WELDER (STRUCTURAL)

NSQF LEVEL - 3

TRADE PRACTICAL

SECTOR : CAPITAL GOODS & MANUFACTURING

(As per revised syllabus July 2022 - 1200 Hrs)

Directorate General of Training

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

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

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Sector : **Capital Goods & Manufacturing**

Duration : **1 Year**

Trade : **Welder (Structural) - Trade Practical - NSQF Level - 3 (Revised 2022)**

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FOREWORD

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

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Welder (Structural) - Trade Practical - NSQF Level - 3 (Revised 2022) in Capital Goods & Manufacturing Sector** under **Annual Pattern.** The NSQF Level - 3 (Revised 2022) Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 3 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 3 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

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

Jai Hind

Additional Secretary /Director General of Training
Ministry of Skill Development & Entrepreneurship,
Government of India.

New Delhi - 110 001

PREFACE

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

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

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

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

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

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

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

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

Chennai - 600 032 **EXECUTIVE DIRECTOR**

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisation to bring out this IMP **(Trade Practical)** for the trade of **Welder (Structural) - NSQF Level - 3 (Revised 2022)** under the **Capital Goods & Manufacturing** Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

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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.

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intented to be used in workshop . It consists of a series of practical exercises to be completed by the trainees during the two years course of the **Welder Structural** in **Capital Goods & Manufacturing** trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF Level - 3 (Revised 2022)

This manual is divided into Seven modules. The Seven modules are given below

Module 1	Introduction Training and Welding process
Module 2	Welding Technique
Module 3	Weldability of Metals
Module 4	Gas cutting and Welding practice
Module 5	Gas Tungsten Arc welding
Module 6	Pipe Welding & Modern Welding Process
Module 7	Fabrication & Testing

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

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

TRADE THEORY

The manual of trade theory consists of theoretical information for the two years course of the **Welder (Structural)** in **Capital Goods & Manufacturing** Trade. The contents are sequenced according to the practical exercise contained in the manual on Trade Theory. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This co-relation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

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

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

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

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

S.No.	Learning Outcome	Ref. Ex.No.
1	Join MS sheet by Gas welding in different positions following safety precautions. (NOS: CSC/N0204)	1.1.01 - 1.1.08
2	Join MS plates by SMAW in different positions. (Mapped NOS: CSC/N0204)	1.1.09 - 1.1.11
3	Perform straight, bevel & circular cutting on MS plate by Oxy-acetylene cutting process. (Mapped NOS: CSC/N0201)	1.2.12 - 1.2.34
4	Perform different type of MS pipe joints by Gas welding (OAW). (NOS: CSC/N0204)	1.3.35 & 1.3.36
5	Weld different types of MS pipe joints by SMAW. (Mapped NOS: CSC/N0204)	1.3.37 - 1.3.48
6	Weld Stainless steel, Cast iron, Aluminium and Brass by OAW. (NOS:CSC/N0204)	1.3.49 - 1.3.51
7	Perform Arc gauging on MS plate. (NOS: CSC/N0204)	1.3.52 - 1.3.54
8	Perform plasma arc cutting. (Mapped NOS: CSC/N0207)	1.4.55
9	Perform fillet welding on M.S plates 1F,2F,3F,4F& 5F positions by SMAW. (Mapped NOS: CSC/N0204)	1.4.56 - 1.4.63
10	Perform Full penetration Single "V" butt joint on MS plates in 1G,2G,3G &4G position adapting root Inspection and clearance by D.P test. (Mapped NOS: CSC/N0204)	1.4.64 - 1.4.69
11	Perform welding of MS, SS and Aluminium sheets, M.S tubes (square butt T,Y,K joints) by GTAW in down hand position. (Mapped NOS: CSC/N0212)	1.5.70 & 1.5.71
12	Perform bending, straightening and edge planing for fabrication of structures. (Mapped-NOS: CSC/N0303)	1.5.72 - 1.5.75
13	Perform Double bevel butt joint on dissimilar thickness MS Flats In down hand positions by SMAW with root Inspection by D.P test and back gouging and with root Inspection by D.P test and back gougingand adapting skip welding & back step welding method for controlling distortion. (Mapped NOS:CSC/N0204)	1.6.76
14	Performe welding of pipe joints different positions by SMAW (Mapped NOS: CSC/N0204)	1.6.77 & 1.6.78
15	Perform Lap, T, Corner joints on GMAW and Flux Cored Arc welding process on M.S in down hand position. (Mapped NOS: CSC/N0209, CSC/N0205)	1.6.79
16	Perform Automatic Submerged Arc Welding machine. (Mapped NOS: CSC/N0211)	1.6.80
17	Manufacture simple structures with L angles, I section and channel sections using welding fixture by SMAW. (Mapped NOS: CSC/N0204)	1.7.81 & 1.7.82
18	Fabricate pipe/cone on M.S. sheet by SMAW. (Mapped NOS: CSC/N0204, CSC/N0303)	1.7.83
19	Prepare weld test specimen as per a standard. Carry out non destructive testing of welds. (Mapped NOS: CSC/N0204)	1.7.84

SYLLABUS FOR WELDER (STRUCTURAL)

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 25Hrs; Professional Knowledge 4Hrs	Join MS sheet by Gas welding in different positions following safety precautions. (NOS: CSC/N0204)	Induction training: 1. Familiarization with the Institute. 2. Importance of trade Training. 3. Machinery used in the trade. 4. Introduction to safety equipment and their use etc. 5. Hack sawing, filing square to dimensions. 6. Marking out on MS plate and punching 7. Setting up of Arc welding machine & accessories and Striking an arc. 8. Setting of oxy-acetylene welding equipment, Lighting and setting of flame.	- General discipline in the Institute. - Elementary First Aid. - Importance of Welding in Industry. - Safety precautions in Shielded Metal Arc Welding, and Oxy-Acetylene Welding and Cutting. - Introduction and definition of welding. - Arc and Gas Welding Equipments, tools and accessories. - Various Welding Processes and its applications. - Arc and Gas Welding terms and definitions.
Professional Skill 22Hrs; Professional Knowledge 04Hrs	Join MS plates by SMAW in different positions. (Mapped NOS: CSC/N0204)	9. Fusion run without and with filler rod on M.S. sheet 2 mm thick in flat position. 10 Edge joint on MS sheet 2 mm thick in flat position without filler rod. 11 Marking and straight line cutting of MS plate. 10 mm thick by gas.	- Different process of metal joining methods: Bolting, riveting, seaming etc. - Types of welding joints and its applications. Edge preparation and fit up for different thickness. - Surface Cleaning.
Professional Skill 184Hrs; Professional Knowledge 31Hrs	Perform straight, bevel & circular cutting on MS plate by Oxy-acetylene cutting process. (Mapped NOS: CSC/N0201)	12 Straight line beads on M.S. plate 10 mm thick in flat position. 13 Small prototype of power transmission tower (skelton) fabrication from MS rode of 0 4mm. 14 Square butt joint on M.S. sheet 2 mm thick in flat Position. 15 Fillet "T" joint on M.S. Plate 10 mm thick in flat position.	- Basic electricity applicable to arc welding and related electrical terms & definitions. - Heat and temperature and its terms related to welding. - Principle of arc welding. And characteristics of arc. - Common gases used for welding & cutting, flame temperatures and uses. - Types of oxy-acetylene flames and uses. - Oxy-Acetylene Cutting Equipment principle, parameters and application.
		16 Beveling of MS plates 10 mm thick. By gas cutting. 17 Open corner joint on MS sheet 2 mm thick in flat Position 18 Fillet lap joint on M.S. plate 10 mm thick in flat position.	- Arc welding power sources: Transformer, Rectifier and Inverter type welding machines and its care & maintenance. - Advantages and disadvantages of A.C. and D.C. welding machines.

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
		19 Triangular beam fabrication from 8mm & 4mm dia. MS rode with GMAW length 3 feet. 20 Fillet"T"jointonMSsheet 2 mm thick in flat position 21 Open Corner joint on MS plate 10 mm thick in flat position.	- Welding positions as per EN & ASME: flat, horizontal, vertical and overhead position. - Weld slope and rotation. - Welding symbols as per BIS & AWS.
		22 Fillet Lap joint on MS sheet 2 mm thick in flat position. 23 Single "V" Butt joint on M S plate 12 mm thick in flat position (1G).	- Arc length - types - effects of arc length. - Polarity: Types and applications.
		24 Square Butt joint on M.S. sheet. 2 mm thick in Horizontal postion. 25 Straight line beads and multi layer practice on M.S. Plate 10 mm thick in Horizontal position. 26 F "T" 10 mm thick in Horizontal position.	- Calcium carbide uses and hazards. - Acetylene gas properties - Acetylene gas Flash back arrestor.
		27 Fillet Lap joint on M.S. sheet 2mm thick in horizontal position. 28 Fillet Lap joint on M.S.plate 2mm thick in horizontal position.	- Oxygen gas and its properties. - Charging process of oxygen and acetylene gases. - Oxygen and Dissolved Acetylene gas cylinders and Color coding for different gas cylinders. - Gas regulators I & II stage and uses.
		29 Fusion run with filler rod in verti cal position on 2mm thick M.S.sheet. 30 Square Butt joint on M.S. sheet. 2 mm thick in vertical position. 31 Single Vee Butt joint on M.S. plate 12 mm thick in horizontal position (2G).	- Oxy acetylene gas welding Systems (Low pressure and High pressure). Difference between gas welding blow pipe(LP & HP) and gas cutting blow pipe. - Gas welding techniques. Rightward and Leftward techniques.
		32. Weaved bead on M.S Plate 10mm in vertical position. 33. Fillet "T" joint on M.S sheet 2 mm thick in vertical position. 34. F "T" 10 mm thick in vertical position.	- Arc blow - causes and methods of controlling. - Distortion in arc & gas welding and methods employed to minimize distortion. - Arc Welding defects, causes and Remedies.
Professional Skill 19Hrs; Professional Knowledge	Perform different type of MS pipe joints by Gas welding (OAW). (NOS: CSC/N0204)	35 Structural pipe welding butt joint on MS pipe 0 50 and 3mm WT in 1G position. 36 Fillet Lap joint on M.S. Plate 10 mm in vertical position	- Specification of pipes, various types of pipe joints, pipe welding positions, and procedure. - Difference between pipe welding and plate welding.

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 117 Hrs Professional Knowledge 23Hrs	Weld different types of MS pipe joints by SMAW. (Mapped NOS: CSC/N0204)	37 Open Corner joint on MS plate 10 mm thick in vertical position. (10hrs.) 38 Pipe welding - Elbow joint on MS pipe 0 -50 and 3mm WT.	- Pipe development for Elbow joint, "T" joint, Y joint and branch joint. - Uses of Manifold system
		39 Pipe welding "T" joint on MS pipe 0 - 50 and 3mm WT. 40 Single "V" Butt joint on MS plate 12 mm thick in vertical position (3G).	- Gas welding filler rods, specifi cation and sizes. - Gas welding fluxes - types and functions. - Gas Brazing & Soldering: prin ciples, types fluxes & uses. - Gas welding defects, causes and remedies.
		41 Pipe welding 45 ° angle joint on MS pipe 0-50 and 3mm WT. 42 Straight line beads on M.S. plate 10mm thick in over head position.	- Electrode: types, functions of flux, coating factor, sizes of electrodes. - Effects of moisture pick up. - Storage and baking of electrodes.
		43 Pipe Flange joint on M.S plate with MS pipe 050 mm X 3mm WT. 44 Fillet "T" 10 mm thick in over head position.	- Weldability of metals, importance of pre heating, post heating and maintenance of inter pass tem perature.
		45 Pipe welding butt joint on MS pipe 0-50 and 5 mm WT. in 1G position. 46 Fillet Lap joint on M.S. plate 10 mm thick in overhead position.	- Welding of low, medium and high carbon steel and alloy steels.
		47 Single "V" Butt joint on MS plate 10mm thick in over head position(4G). 48 Pipe butt joint on M.S. pipe 0-50mm WT 6mm (1G Rolled).	- Stainless steel: types- weld decay and weldability.
Professional Skill 24 Hrs; Professional Knowledge 04 Hrs	Weld Stainless steel, Cast iron, Aluminium and Brass by OAW. (NOS:CSC/N0204)	49 Square Butt joint on S.S sheet. 2 mm thick in flat position. 50 Square Butt joint on S.S. Sheet 2 mm thick in flat position. 51 Square Butt joint on Brass sheet 2 mm thick in flat position.	- Brass - types - properties and welding methods. - Copper - types - properties and welding methods.
Professional Skill 25Hrs;	Perform Arc gauging on MS plate. (NOS: CSC/N0204)	52 Square Butt & Lap joint on M.S.sheet 2 mm thick by brazing.Single "V" butt joint C.I. plate 6mm thick in flat position.	- Aluminum properties and weldability, Welding methods

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Knowledge 08Hrs		53 Arc gouging on MS plate 10 mm thick.	- Arc cutting & gouging,
		54 Square Butt joint on Aluminium sheet. 3 mm thick in flat position. Bronze welding of cast iron (Single "V" butt joint) 6mm thick plate.	- Cast iron and its properties types. - Welding methods of cast iron.
Professional Skill 18Hrs; Professional Knowledge 04Hrs	Perform plasma arc cutting. (Mapped NOS: CSC/N0207)	55 Setting up Gas cutting equipment and cutting MS Flats to required size.	- Outline of the subjects to be cov ered - Importance of structural welding - Welding processes-brief description, Classification and application
Professional Skill 118Hrs; Professional Knowledge 23Hrs	Perform fillet welding on M.S plates 1F,2F,3F,4F& 5F positions by SMAW. (Mapped NOS: CSC/N0204)	56 Setting up SMAW Welding equip ment and making straight and weav ing bead on MS in all positions. Practice on plasma cutting. Practice on gouging techniques.	- Welding terms and definitions - Principles of OxyAcetylene Cut ting and equipments required. - Principles of shielded metals arc welding, its advantages and limitations.
		57 Weld joint preparation for fillet weld (Cutting to size, fit up, tack weld etc.). 58 Fillet, Lap and T joint on MS flat by SMAW, position - 1F.	- Types of weld joints. - Basic Electricity applicable to welding - Arc welding power source AC / DC - advantages and disadvantages - Types of metal and their characteristics. - Classification of steel and their Weldability. - Heat affected zone and requirement for pre- heating and maintaining inter pass temperature.
		Weld joint preparation for fillet welds (cutting to size, fit up, tack weld etc.).Fillet, lap and T joint on MS flat by SMAW position - 2F.	- Welding symbols and their importance - Welding positions and necessity of positional welding. - Weld joint edge preparation. - Welding procedure and techniques - Tack welding, root run welding, intermediate and cover pass welding, cleaning, checking etc.
		59 Weld joint preparation for fillet welds (cutting to size, fit up, tack weld etc.).Fillet, lap and T joint on MS flat by SMAW, position - 3F.	- Welding tools and accessories - Arc and its characteristics - Polarity types and application - Arc length - Welding fixtures and clamps
		60 Weld joint preparation for fillet welds (cutting to size, fit up, tack weld etc.)	- Coated electrodes- Types, description - Standard size and length of electrodes.

