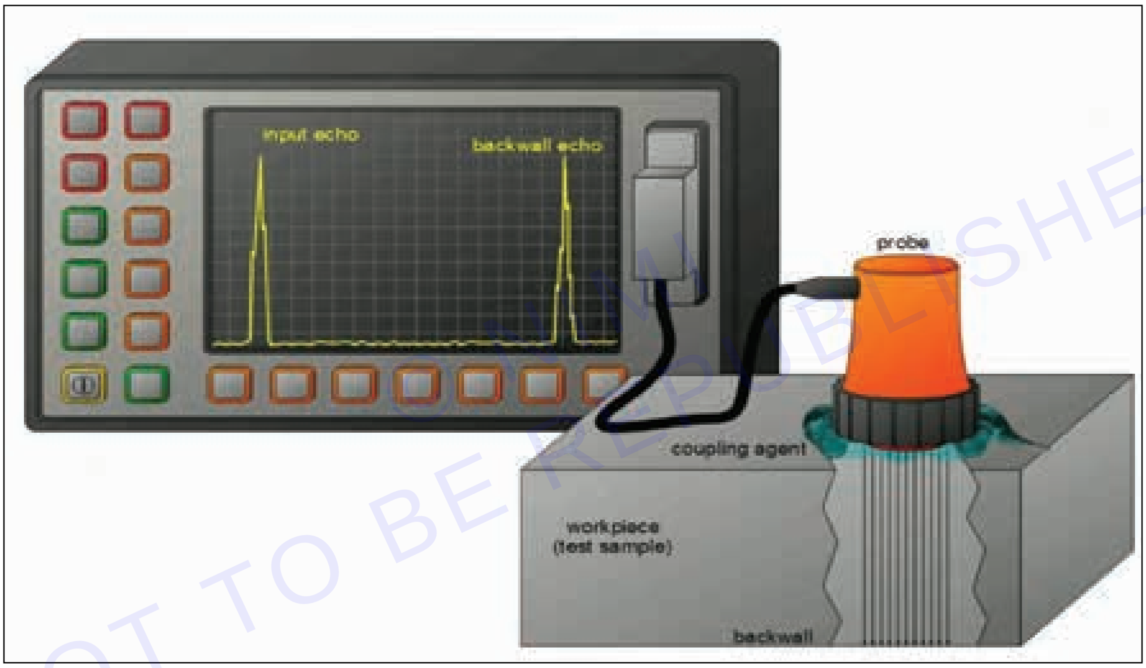
Wear protective clothing.

EXERCISE 94 : Assess Ultrasonic Flaw detector- application on weldments

Objectives

At the end of this exercise, you will be able to

- understanding ultrasonic testing
- types of ultrasonic waves
- process of ultrasonic testing
- ultrasonic testing of welds.
- ultrasonic testing in welding for thickness detection
- advantages of ultrasonic testing.



Job Sequence

- Ultrasonic Testing (UT) emerges as a vital tool in the arsenal of non-destructive testing techniques as it ensures the quality and integrity of weld joints.
- This method allows for the detection of defects and irregularities within welds, helping to prevent potential failures that could have serious consequences.
- Ultrasonic Testing involves the use of ultrasonic sound waves to detect defects inside a material.
- The welded joints have the possibility of defects inside the welds or somewhere near the weld zone.
- The few defects that are often found in welds are Porosity, Cracks, Slag Inclusion, Lack of fusion, Lack of Penetration, Root concavity, Crater pipes, sharp undercuts, burn-through, HAZ cracks, and much more.
- These defects are located deep and cannot be viewed manually; ultrasonic scanning is used to detect these discontinuities. The conventional Ultrasonic Testing of weld joints method shown here is totally operator-reliable.
- Therefore, international bodies require the operator to be qualified as per a standard, and the machine used also meets the requirements.

- Ultrasonic Testing is a non-invasive inspection technique that uses high-frequency sound waves to evaluate the internal structure of weld joints and materials.
- This method is particularly useful for identifying flaws such as cracks, voids, inclusions, and porosity that may compromise the weld's strength.
- The principle behind ultrasonic testing lies in the transmission of sound waves into the material being inspected and the interpretation of the echoes that bounce back.
- Longitudinal waves, also known as compression waves or "L-waves," are a fundamental type of ultrasonic wave used in testing.
- These waves involve the vibration of particles in the same direction as the wave's propagation.
- In weld joint testing, L-waves are effective in detecting volumetric defects such as voids and inclusions.
- Their ability to penetrate deeply into materials makes them an essential tool for assessing the internal quality of welds.