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
		61 Fillet, lap and T joint on MS flat by SMAW position - 4F.	- Selection of electrodes and coating factor. - Electrode storage and necessity of backing.
		62 Weld joint preparation for pipe fil let welding.	- Effect of Heat on Weldments.
		63 Pipe to pipe fillet weld on MS pipes by SMAW, position -5F.	- Welding distortion and stresses.
Professional Skill 75 Hrs; Professional Knowledge 12Hrs	Perform Full penetration Single "V" butt joint on MS plates in 1G,2G,3G &4G position adapting root Inspection and clearance by D.P test. (Mapped NOS: CSC/N0204)	64 Weld joint preparation for plate groove welding.Full penetration Single "V"butt joint on MS Flat by SMAW in 1G Positions.Root pass welding & LPI testing.Cover pass welding &inspection.	- Methods of controlling distortion by various methods. - Methods of relieving stress on Weldments. - Advantages of welded structures over riveted structures
		65 Weld joint preparation for plate groove welding.Full penetration Single "V"butt joint on MS Flat by SMAW in 2G Positions.Root pass welding & LPI testing.Cover pass welding & inspection.	- Types of Steel sections / forms used in structural fabrication and their standard sizes - Importance of structural welding and workmanship - Necessity of Qualifying welders, welding operators and tack welders - Necessity of Qualifying the welding procedure - Positions of test plates for filter welds and groove welds
		66 Full penetration single "V" butt joint on MS Flat by SMAW in 3G Positions. 67 MS Flat by SMAW in 4G Positions. 68 Root pass welding & LPI testing. 69 Cover pass welding & inspection.	- Types of Fillet welded and groove welded joints on statically loaded structures. - Types of fillet welded and groove welded joints on dynamically loaded structures
Professional Skill 19Hrs; Professional Knowledge 04Hrs	Perform welding of MS, SS and Aluminium sheets, M.S tubes (square butt T,Y,K joints) by GTAW in down hand position. (Mapped NOS: CSC/N0212)	70 Setting up GTAW welding equipment and making beading practice on MS in down hand position. 71 Square butt joint on M.S Sheet in down hand position.	- GTAW equipments - Advantages of GTAW Welding process - Power source types AC/DC - Types of polarity and application
Professional Skill 55 Hrs;	Perform bending, straightening and edge planing for fabrication of structures.	72 Suare butt joint on S.S Sheet in down hand position.	- Tungsten electrode, types, sizes and uses - Types of shielding gases - Preparation for TIG Welding under drift conditions

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Knowledge 12Hrs	(Mapped-NOS: CSC/N0303)	73 Square butt joint on Aluminium in down hand position.	- Necessity of back purging
		74 M.S square butt Tube (Square or rectangular) welding.	- Types of Tubular structures used on structural fabrication
		75 T,Y,K tube(Square or rectangular) joints by TIG welding.	- Development of templates for marking and preparation of pipe elbow, - T, Y and K joints (Similar and dissimilar diameter pipe connections)
Professional Skill 23Hrs; Professional Knowledge 04Hrs	Perform Double bevel butt joint on dissimilar thickness MS Flats In down hand positions by SMAW with root Inspection by D.P test and back gouging and with root Inspection by D.P test and back gougingand adapting skip welding & back step welding method for controlling distortion. (Mapped NOS:CSC/ N0204)	76 Double bevel butt joint on MS Flats in dissimilar thickness in down hand positions by SMAW. Root Inspection. Back Gouging. Adopting weld sequence for controlling distortion.	- Types of welding defects - Causes and remedy.
Professional Skill 19Hrs; Professional Knowledge 04Hrs	Performe welding of pipe joints different positions by SMAW (Mapped NOS: CSC/N0204)	77 Pipe Elbow and T joints on MS pipes by SMAW in flat position. (10hrs. 78 Pipe Y and K connection on M.S. pipe by SMAW, positions – Horizontal.	- Procedure of rectifying, weld defects -Gouging methods , grinding, testing with die penetrant, preheating and re welding
Professional Skill 18Hrs; Professional Knowledge 04Hrs	Perform Lap, T, Corner joints on GMAW and Flux Cored Arc welding process on M.S in down hand position. (Mapped NOS: CSC/N0209, CSC/N0205)	79 Practice on C02 welding and Flux Cored Arc Welding.	- Introduction to GMAW, Flux cored arc welding - Advantages - Power source- Wire feeder - Electrode wires - shielding gases - Types of metal transfer and welding parameters.
Professional Skill 18Hrs; Professional Knowledge 04 Hrs	Perform Automatic Submerged Arc Welding machine. (Mapped NOS: CSC/N0211)	80 Practice on Automatic Submerged ArcWelding machine	- Introduction to Submerged arcwelding (SAW). Advantage,limitation, Equipment and operating conditions.

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 25 Hrs; Professional Knowledge 05 Hrs	Manufacture simple structures with L angles, I section and channel sections using welding fixture by SMAW. (Mapped NOS: CSC/N0204)	81 Manufacturing of simple structures with L angles, I section and channel sections using welding fixture by SMAW.Correction of distortion by cold &hot.Manufacturing of structures using M.S. Flat by SMAW. 82 Adapting skip welding & back step welding method for controlling distortion	- Procedure of structural fabrication. - Planning for structural members, marking and edge preparation, assembling, tack welding, measurement of weldment size, root pass welding, inspection of root pass welding, making cover pass and Inspection & Testing etc. Inspection and testing of weldments. Visual inspection kits and Gauges
Professional Skill 18Hrs; Professional Knowledge 04 Hrs	Fabricate pipe/cone on M.S. sheet by SMAW. (Mapped NOS: CSC/N0204, CSC/N0303)	83 Fabrication of pipe/cone on M.S. sheet bySMAW.	- Non-destructive testing methods - Structural welding codes andstandards - Writing procedure for WPS and PQR - Requirement for qualification in different codes
Professional Skill 18Hrs; Professional Knowledge 04Hrs	Prepare weld test specimen as per a standard. Carry out non destructive testing of welds. (Mapped NOS: CSC/N0204)	84 Weld test specimen -preparation as per standardInspection & Testing.	- Qualification procedure under variouscodes. - Different tests and inspection involved In qualification.

Familization with the institute

Objectives: At the end of this lesson you shall be able to
- **state brief introduction about Industrial Training Institutes (ITI)**
- **state about the organized structure of the Institute.**

Brief Introduction of Industrial Training Institute (ITIs)

Industrial Training Institute plays a vital role in economy of the country, especially interms of providing skilled manpower.

The Directorate General of Training (DGT) comes under **Ministry of Skill Development and Entrepreneurship (MSDE)** offers a range of vocational training trades in different sectors based on economy /labour market. The vocational training programs are delivered under the aegis of **National Council of Vocational Training (NCVT).** Craftsman Training scheme (CTS) and Apprenticeship Training Scheme (ATS) and two pioneer programs of NCVT for Propagatory Vocational Training.

Total number of ITIs in India as on April 2016 is about 13105 (Govt. 2293 + 10812 Private ITIs). They are giving training about 132 trades including Engineering and Non-engineering with the duration of 1 or 2 years. The minimum eligibility for admission in ITIs 8th, 10th and 12th pass with respect to the trades and admission process will be held in every year in July.

All India Trade Test (AITT) will be conducted After passing, National trade certificates (NTC), will be issued by DGT which is authorized and recognized internationally. In 2017, for some trades they have introduced and implemented **National Skill Qualification Frame** work (NSQF) with Level 3

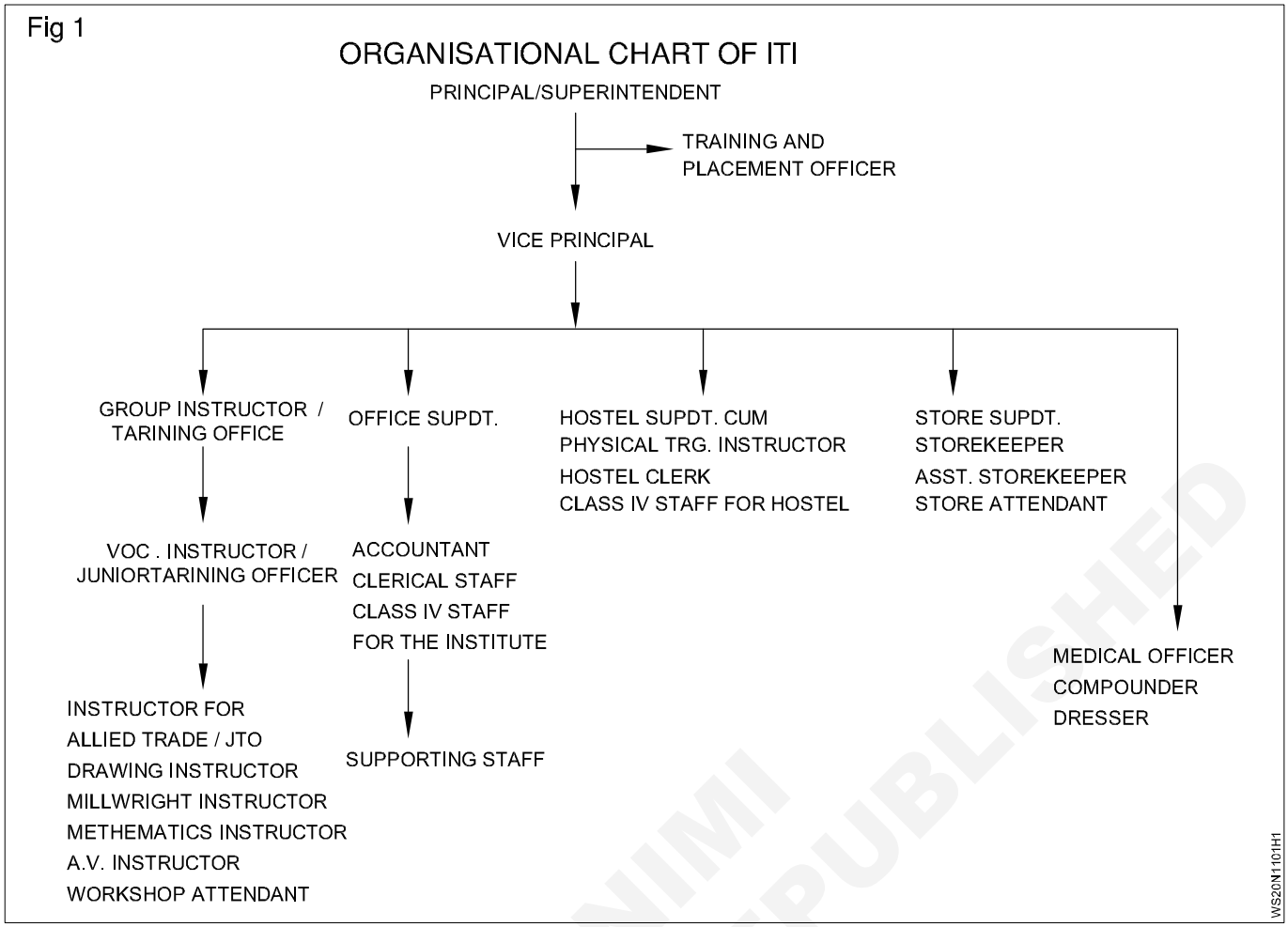
After finishing instructional training with 'NTC' certificate, they have to undergo Apprenticeship training (ATS) for one or two year in respective trades under the Apprentice ACT 1961, in various government and private establishments with stipend. At the end of the Apprenticeship training, All India Apprentice Test will be conducted and apprentice certificate will be issued. They can get job opportunities in private or government establishment in India/Abroad or they can start small scale industries in manufacturing or in service sector with subsidiary government loan.

Organizational Structure of ITIs

In most of the ITIs, the head of the institute is the principal under him one vice-principal (VP). then Training Officers (TO)/Group Instructors (GI) who are the management and supervisory staff. Then Assistant Training Officers(ATO), Junior Training Officer (JTO), and Vocational Instructors (VI) are under Training officers for each trade and for Workshop calculations, Engineering Drawing, Employability skills etc. Administrative staff, Hostel Superintendent (H.S.) physical Education Trainer (PET), Library incharge, Pharmacist, etc. will be under the head of the Institution.

The typical organizational of ITI chart is shown in Fig 1

Fig 1



Importance of trade training

Objectives: At the end of this lesson you shall be able to
- **competencies achieved in this welder trade**
- **further learning path ways craftsman training scheme**
- **employment opportunities on completion of welder trade.**

This trade is meant for the candidates who aspire to become a professional WELDER. The duration of the trade is one year under craftsman training scheme.

Competencies achieved

After successful completion of this trade trainee shall be able to perform the following skills with proper sequence.

1 Welding of M.S. sheet and M.S. pipe by Gas welding process.

2 Welding of M.S. plate in all position by SMAW process.

3 Straight, bevel & circular cutting on MS. plate by Oxy-acetylene cutting process.

4 Repair & Maintenance works

5 GMAW welding on M.S sheet & M.S plate.

6 Operating skills of spot welding machine, PUG cutting machine,

7 Welding C.I using SMAW process.

Further learning pathways

Also on successful completion of the trade the candidate can pursue apprenticeship training in Registered Industries/ Organization, further for a period of one year under Apprenticeship Training scheme to acquire practical skills and knowledge.

Employment Opportunities

On successful completion of this trade, the candidates shall gain to be fully employed in the following industries:

1 Structural CG & M like bridges, Roof structures, Building & construction.

2 Automobile and allied industries.

3 Site construction activities for power stations, process industries and mining.

4 Service industries like road transportation and railways.

5 Ship building and repair.

6 Infrastructure and defence organizations.

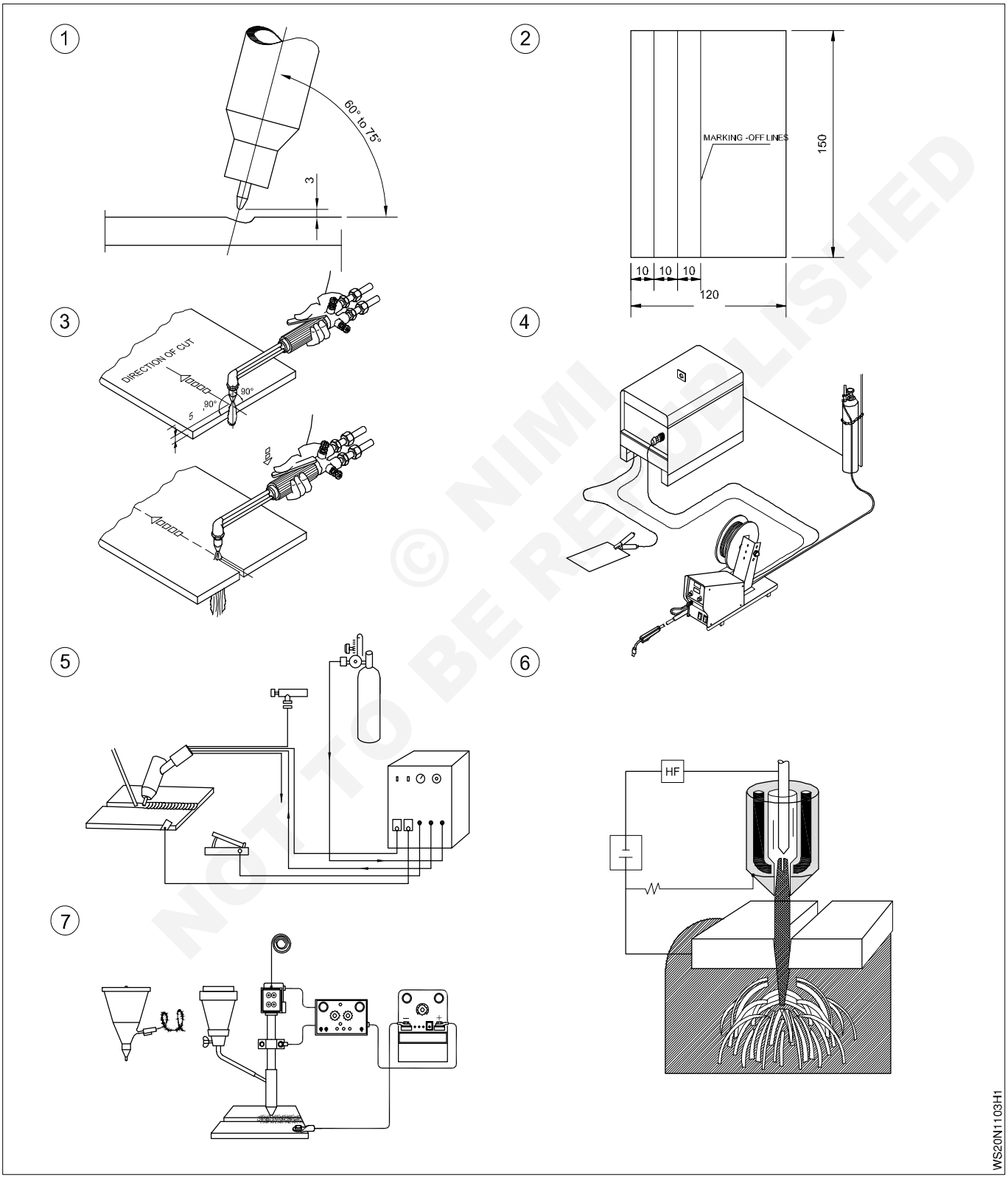
7 In public sector industries like BHEL, NTPC, etc and private industries in India & Abroad.

8 Petrochemical industries like ONGC, LOCL, and HPCL etc

9 Self employment.

Machinery used in the trade

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.**



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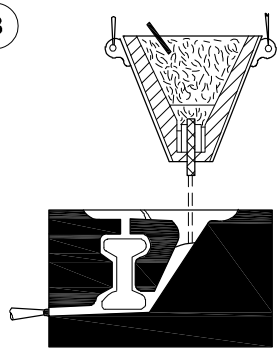

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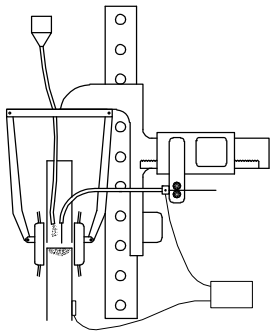

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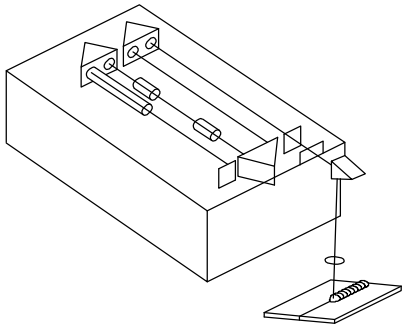

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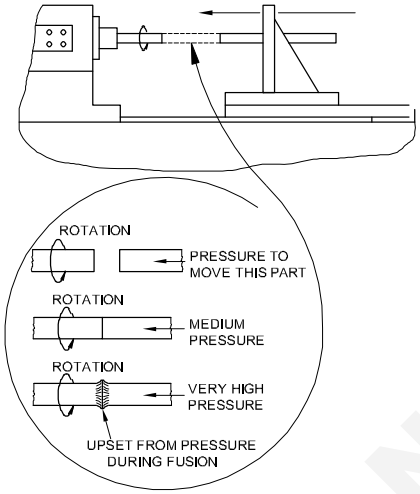

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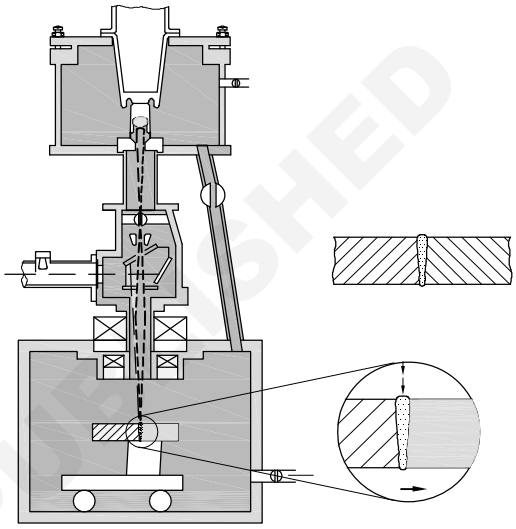

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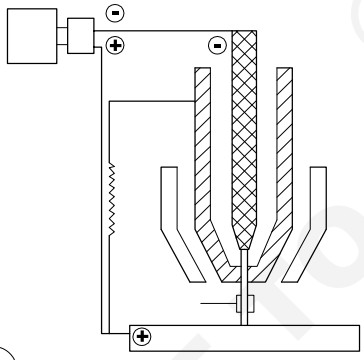

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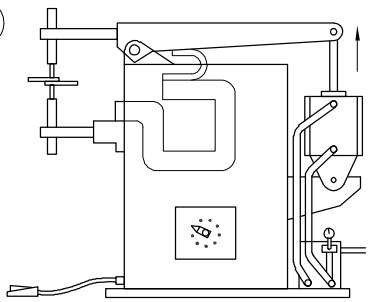

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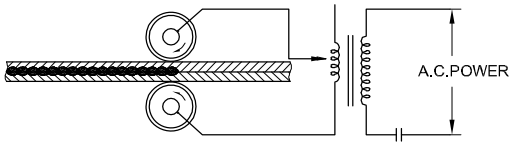

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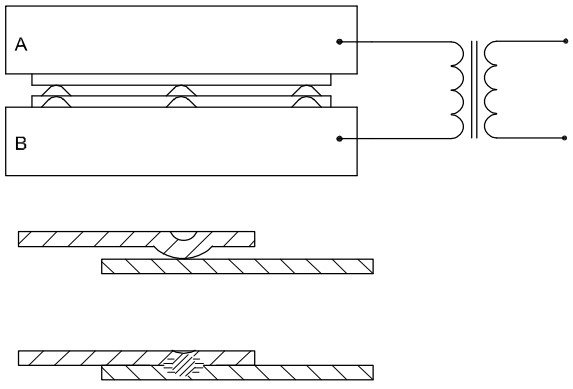


WS20N1103H2

TABLE 1

Types of machine	Name of the machine	Uses
1. SMAW Ex. 1.4.01 - TP - Fig 1 - P. 92 WL1401J1 - I SEM		
2. OAW Ex. 1.2.01 - Fig 1 - P. 23 - WL 1201J1 TP - I SEM		
3. OAGC Ex. No. 1.2.02 - TT - I SEM Ex. No. 1.2.02 - P. 34 - WL 120432		
4. GMAW - 2.1.02 - TT - II SEM - TT - II SEM Ex. No. 2.1.02 - Fig 2 - P. 4 - WL 210212		
5. SMAW - TT - II SEM - P. 48 - Ex. No. 2.1.03 WL 220411		
6. PAC - TT - II SEM - P. 80 - Fig 1 Ex. No. 2.3.01 - WL 240117		
7. SAW - II SEM - TT - Ex. No. 2.4.01 - P. 82 Fig 4 - WL 230114		
8. Thermit welding - II SEM - TT - P. 85 - Fig 1 Ex. No. 2.4.01 - WL 230211		
9. Electro slag welding - II SEM - TT Ex. No. 2.4.01 - P. 86 - Fig 2 - WL 230312		
10. Friction welding - II SEM - TT - P. 88 - Fig 1 Ex. No. 2.4.01 - WL 230411		
11. Laser beam welding - II SEM - TT - P. 89 Fig 1 - Ex. No. 2.4.02 - WL 230511		
12. Electron beam welding - II SEM - TT - P. 90 Fig 2 - WL 230612		
13. Plasma arc welding - II SEM - TT - P. 92 Fig		
14. Resistance welding - II SEM - TT - P. 95 Fig 1 - WL 230811		
15. Spot welding - II SEM - TT - P. 95 Ex. No. 2.4.02 - WL 230812		
16. Seam welding - II SEM - TT - P. 96 Ex. No. 2.4.02 - WL 230816		
17. Projection welding - II SEM - TT - Fig 6 P. 97 - Ex. No. 2.4.02 - WL 230816		

Introduction to safety equipment and their uses etc.

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

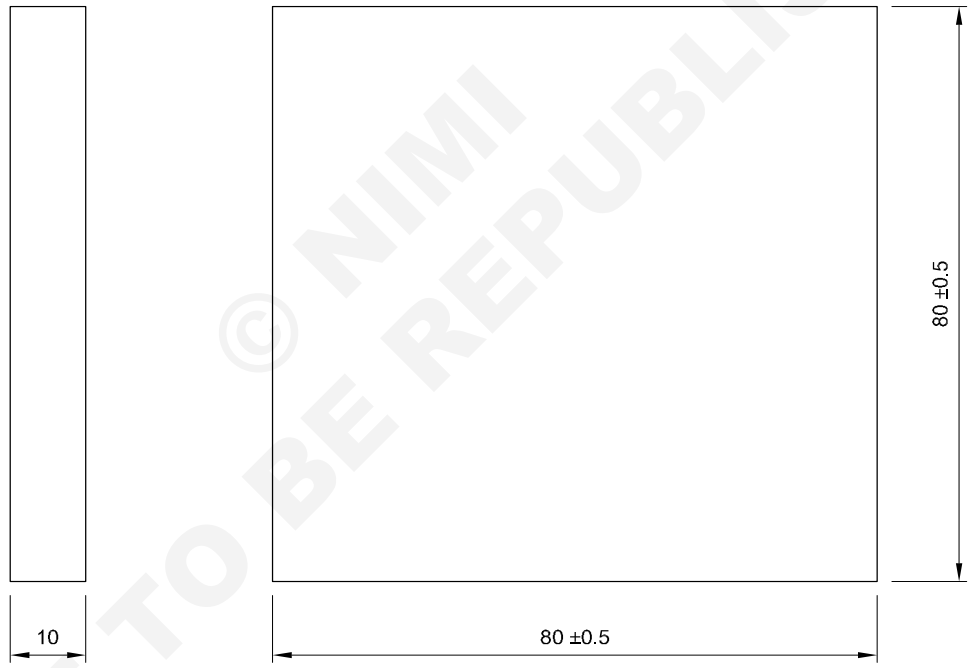
S. No.	Name of the PPE	Hazards	Type of protection
1			
2			
3			
4			
5			
6			
7			
8			
9			

Get it checked by your instructor.

Hack sawing, filing square to dimension

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

- **file the surface to 90°**
- **mark the overall size using scribing block**
- **cut excess metal by hack saw**
- **file to square and maintain the dimension ±0.5 mm check the dimensions with steel rule.**



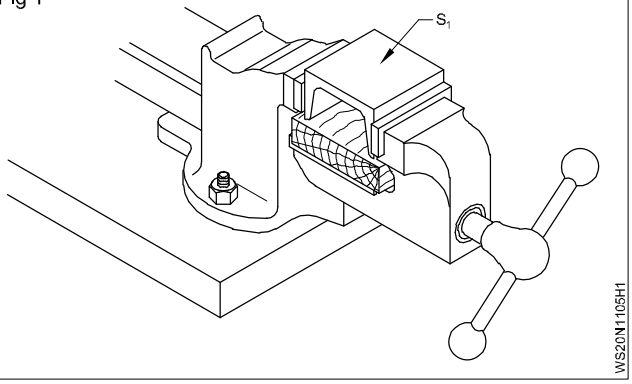
1	100ISF x 10-100	-	Fe310	-	-	1.1.05
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	HACKSAWING,FILING SQUARE TO DIMENSION	DEVIATIONS ±0.5	TIME 5hrs
		CODE NO. WS20N1105E1	

Job Sequence

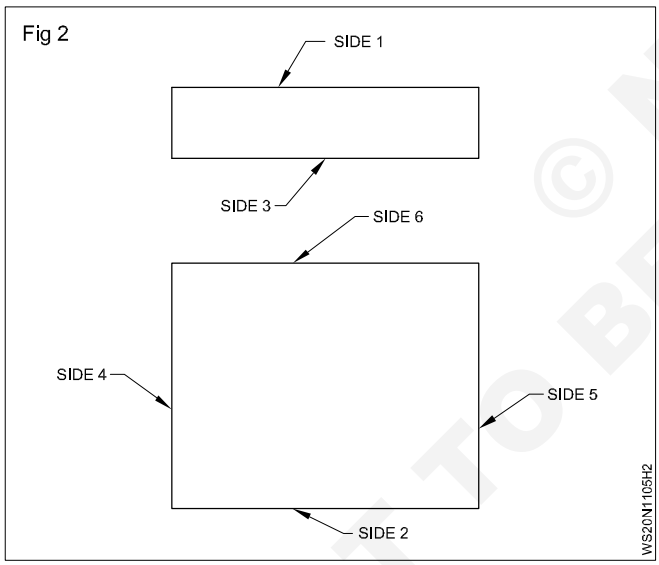
- Check the stock size material using steel rule.
- Remove burrs, if any.
- Hold the job in vice, so that surface side 1 comes on top (Fig 1).

Fig 1



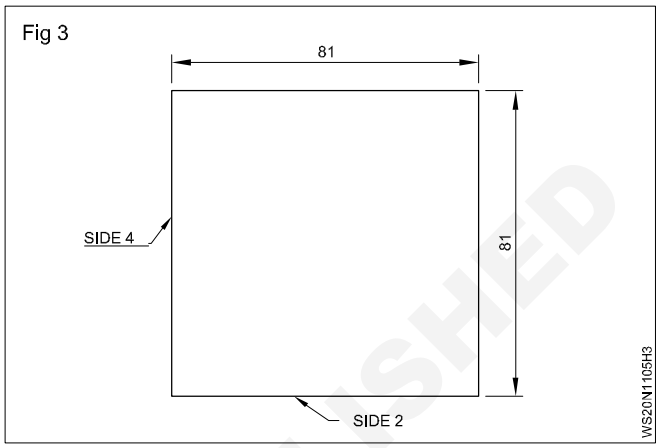
- File the surface side 1 with a flat bastard file.
- Check the surface level with straight edge (blade of a try square).
- File one edge (side 2) flat and 90°, to side 1 (Fig 2).

Fig 2



- File side 3 flat and parallel to side 1.
- File side 4 to 90° to side 2.
- Check the 90° angle with try square.
- Apply marking media on side 1.
- Mark 81 mm keeping side 2 on surface plate (Fig 3).

Fig 3



- Similarly mark 81 mm on side 5 keeping side 4 on surface plate.
- Punch the marked line.
- Hold the job in the bench-vice keeping 10 mm away from the marked line.
- Make a notch on the line to start hack sawing.
- Cut along the marked line.
- Similarly cut on the other side.
- File sides 5 and 6 and check the squares and maintain the dimension of 80.00 mm ±0.5 mm.
- Deburr the job and apply oil and preserve it for evaluation.

Skill Sequence

Filing flat surface

Objective: This shall be help you to
- **file flat surface**

Hold the job in the bench vice with a projection of 5 to 10 mm from the top of the vice jaw.

Select the files of various grades and length according to the

– size of the job

– quantity of metal to be removed

– material of the job.

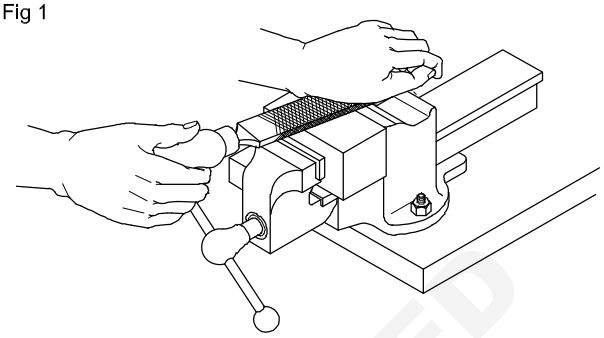
Check whether the handle of the file fits tightly. Hold the handle of the file and push the file forward using your right hand palm.

Hold the tip of the file according to the quantity of the metal to be removed.

For heavy filing.

For removing the local unevenness draw filing can also be done. The same filing can also be done for fine finishing.

Fig 1



Start filing by pushing the file uniformly during the forward stroke and release the pressure during the return stroke.