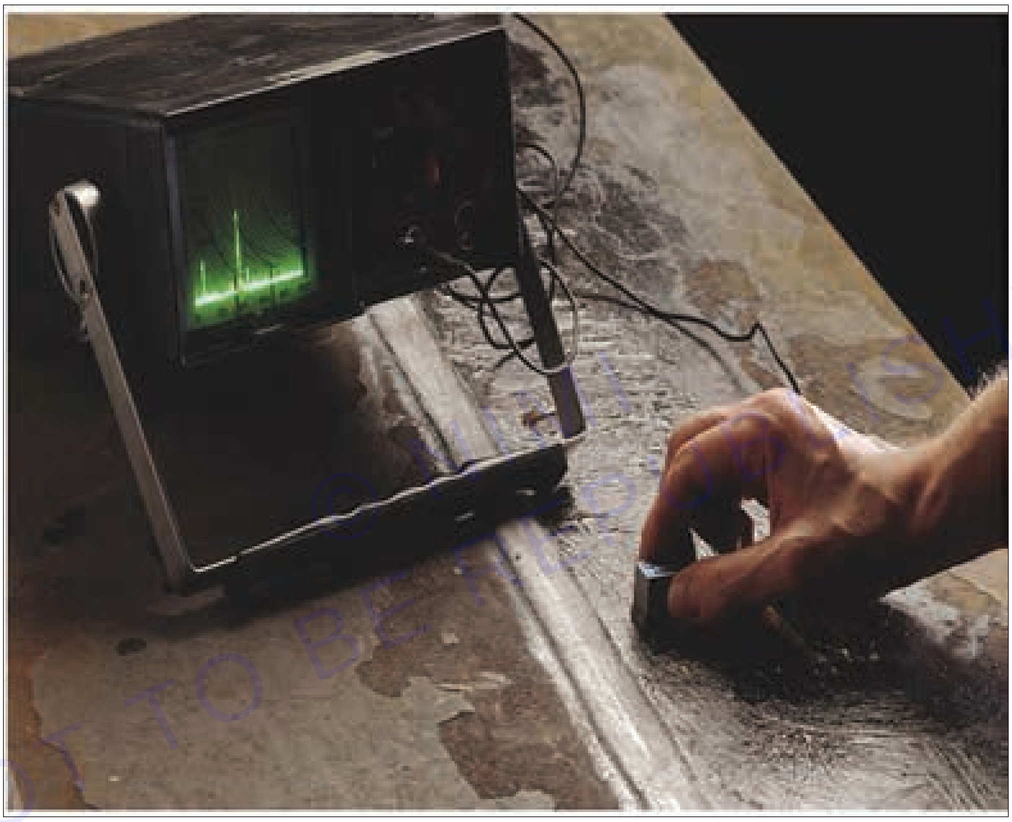
Wear protective clothing.

EXERCISE 95 : Illustrate Study of IIW / ASTM reference Radiograph

Objectives

At the end of this exercise, you will be able to

- this method of weld testing makes use of X-rays
- produced by an X-ray tube or gamma rays
- produced by a radioactive isotope.



Job Sequence

- Radiographic and ultrasonic weld inspection are the two most common methods of non-destructive testing (NDT) used to detect discontinuities within the internal structure of welds.
- The obvious advantage of both these methods of testing is their ability to help establish the weld's internal integrity without destroying the welded component.
- We shall briefly examine these two methods of non-destructive testing (NDT).
- We shall consider how they are used and what types of welding discontinuities they can be expected to find. We shall also examine their advantages over other inspection methods and their limitations.
- This test method provides a uniform procedure for radiographic examination of weldments using industrial radiographic film.
- Requirements expressed in this method are intended to control the quality of the radiographic images and are not intended for controlling acceptability or quality of welds.

- The apparatus shall comprise of a radiation source which may be X-ray or gamma-ray source; film holders and cassettes; intensifying screens such as lead-foil, fluorescent, fluor metallic, or other metallic screens; filters which shall be used whenever the contrast reductions caused by low energy, scattered radiation, or the extent of undercut (edge burn-off) occurring on production radiographs are of significant magnitude to cause difficulty in meeting the quality level or radiographic coverage requirements stipulated by the job order or contract; masking to improve radiographic quality; IQI's or penetrometers; shims, separate blocks, or like sections to facilitate IQI positioning; radiographic location and identification markers; and radiographic density measurement device. The test method shall meet the radiographic coverage, radiographic film quality, radiographic quality level, acceptance level, and radiographic density limitations. Procedures for surface preparation, radiation application and protection, IQI selection and placement, shim utilization, radiograph identification, and single-wall or double-wall radiographic techniques are addressed.
- This practice provides a uniform procedure for radiographic examination of weldments using industrial radiographic film.
- Requirements expressed in this practice are intended to control the quality of the radiographic images and are not intended for controlling acceptability or quality of welds.