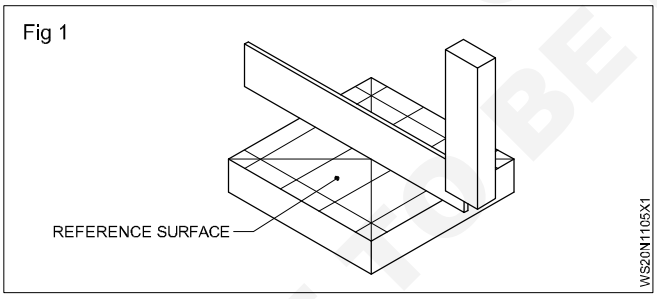
Continue giving strokes. Balance the pressure of the file in such a way that the file always remains flat and straight over the surface to be filed.

Checking flatness and squares

Objectives: This shall help you to
- **check flatness**
- **check squares.**

Checking flatness (Fig 1)

Fig 1



Use the blade of the try square as a straight edge for checking flatness.

Place the blade of the try square on the surface to be checked in all directions so as to cover the entire surface.

Do the checking facing the light. Light gap will indicate high and low spots.

Checking squares: Consider the large finished surface as the reference surface. Ensure that the reference surface is filed perfectly and is free from burrs.

Butt and press the stock against the reference surface. (Fig 2)

Fig 2

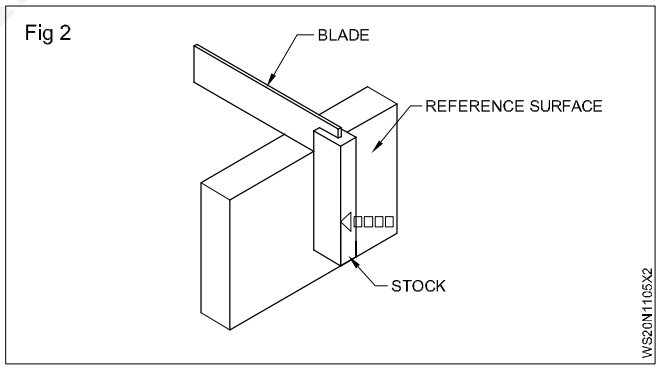
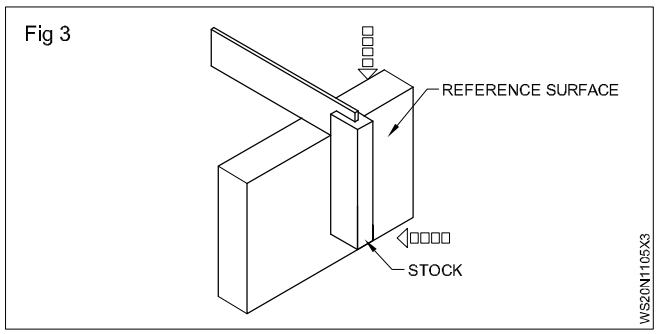


Fig 3



Bring down slowly (Fig 3) and make the blade touch the second surface with which the squares is to be checked.

Light gap will indicate the high and low spots.

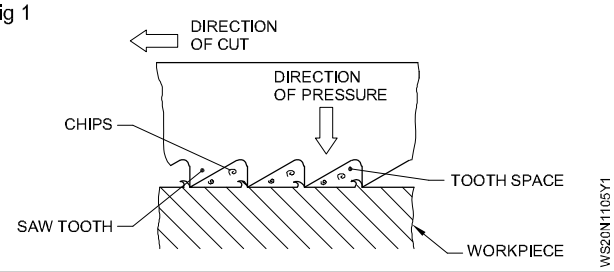
Hacksawing

Objectives: This shall help you to
- **fix hacksaw blades maintaining correct tension and direction**
- **cut metal pieces with a hacksaw.**

Insert the hacksaw blade pin holes in the blade holder pins (fixed and adjustable) of the hacksaw frame.

Ensure that the teeth of the hacksaw blade is pointed in the direction of the cut and away from the handle. (Fig 1)

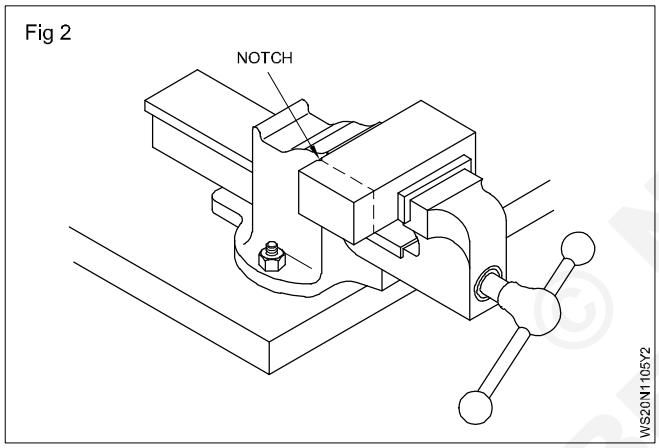
Fig 1



Ensure that the blade is held vertical and correctly tensioned before starting.

While starting the cut, make a small notch. (Fig 2)

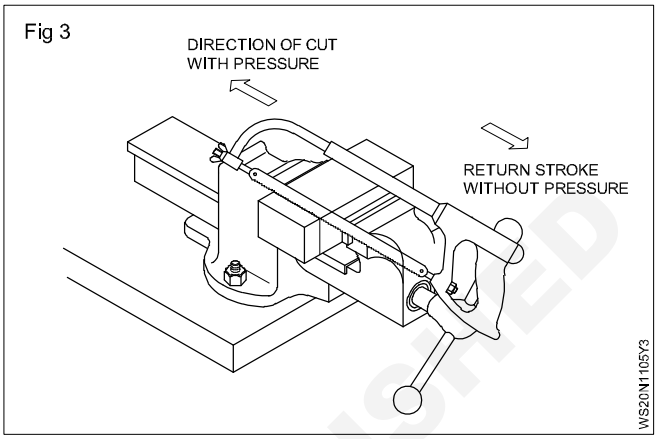
Fig 2



The cutting movement should be steady, and the full length of the blade must be used.

Apply pressure only during the forward stroke. (Fig 3)

Fig 3



While cutting, make sure that at least two to three teeth are in contact with the work.

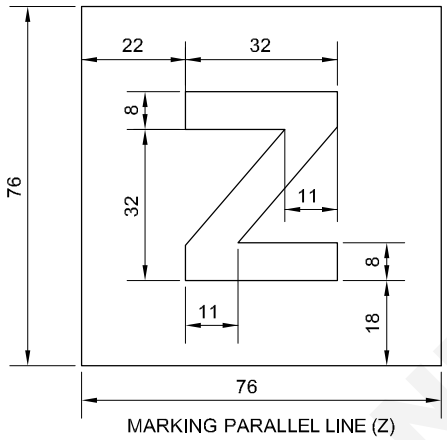
Normally, a coolant is not necessary while hacksawing.

Do not move the blade too fast. While finishing a cut slow down to avoid breakage of blade or injury to yourself and others.

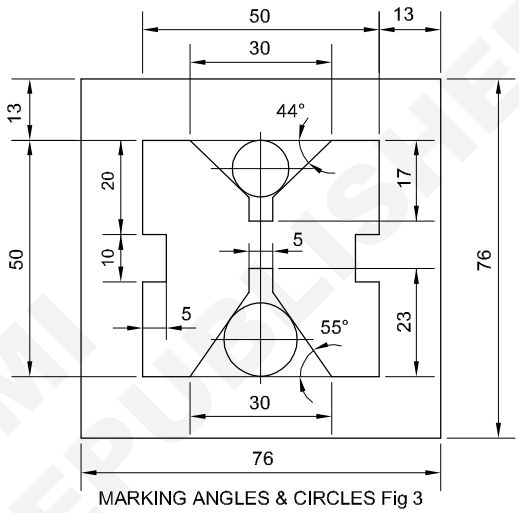
Marking out on MS plate and punching

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

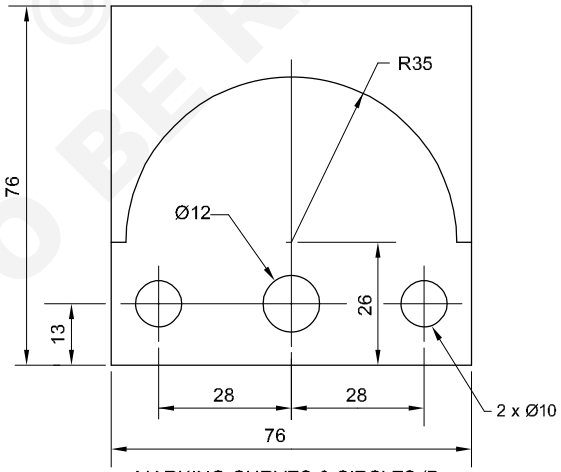
- **draw lines on metallic surfaces by scribers**
- **draw parallel lines by jenny calipers**
- **draw parallel lines with a surface gauge**
- **draw angles with a simple protractor and scriber**
- **bisect the angles with a divider**
- **draw circles, arcs and tangents with divider and scriber**
- **register the profile by dot punching.**



MARKING PARALLEL LINE (Z)
(By Jenny caliper and scriber) Fig.1



MARKING ANGLES & CIRCLES Fig 3



MARKING CURVES & CIRCLES (By
Jenny caliper and divider) Fig.2

1	80 ISF 6-80 (Pre machined) 76x76x6	–	Fe 310	--	--	1.1.06
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX.NO.

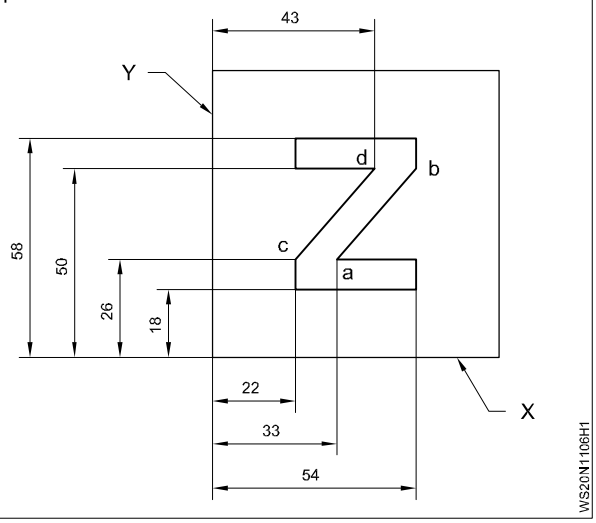
SCALE NTS	MARKING OUT ON M.S.PLATE AND PUNCHING	DEVIATIONS	TIME 8hrs
		CODE NO. WS20N1106E1	

Job Sequence

Marking 1

- Check the raw material for its size and its squares.
- Apply copper sulphate solution on one side of the job and allow it to dry.
- Scribe parallel lines to the edges 'x' and 'y' using a jenny caliper. (Fig 1)

Fig 1



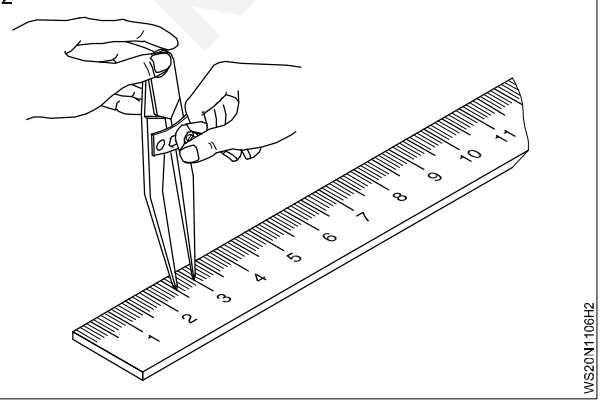
To avoid confusion, do not scribe the line longer than necessary.

- Scribe two lines by joining points ab and cd, using a steel rule and scriber.
- Punch witness marks and complete 'Z'.

Marking 2

- Apply the marking medium on the other side of the job and allow it to dry.
- Mark the center lines of three circles and one semicircle using the jenny caliper.
- Punch all the four centers using a 30° prick punch. (Fig 4)
- Open and set the divider to 5 mm. (Fig 2)

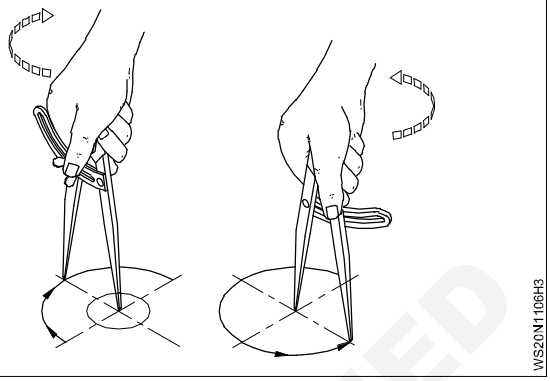
Fig 2



Make sure that both the legs of the divider are of equal length.

- Draw two circles of ø10 using the divider. (Fig 3)

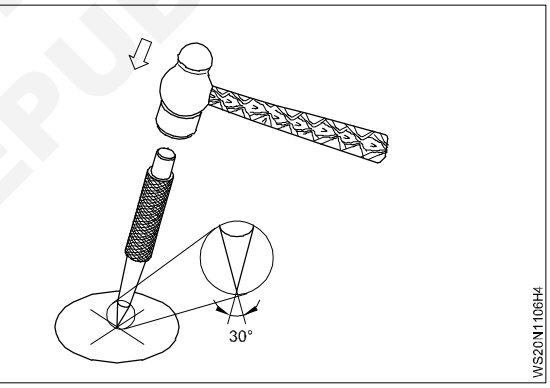
Fig 3



- Set and draw ø12 circle and R35 semicircle.
- Punch witness marks on the circles and semicircles. Show the markings on both the sides to the instructor for evaluation.(Fig 4)

Reuse the same material for marking 3 and 4.

Fig 4



Marking 3

- File and finish one of the marked surfaces flat and de-burr.
- Apply copper sulphate solution on the finished side.
- Butt the job against the angle plate.
- Mark all the parallel lines to the edges using the surface gauge.
- Also mark the starting points of the V groves.
- Set and lock the bevel protractor at 55°.
- Butt the bevel protractor on to the edge of the job and mark one side of the V groove. (Figs 5 & 6)
- Continue the same procedure and complete the 44° V groove.
- Complete the V block marking.

Fig 5

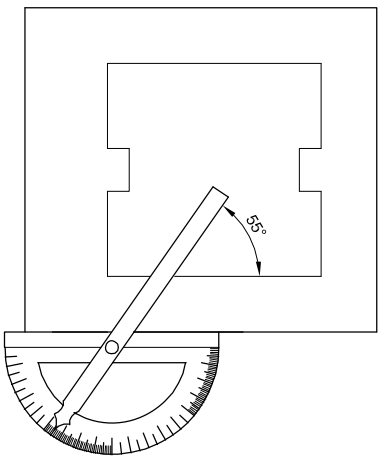


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Fig 6

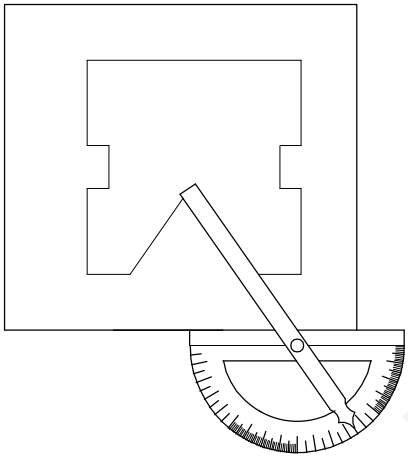

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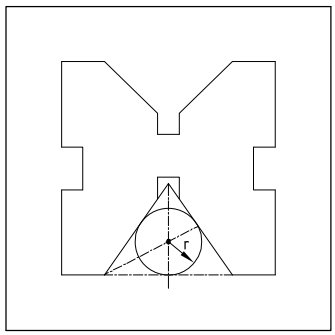
Fig 7



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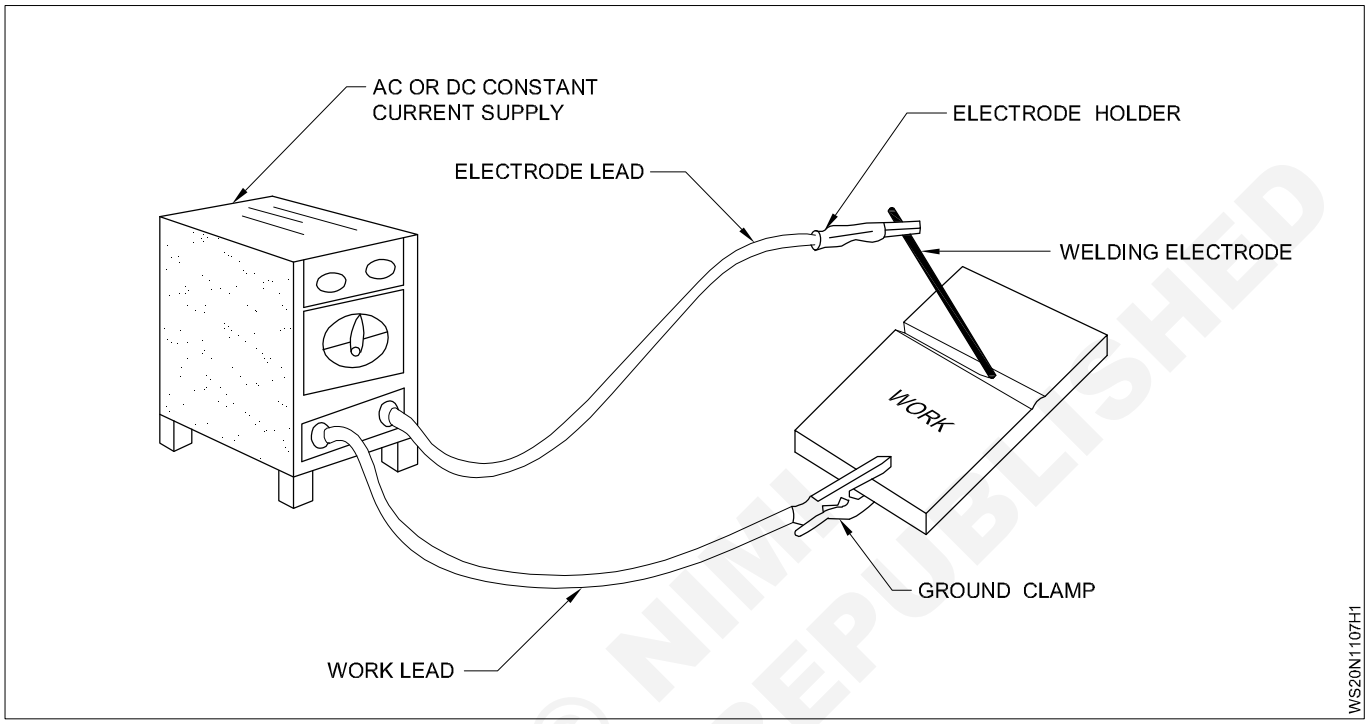
- Bisect any two sides of the triangle formed by the 55° V groove, and get the center and radius of the circle.
- Draw the circle on the 55° V groove. (Fig 7)
- Similarly draw the circle on the 44° V groove.
- Punch witness marks.

Setting up of arc welding machine & accessories and striking an arc

Objectives: At the end of this exercise you shall be able to
- **connect the welding cables between the welding machine, electrode holder and the job**
- **start and operate the controls and stop are welding machine in sequence**
- **set welding current and strike and maintain the arc.**



Job Sequence

- Set up the equipment in a safe place
- Organize the tools that you are using.
- Obtain the piece for welding and connect the ground clamp to one of them.
- Turn on the welding transformer.
- Set the amperage as per the suggested list on the machine.
- Insert the electrode in to the electrode holder into angled groove.
- Position the rod tip 25 to 50mm away from the welding position.
- Lower the helmet and now it is ready to strike the arc.

Skill Sequence

Setting up of arc welding machine & accessories and striking an arc

Objective: This shall help you to
- **assist in setting up arc welding plant.**

Setting up Arc Welding plant (Fig 1)

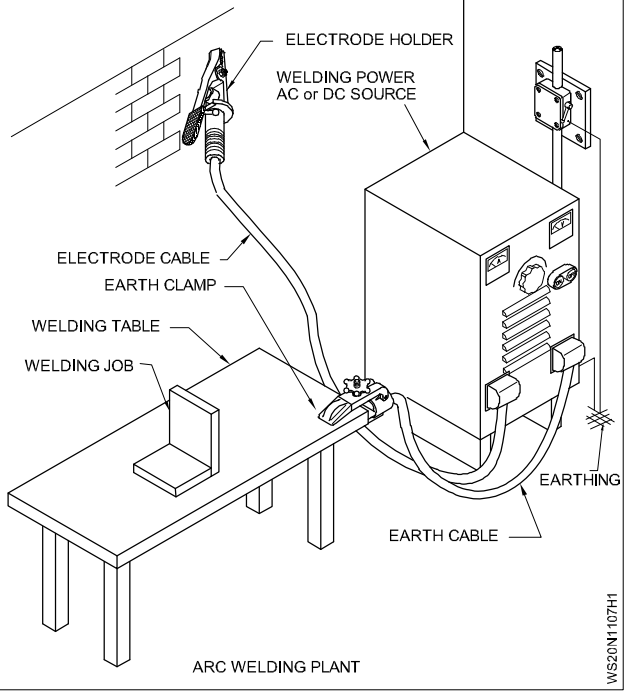
Check the welding machine and other accessories as per sketch. A welding generator or a welding rectifier (Fig 2) gives a direct current for welding and a welding transformer (Fig 3) gives an alternating current for welding.

Connect the welding machine to the power supply.

Be sure that the main supply switch and the welding machine are properly earthed. This will avoid any electric shock to the welder. (Fig 1)

Switch on the starter.

Fig 1



ARC WELDING PLANT

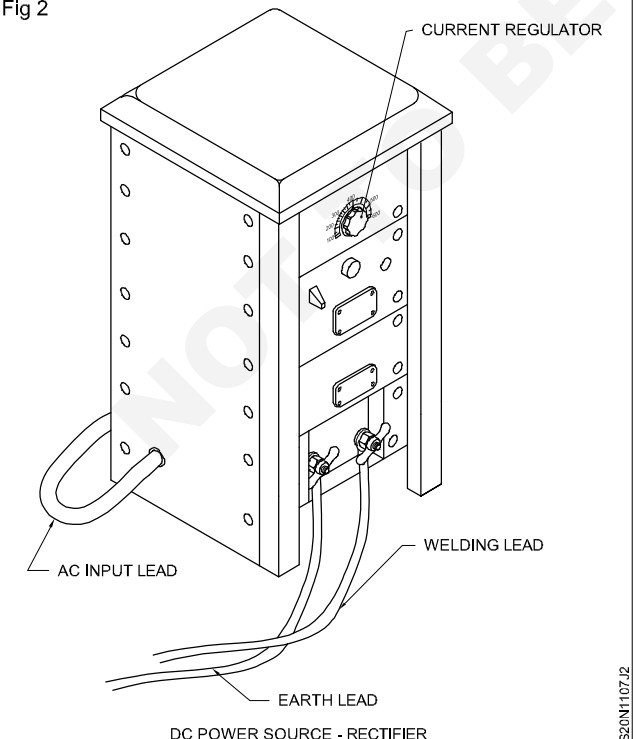
Check and ensure the electrode holder and earth cable are without any loose connection or damage.

Loose cable connections cause spark, heat and unstable arc.

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

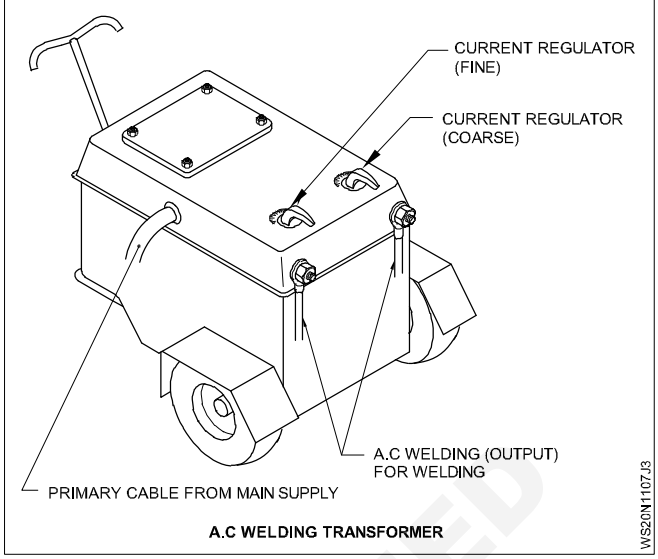
Hang the electrode-holder on an insulated hook provided near the welding table whenever it is not in use.

Fig 2



DC POWER SOURCE - RECTIFIER

Fig 3



A.C WELDING TRANSFORMER

Connect the welding machine to the main supply as follows.

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

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

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

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

Check the proper operation of the main switch.

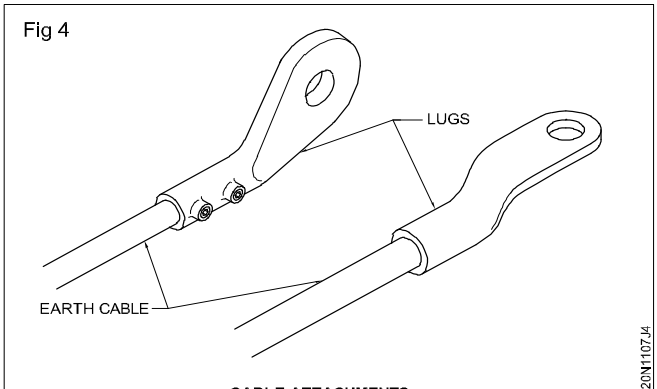
Check the proper operation of the on/off switch of the machine.

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

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

Welding cables are used to carry the welding current from the welding machine to the electrode-holder and the job and suitable lugs are attached to the earth cable ends (Fig 4).

Fig 4

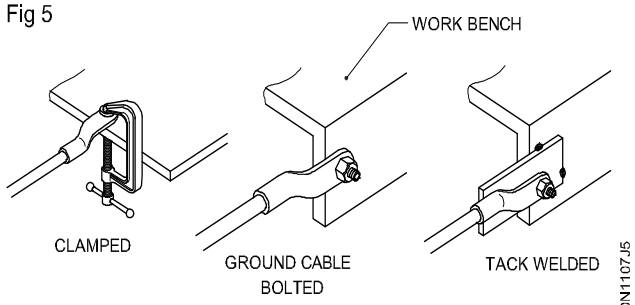


CABLE ATTACHMENTS

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

Connect the other end of the earth cable with the welding table or work tightly using the earth clamp as shown in (Fig 5).

Fig 5



METHOD OF ATTACHING EARTH CABLES

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

Starting and stopping of arc welding machines

Welding transformer

Switch 'on' the main supply of the welding transformer.

Start and stop the welding transformer (2-3 times) using the on/off switch provided on the machine.

Welding rectifier

Switch 'on' the main supply of the welding rectifier.

Start and stop the welding rectifier 2-3 times using the 'on' - 'off' switch provided with the machine.

In some of the rectifiers, a transfer switch is provided. By operating this switch the machine can be used as DC welding machine or as AC welding machine.

Striking of arc on mild steel (M.S.) plate in flat position

Fix a 3.15 mm dia medium coated mild steel electrode between the jaws of the electrode holder. (Fig 6).

Fig 6

WELDER ABOUT TO STRIKE AN ARC

Ensure the bare wire end of the flux coated electrode is firmly held in the slot/groove provided in the electrode holder.

Set 110 ampere for the 3.15 ø electrode. All electrode manufacturers indicate the current values for different size electrodes which can be used as a guide while setting currents.

Striking the arc is a basic action whenever a welder has to start welding or an electrode is changed or an arc is put-off during welding.

Connect the electrode to negative if the machine is a DC welding machine.

Clean the given scrap iron plate (work piece) surface with a steel wire brush, and clean the oil or grease, water and paint, if any.

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

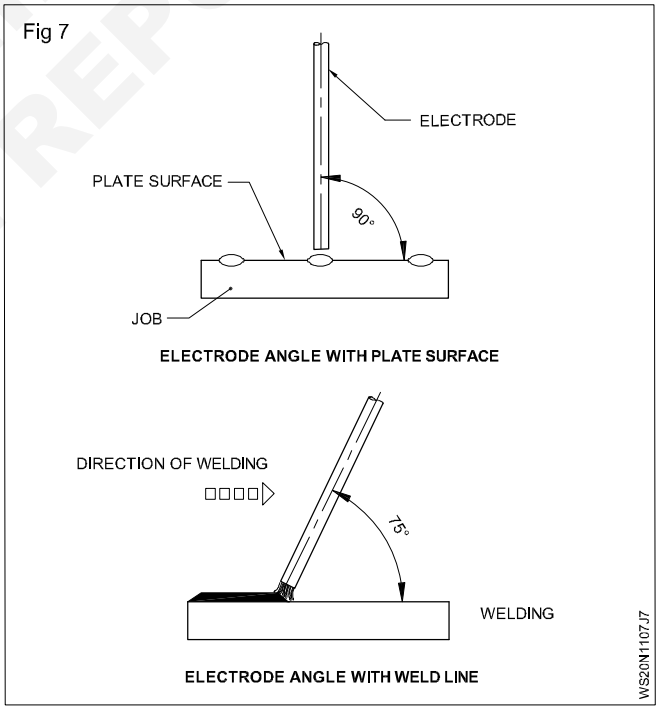
Set the work piece on the welding table in a flat position.

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

Ensure safety apparels are worn. (Fig 6)

Hold the electrode about 5 mm above the job piece at one end at 75° angle to the line of weld and at 90° to the plate surface. (Fig 7)

Fig 7



ELECTRODE ANGLE WITH PLATE SURFACE

ELECTRODE ANGLE WITH WELD LINE

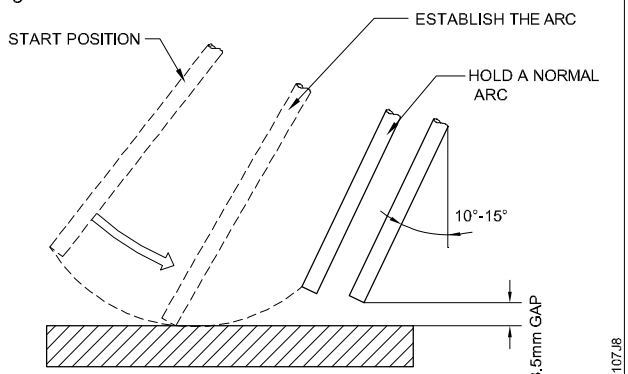
Scratching method (Fig 8)

Put on the welding helmet or bring the welding shield in front of your eyes.

Strike the arc by dragging the electrode quickly and softly across the welding job using wrist movement only.