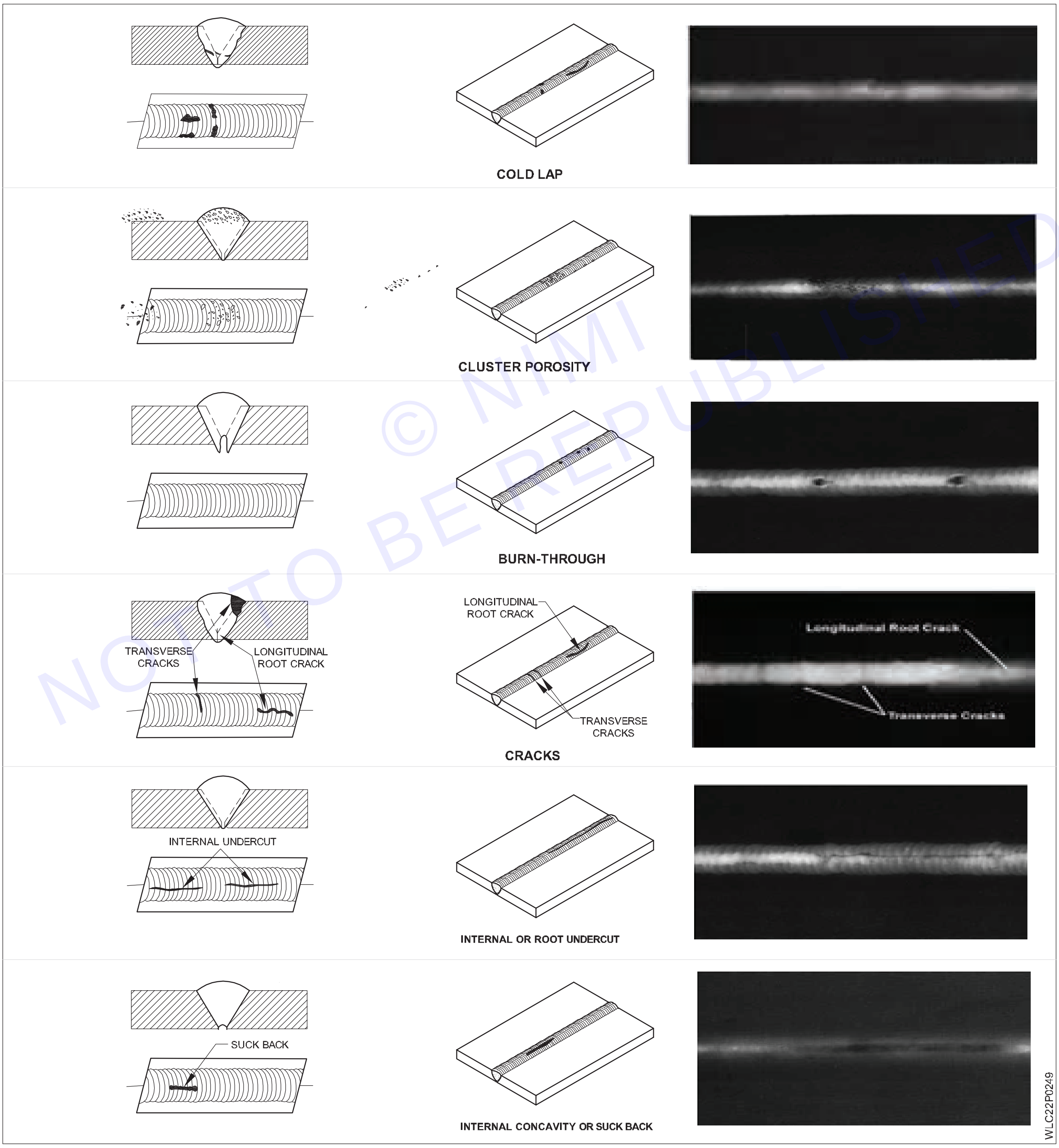
Wear protective clothing.

EXERCISE 96 : Interpret radiographic films

Objectives

At the end of this exercise, you will be able to

- radiographic image shows a noticeable difference in density between the two pieces
- difference in density is caused by the difference in material thickness
- dark, straight line is caused by the failure of the weld metal to fuse with the land area.



Job Sequence

- The major objective of radiographic testing of castings is the disclosure of defects that adversely affect the strength of the product.
- Castings are a product form that often receive radiographic inspection since many of the defects produced by the casting process are volumetric in nature, and are thus relatively easy to detect with this method.
- These discontinuities of course, are related to casting process deficiencies, which, if properly understood, can lead to accurate accept-reject decisions as well as to suitable corrective measures. Since different types and sizes of defects have different effects of the performance of the casting, it is important that the radiographer is able to identify the type and size of the defects.
- ASTM E155, Standard for Radiographs of castings has been produced to help the radiographer make a better assessment of the defects found in components.
- The castings used to produce the standard radiographs have been destructively analyzed to confirms the size and type of discontinuities present.
- The following is a brief description of the most common discontinuity types included in existing reference radiograph documents (in graded types or as single illustrations).
- Gas porosity or blow holes are caused by accumulated gas or air which is trapped by the metal. These discontinuities are usually smooth-walled rounded cavities of a spherical, elongated or flattened shape.
- If the sprue is not high enough to provide the necessary heat transfer needed to force the gas or air out of the mold, the gas or air will be trapped as the molten metal begins to solidify.
- Blows can also be caused by sand that is too fine, too wet, or by sand that has a low permeability so that gas cannot escape.
- Too high a moisture content in the sand makes it difficult to carry the excessive volumes of water vapor away from the casting.
- Another cause of blows can be attributed to using green ladles, rusty or damp chills and chaplets.