Withdraw the electrode approximately 6 mm from the surface for a few seconds and then lower it to approximately 3 mm distance to maintain the arc. (Fig 8)

Fig 8



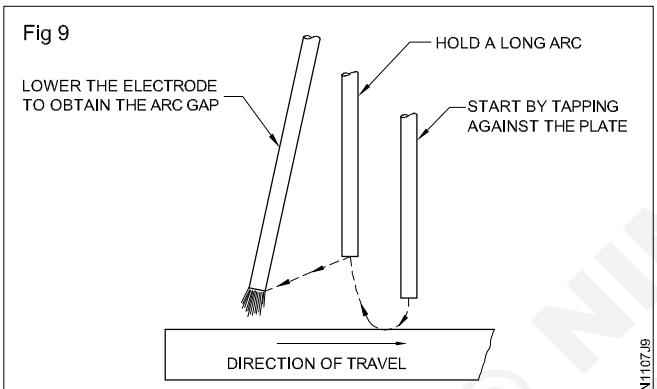
SCRATCH START METHOD

If the arc has been properly struck a 'burst of light with a steady sharp crackling sound' will be produced.

To break the arc quickly withdraw the electrode up.

Tapping method (Fig 9)

Fig 9



TAPPING METHOD OF STRIKING AN ARC

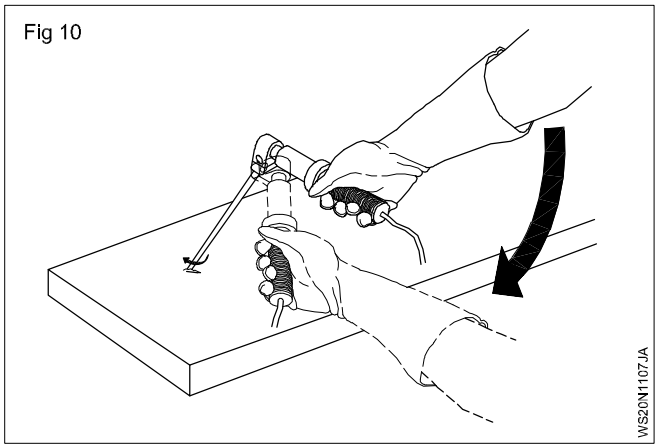
Strike the arc by moving the electrode down to touch the job surface lightly.

Lift the electrode up slowly approximately 6 mm for a few seconds and then lower it to approximately 3 mm from the surface to maintain a correct arc.

The tapping method is mostly recommended as it does not put pit marks on the job surface.

If the electrode freezes (sticks) to the plate, it should be immediately freed by a quick twist of the wrist to avoid its overheating or spoiling. (Fig 10)

Fig 10



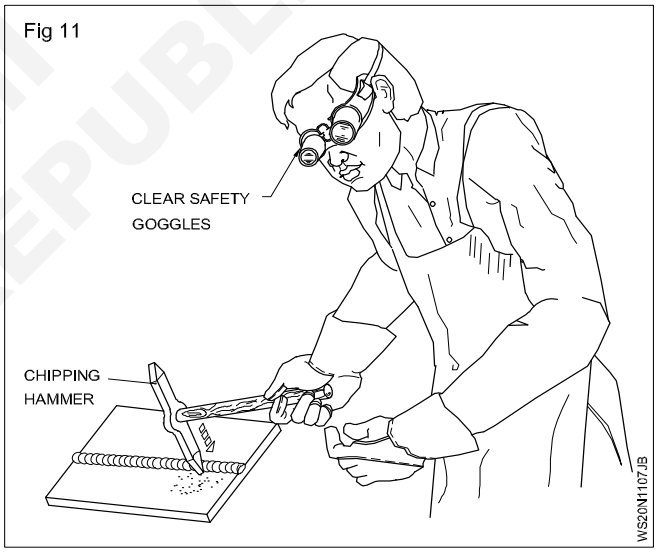
Strike the arc by the scratching method.

Look at the arc through the filter glass only fitted in the welding screen/shield or helmet.

Remove the slag covering from the top of the short weld deposits by using a chipping hammer, and clean with a wire brush. (Fig 11).

Use chipping goggle or chipping screen, while Deslagging welds.(Fig 11)

Fig 11



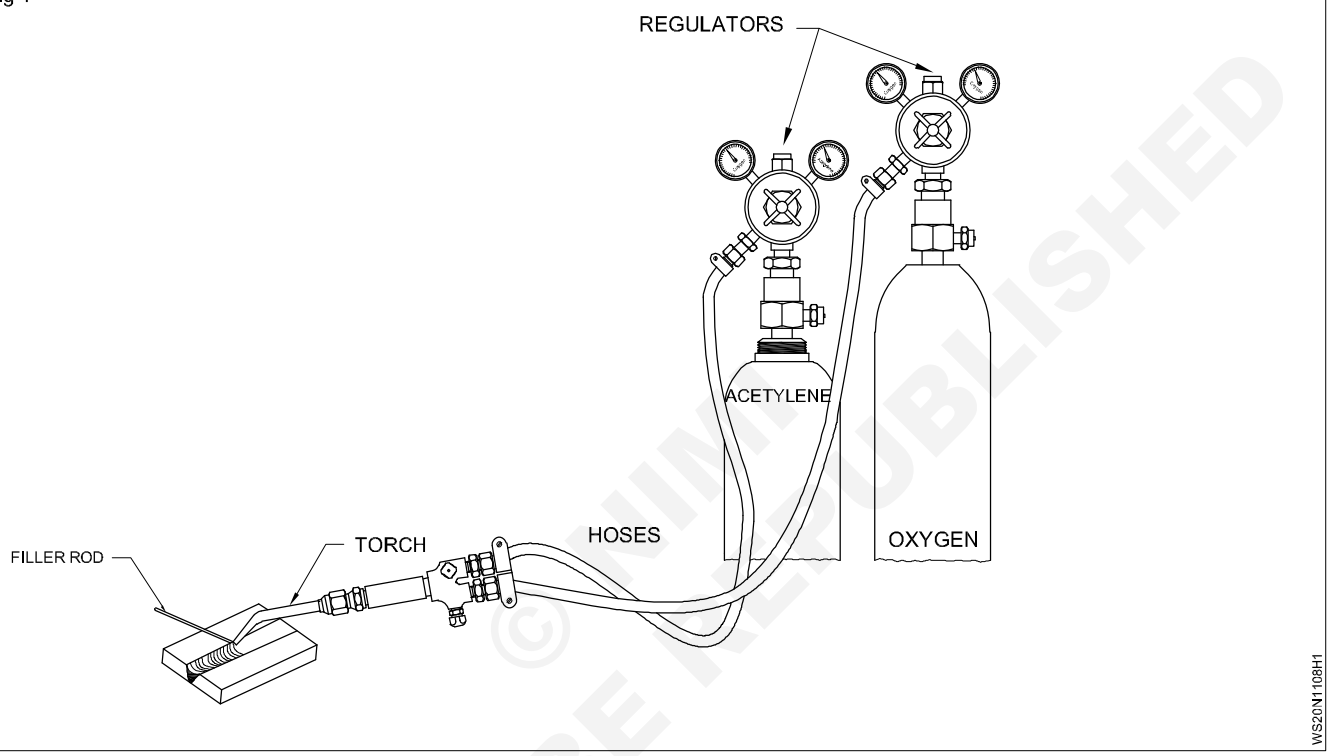
If the welded job is small in size use tongs to hold a hot job.

Repeat striking the arc on the scrap MS plate until the arc can be struck every time without the electrode freezing.

Setting of oxy-acetylene welding Equipments, Lightting,and setting of flame

Objectives: At the end of this exercise you shall be able to
- **setup the oxy-acetylene gas welding plant by connecting all components**
- **test for gas leakages at all connections**
- **set the required gas pressure on the regulators**
- **set natural oxidizing and carburizing flames**
- **close down the oxy-acetylene gas welding plant maintaining correct sequence.**

Fig 1



Job Sequence

- Inspect all inlet and outlet valves, threads and seats onboth cylinders and regulators.
- Crack the valves.
- Install the regulator.
- Inspect hose fittings for damage and attach it.
- Open the gas cylinders, oxygen and Acetylene.
- Purge both hoses by opening the regulator valve correctly as per gas, one at a time.
- Inspect torch handle.
- Assemble the torch handle.
- Attach the hose correctly.
- Leak check and purging.
- Light the flame.
- Adjust the flame to get neutral flame.
- Observe the flame pattern.
- Adjust the flame to get oxidizing flame.
- Observe the flame pattern.
- Adjust the flame to get carburizing flame.
- Observe the flame pattern.
- Shut down the torch flame.
- Shut down and bleed the pressure from the system.

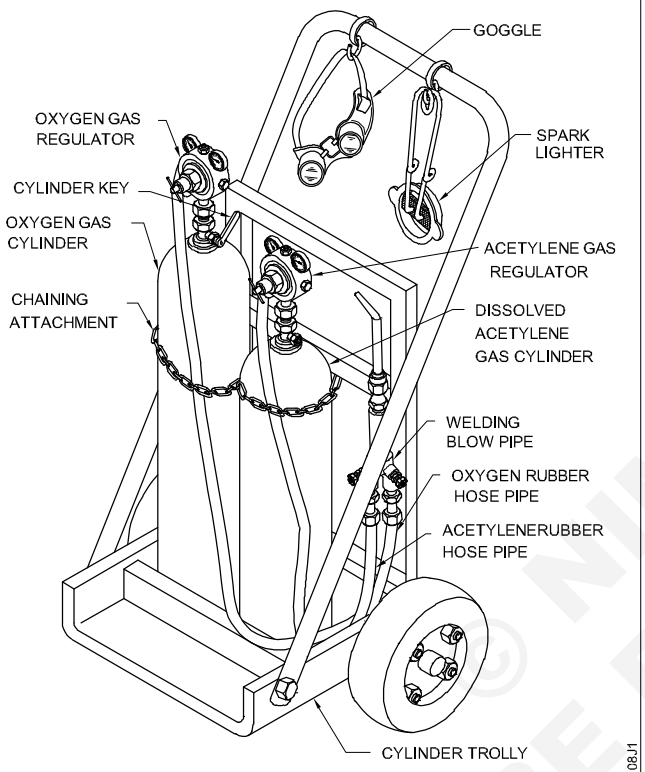
Skill Sequence

Setting of oxy-acetylene welding equipment, lighting and setting of flame

Objectives: This shall help you to
- **set up oxy-acetylene plant**
- **set up the flames neutral oxidizing and carburizing**
- **close down the gas welding plans.**

Setting up oxy-acetylene plant (Fig 1)

Fig 1



SETTING OF OXY-ACETYLENE PLANT

Move oxygen and acetylene cylinders with the caps from the store to the gas welding area.

An oxygen cylinder is identified by the black color painted on it. An acetylene cylinder is identified by the maroon color painted on it. Also the oxygen cylinder will be taller than an acetylene cylinder and the diameter of oxygen cylinder will be less than the diameter of an acetylene cylinder.

Ensure full cylinders are kept separately from the empty cylinders.

Position the gas cylinders in a trolley and secure them with a chain.

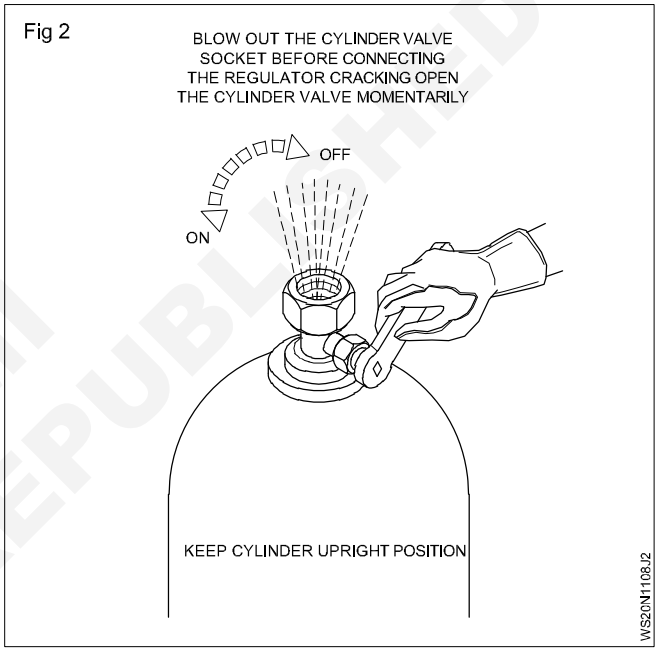
Always keep the cylinders upright/vertically in the cylinder stand/on the floor.

While moving, the gas cylinders should be kept slightly inclined to the vertical position and the protector cap used to avoid damage to the cylinder valves.

Do not roll the cylinders horizontally on the ground.

Remove the cylinder caps. Crack the gas cylinder valves by quickly opening and closing them using the cylinder key. (Fig 2)

Fig 2



Dirt and dust particles from the cylinder valve sockets are cleaned by cracking the cylinder valve. This will avoid leakage of gas due to improper seating of the cylinder valve and also to prevent the dust particles from entering into the regulators which may cause damage to the regulators.

Always stand opposite to the valve outlet while cracking the cylinders.(Fig 3)

Ensure that your hands are free from grease or oil.

Connect the oxygen regulator to the oxygen gas cylinder (right hand threads).

Connect the acetylene regulator to the acetylene gas cylinder (left hand threads).

Ensure the pressure adjusting screws of both regulators are in a released condition.

Connect the correct regulator on cylinders. Acetylene connections have left hand thread and oxygen has right hand thread.

The acetylene regulator connecting nut will have a groove cut on it (Fig 4) and the pressure gauge dial will be of maroon color.

Fig 3

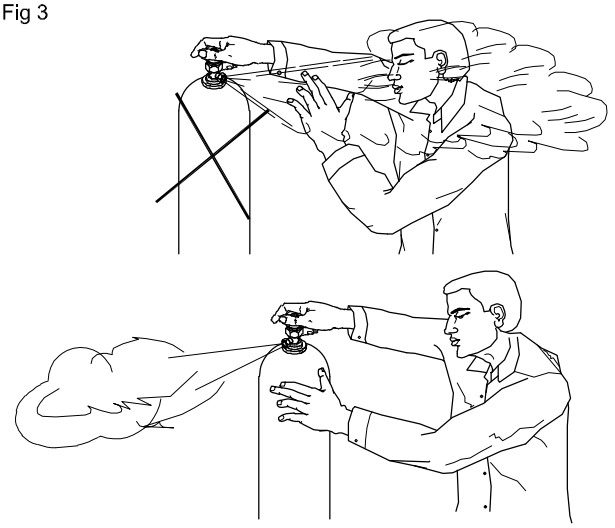


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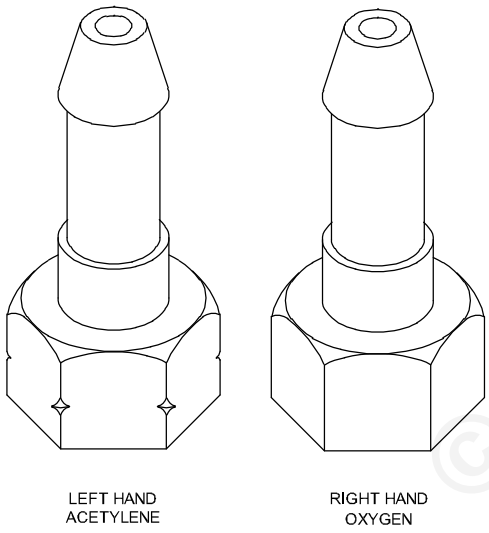
Fig 4



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All threaded connections should be fixed initially by tightening by hands and then only a spanner should be used. This will help to avoid assembly with cross thread leading to damage to threads.

It is dangerous to apply lubricants in the threaded assemblies of gas welding equipment as it can cause fire. (Fig 5)

While tightening avoid undue force. The connections should be just tight.

Connect the hose connector at the regulator end and the hose-protectors at the blowpipe end.(Fig 6)

(Use black hose for oxygen line and maroon hose for acetylene line).

Acetylene connections have left hand threads with a cut on the comers of the nut while oxygen connections have right hand thread without a cut.

Attach one end of the black hose-pipe to the oxygen regulator outlet and the maroon colored hose-pipe to the acetylene regulator outlet. (Fig 7)

Secure the joints using hose-clips to ensure good grip and to avoid gas leakage.

Use a screwdriver to tighten the hose-clips.

Always use the correct size hose-clips. (Fig 8)

Turn on the pressure adjusting screw of the regulator to which the oxygen hose pipe is connected.

Exert sufficient pressure to blow out dust or dirt particles if any are tapped inside the hose-pipe and then release the pressure adjusting screw.

Repeat the same for the acetylene hose also.

Attaching blowpipe (Fig 9)

Fig 5

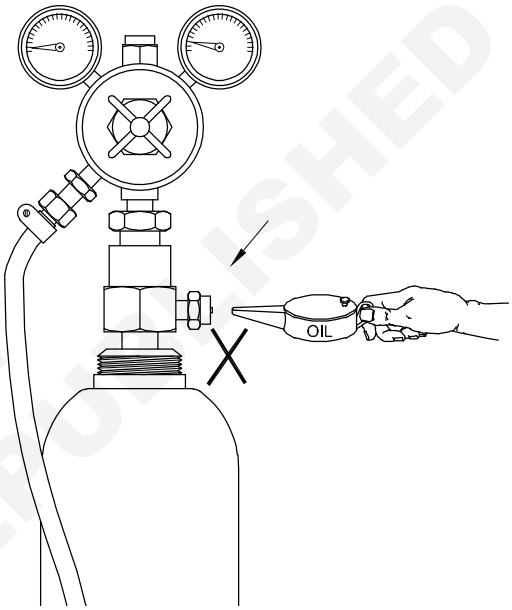

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Fig 6

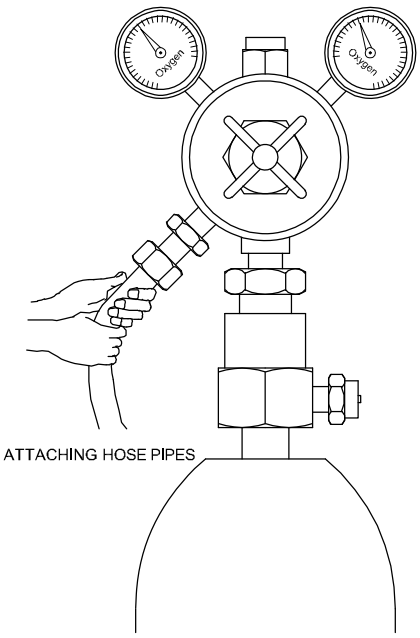

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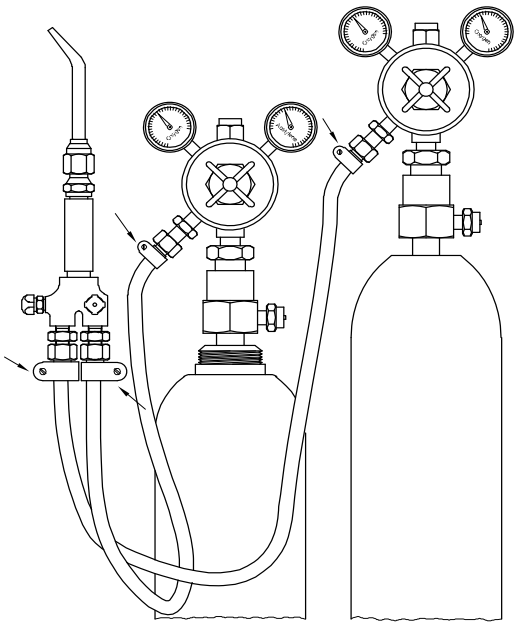
Fig 7



USE HOSE CLIPS BEFORE CONNECTING TO REGULATOR AND BLOW PIPE

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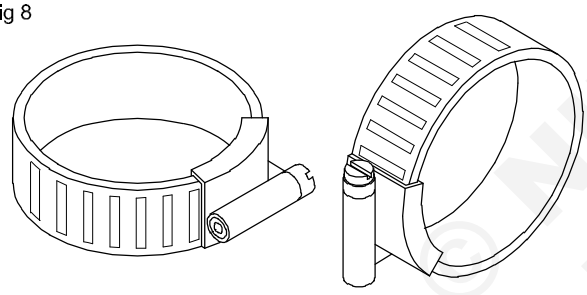
Fig 8



HOSE CLIPS

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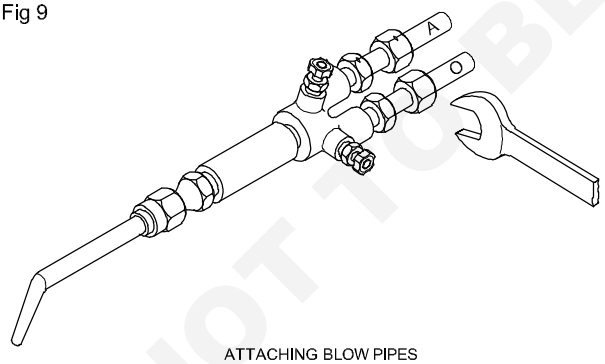
Fig 9



ATTACHING BLOW PIPES

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The other end of the hose-pipe is to be attached to the blowpipe inlets.

Fix the hose-protectors at the blowpipe ends. The hose-protectors with a groove at the corners are fixed on the acetylene hose-pipe and connected to the acetylene inlet of the blowpipe. The hose-protectors without cutting marks are fixed on the oxygen hose-pipe and connected to the oxygen inlet of the blowpipe.

Lighting the flame

Attach the recommended size of nozzle to the neck of the welding blowpipe i.e. nozzle No. 3.

Open the gas cylinders and adjust the recommended gas pressures on the regulators.

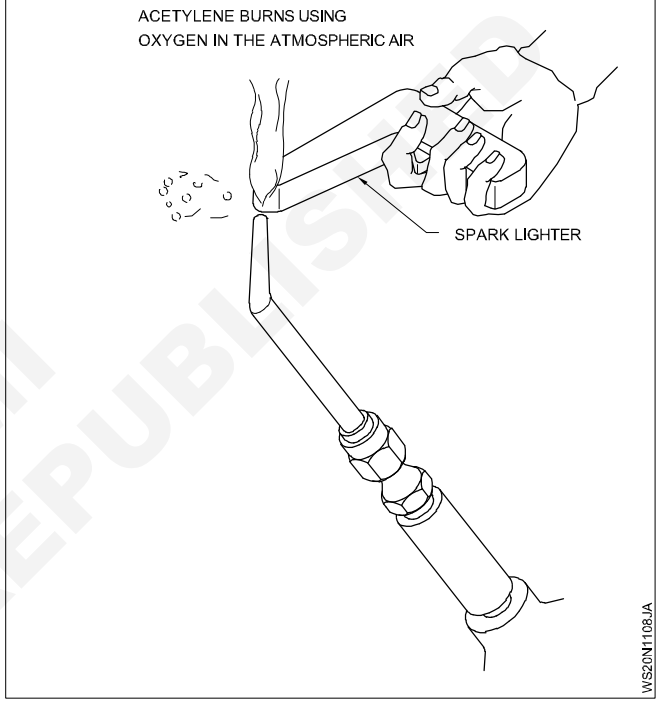
The pressure of oxygen and acetylene is 0.15 kgs/cm^2 for nozzle No. 3.

Open cylinder valves very slowly.

While setting pressure on the regulator, keep the blowpipe control valve open for accurate setting.

Open the acetylene control valve 1/4 turn on the blowpipe and ignite with a spark lighter.(Fig 10) Acetylene burns using the oxygen in the atmospheric air with a black smoke.

Fig 10



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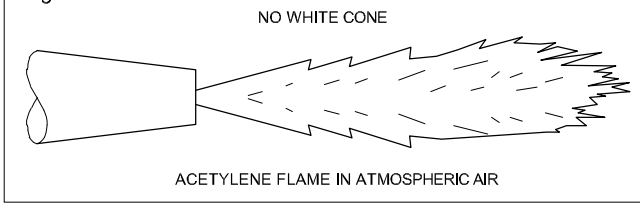
Avoid using any other source of fire other than the spark lighter.

Point the blowpipe in a safe direction in the open space, away from you and others.

Increase the acetylene till the black smoke disappears. (Fig 11)

Fig 11



ACETYLENE FLAME IN ATMOSPHERIC AIR

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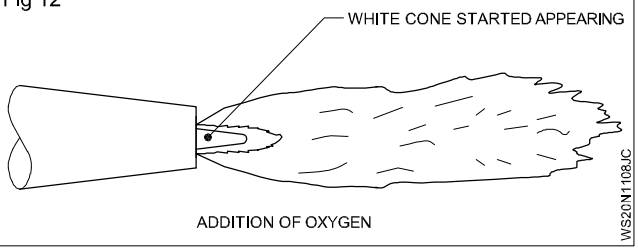
Observe the flame and add oxygen by opening the oxygen control valve of the blowpipe. Now a bright white cone starts appearing at the tip of the nozzle. (Fig 12)

Flame adjusting to set different types of oxy-acetylene flames.

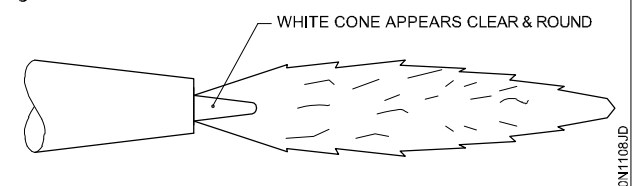
To adjust the neutral flame, add sufficient oxygen to make the white cone clear and round. (Fig 13)

Fig 12



ADDITION OF OXYGEN

Fig 13



NEUTRAL FLAME WITH SUFFICIENT OXYGEN

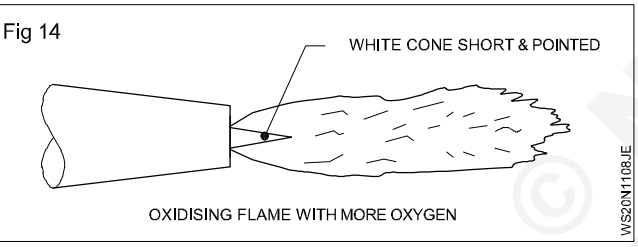
The gas mixture from the blowpipe has equal volume of oxygen and acetylene.

To adjust the oxidizing flame, from neutral flame decrease acetylene flow.

The white cone will become short and sharp.

The flame will produce a hissing sound and will have a short length. (Fig 14)

Fig 14



OXIDISING FLAME WITH MORE OXYGEN

The gas mixture from the blowpipe has more volume of oxygen than acetylene.

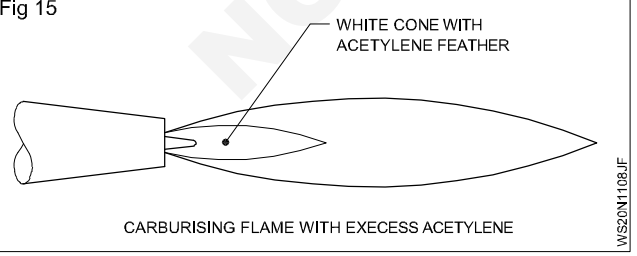
To adjust the carburizing flame, adjust the flame to neutral and then add acetylene.

The white cone will become long surrounded by a feather like portion.

The flame will burn quietly having more length.(Fig 15)

The gas mixture from the blowpipe has more volume of acetylene than oxygen.

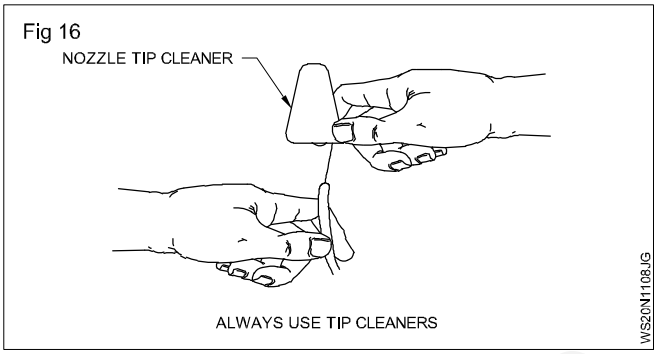
Fig 15



CARBURISING FLAME WITH EXECESS ACETYLENE

After continuous use of the blow pipe during welding the nozzle may get blocked by metal particles or spatters. This blockage has to be removed to get continuous flow of gases by using a nozzle cleaner.(Fig 16)

Fig 16



ALWAYS USE TIP CLEANERS

Repeat the setting of flames till you manage to set the flame without any backfire or flash back.

Extinguishing the flame

To extinguish the flame close the acetylene control valve (blowpipe) first and then the oxygen control valve.

Closing down the plant

At the close of work, shut off the plant in the sequence given below.

Close the acetylene cylinder valve.

Close the oxygen cylinder valve.

Open the blowpipe acetylene valve and release all the gas pressure.

Open the blowpipe oxygen valve and release all the gas pressure.

Both the pressure gauges on the regulators should read zero.

Release the acetylene regulator pressure adjusting screw.

Release the oxygen regulator pressure adjusting screw.

Close the blowpipe acetylene valve.

Close the blowpipe oxygen valve.

Ensure

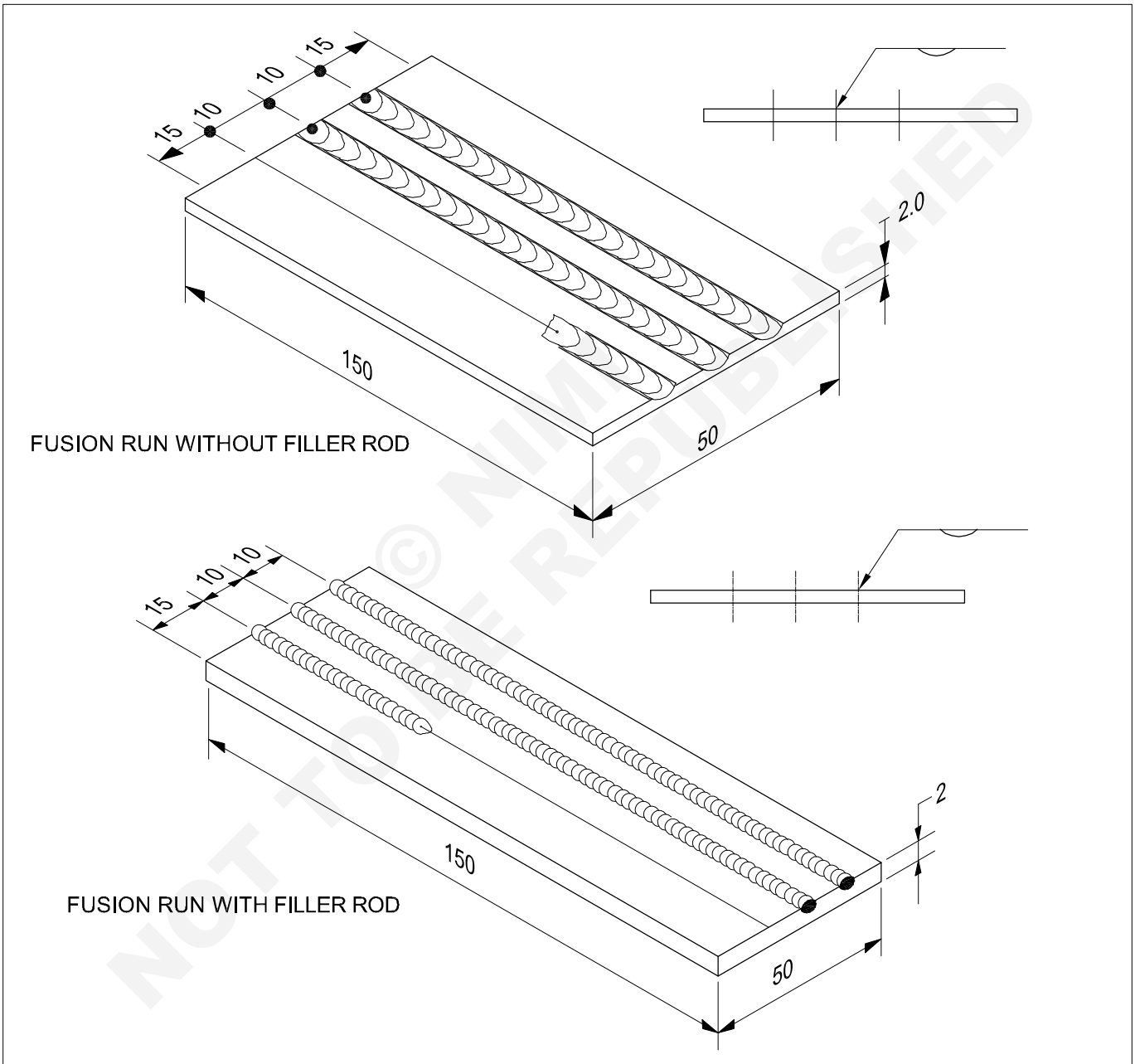
– there is no fire around the equipment

– the gas is completely exhausted by dipping the nozzle in water.