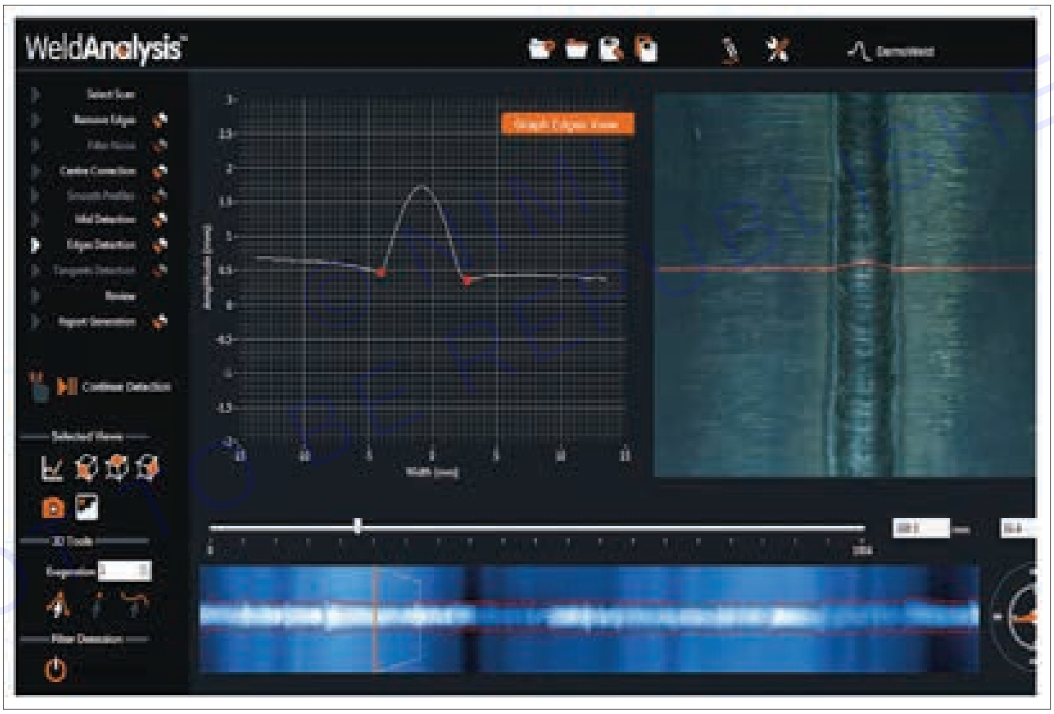
Wear protective clothing.

EXERCISE 97 : Analyze & Prepare welding inspection reports

Objectives

At the end of this exercise, you will be able to

- check all documentation
- check all consumables
- check materials, dimensions, and condition
- preheating, method, and temperature
- check fit and set-up
- ensure no undue stress is applied to the joint
- check welding equipment
- check amperage, voltage, polarity.



Job Sequence

- Welding symbols and weld sizes clearly specified in drawing and related documents.
- Weld joint designs and dimensions clearly specified in drawings and related documents.
- Weld maps identify the welding procedure specification (WPS) to be used for specific weld joints.
- Dimensions detailed and potential for distortion addressed.
- Welding consumables specified.
- Proper handling of consumables, if any, identified.
- Base material requirements specified (such as the use of impact tested materials where notch ductility is a requirement in low temperature service).

- Mechanical properties and required testing identified.
- Weather protection and wind break requirements defined.
- Preheat requirements and acceptable preheat methods defined.
- Post-weld heat treatment (PWHT) requirements and acceptable PWHT method defined.
- Inspection hold-points and NDE requirements defined.
- Additional requirements, such as production weld coupons, clearly specified.
- Pressure testing requirements, if any, clearly specified
- Competency of welding organization to perform welding activities in accordance with codes, standards, and specifications specified
- Roles and responsibilities of engineers, welding organization, and welding inspectors defined and appropriate for the work.
- Independence of the inspection organization from the production organization is clear and demonstrated.
- WPS(s) are properly qualified and meet applicable codes, standards and specifications for the work.
- Procedure qualification records (PQR) are properly performed and support the WPS(s).

Wear protective clothing.