Fusion run without and with filler rod on MS sheet 2mm thick in flat position

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

- **set job for flat position welding**
- **select and fit the correct size nozzle according to the job thickness**
- **set gas pressure according to nozzle size**
- **fusion run with and without the filler rod in flat position using leftward technique**
- **clean the weldment and visually inspect for weld defects.**



2	ISST 150 x 2.0-50	-	Fe310-W	-	-	1.1.09
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS	PERFORM FUSION RUN WITH AND WITHOUT FILLER ROD ON MS SHEET 2mm THICK IN FLAT POSITION (QAW-01)	DEVIATIONS	TIME : 5 hrs
		CODE NO. WS20N1109E1	

Job Sequence

Fusion runs without filler rod in flat position

- Mark and cut the M.S. sheet pieces of size 152 × 122 × 2.5mm using a hand lever shear.

Care should be taken to keep the fingers off from the shearing blades. Wear gloves to avoid injury.

- Straighten the cut pieces by hammering on an anvil.
- File and finish the sheet to dimensions as per drawing.
- Mark and punch parallel lines on the sheet surface as per sketch and set the job piece on the welding table in that position with fire brick support.
- Select and attach nozzle size 5 to the blowpipe.

Wear safety apparels and gas welding goggles.

- Set acetylene and oxygen pressure 0.15 kg/cm^2 on the regulators.
- Ignite the oxy-acetylene gases and adjust the neutral flame.
- Hold the blowpipe on the job at its right hand end at the required angle.
- Start heating the surface on the right end of the sheet with slight circular motion to the blowpipe and produce a molten pool on the marked line.
- Move the blowpipe from right to left direction maintaining a uniform speed and blow pipe angle.
- Avoid excessive concentration of heat at any one point.

If the metal becomes too hot, lift the blowpipe momentarily away from the molten pool.

Do not touch the inner cone with the molten pool, to avoid backfire and flashback.

- Keep the molten pool in correct size by adjusting the rate of travel and giving slight circular motion to the blowpipe.
- Stop at the left end and lift and blowpipe quickly.
- Extinguish the flame and cool the blowpipe in water.
- Clean the fused surface with a steel wire brush and inspect for the uniformity of fusion runs.

If the speed of travel and blowpipe motion are correct, the fusion runs will appear with uniform width and even ripples.

Repeat the above 4 more times to achieve uniform fusion and better manipulation of blow-pipe.

Fusion run with filler rod in flat position

- Select and fix the nozzle size 5 and set acetylene / oxygen pressure 0.15 kg/cm^2.
- Select copper-coated mild steel (CCMS) filler rod of ø1.6 mm.
- Wear safety apparels and gas welding goggles.
- Ignite the oxy-acetylene gases and set the neutral flame.
- Hold the blowpipe on the right hand at an angle of 60° - 70° with the punched line of the job and make a small molten pool at the right hand edge of the line.
- Keep the flame cone distance 2.0 to 3.0 mm above the job surface.
- Hold the filler rod in the left hand, pointing near the molten pool with an angle of 30° - 40° with the line of weld.
- Melt the base metal at the right end of a punched line and create a molten pool/puddle.
- Fuse the end of the filler rod by dipping at the center of the molten pool and add filler metal on the job surface to form a weld bead.
- Move both the blow pipe and the filler rod towards left with uniform speed along the punched line with a slight circular motion to the blowpipe.
- Move the filler rod up and down (piston like motion) at a constant speed.
- Add enough rod into the molten pool to build up the bead evenly in height and width.
- Adjust the rate of travel of the blowpipe with the filler rod to control the size of the bead and the required penetration/depth of fusion.
- Keep the filler rod end within the flame outer flame to avoid oxidation.
- Stop at the left hand end of the punched line by filling the crater properly.
- Extinguish the flame and cool the nozzle.
- Clean the weld surface. Inspect for even ripples and uniform width/height of weld bead.
- Repeat this for the remaining 4 more punched lines to achieve better manipulation of blow pipe and filler rod.

Skill Sequence

Fusion run with and without filler rod

Objective: This shall help you to
- **set and carry out fusion run with and without filler rod.**

The beginner for gas welding must practice:

– holding the blowpipe in the correct position

– fusing of the metal by using a proper blow pipe manipulation

– getting proper coordination of both hands to manipulate the blow pipe and filler rod together

– deposit fusion run in a straight line from the right end to the left end of the job.

Preparation of sheet for welding

Use gloves while handling sheets.

Shear the MS strip to get job pieces 152 mm long × 122 mm wide × 2.5 mm thick.

2 mm is the shearing allowance so that the finished size after filling will be 150 × 120mm.

Remove buckling of sheet due to shearing by hammer on the anvil.

File the irregular edges of the job to remove burrs and unevenness on the edge to get a sheet size of 150 × 120mm.

Cleaning and setting job piece

Remove rust if any using a wire brush and emery paper.

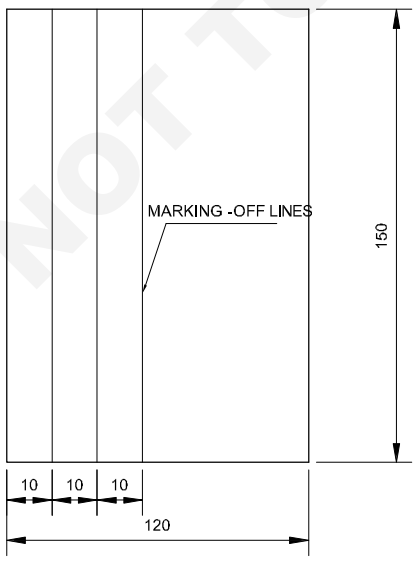
Do not rub with heavy pressure on the wire brush.

Use the emery paper rolled on a piece of wood while cleaning.

Remove paint, oil or grease by dipping the M.S. sheet in a solvent of dilute hydrochloric acid.

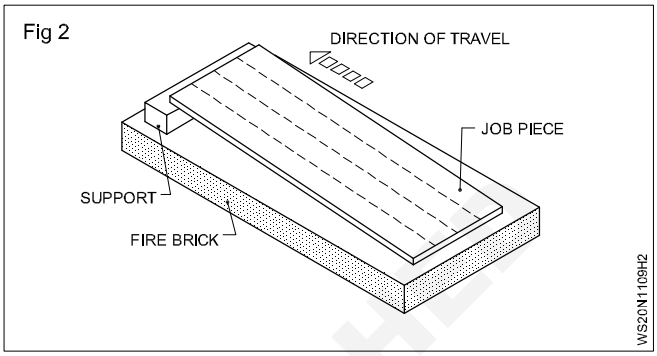
Draw lines parallel to the longer edge of the sheet at 10mm from one edge and punch along the lines to serve as a guide. (Fig 1)

Fig 1



Keep the job on the work table on a fire brick (Fig 2) to reduce the heat conduction and to position the job flat.

Fig 2



Use welding goggles.

Hold the blowpipe and flame in correct position (angle) for proper fusion.

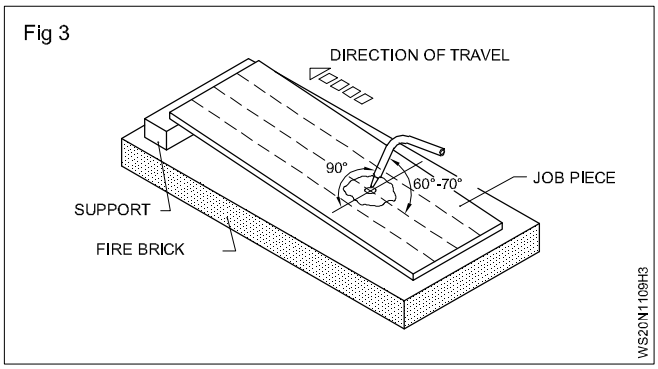
Position the blowpipe in such a way that:

– the punched lines of the sheet is parallel to the operator

– there is less fatigue to the hand of the operator

– the angle of the nozzle with the welding line is between 60° - 70°. The angle between the nozzle and the job surface should be 90°.(Fig 3)

Fig 3



Fuse the metal to form a small puddle of molten pool on the job surface at the right end.

Making fusion run without filler rod

Move the blowpipe in the leftward direction as location fusion is obtained at the right end of a line.

Keep the molten pool on the punch line.(Fig 4)

Maintain constant speed of travel with slight circular motion to the blowpipe. (Fig 5)

Fig 4

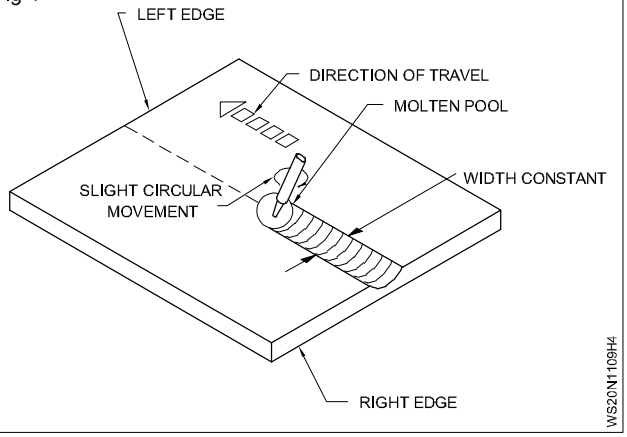
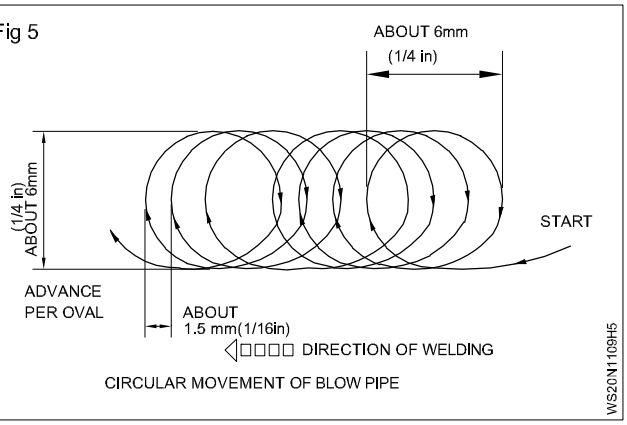


Fig 5



Reduce the blowpipe angle slightly near the left edge and slowly withdraw the flame to avoid burn through at the end.

Maintain a constant distance of 2-3mm between the white cone of the flame and the sheet surface for proper heat input and to avoid backfire.

Making fusion run with filler rod: During gas welding, most of the joints require filler metal to obtain proper size of weld and to get a strong joint. So while the flame melts the base metal, it also melts the filler rod to fill the groove or depression in the joint.

The feeding of filler metal in molten pool requires special skills.

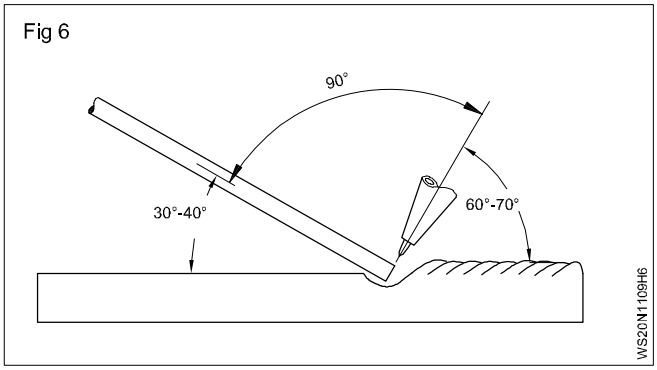
The heat input by the flame depends on the volume of acetylene and oxygen gas burnt. Different size nozzles will give different volume of gases and heat required to melt the metal depends on the thickness of metal to be welded. So select nozzles based on thickness of base metal to be welded.

For 3.0mm thick MS sheet select No. 5 nozzle and fix it to the blow pipe.

Blowpipe angle 60° - 70° with weld line (towards right). Filler rod angle 30°- 40° with weld line (towards left).(Fig 6)

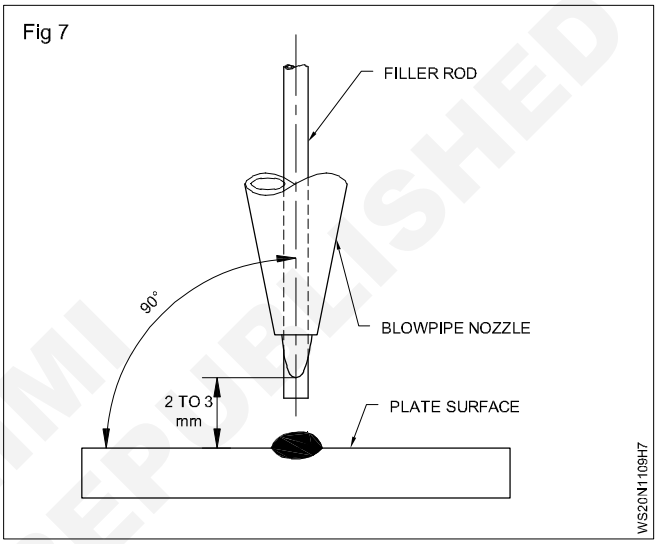
This angle helps in moving the molten puddle along the line of weld and keeps the unwanted materials like scale, any dirt, etc. away from the molten pool. This also controls the depth of fusion (penetration) to the required extent. In addition the visibility of the melting region is better.

Fig 6



Keep the blowpipe and filler rod at 90° to the plate surface, so that the metal melts equally on both sides of the inner cone of the flame. (Fig 7)

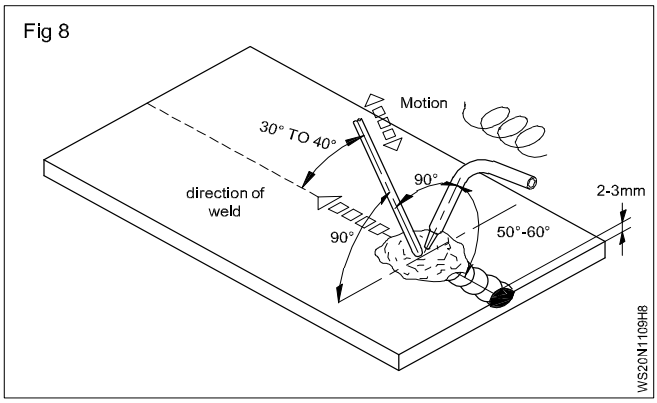
Fig 7



Fuse the metal surface, maintain the molten pool and add filler metal with proper motion.

For the blowpipe, a slight circular motion is required and for the filler rod, a piston like motion(Fig 8) (up and down) is required.

Fig 8

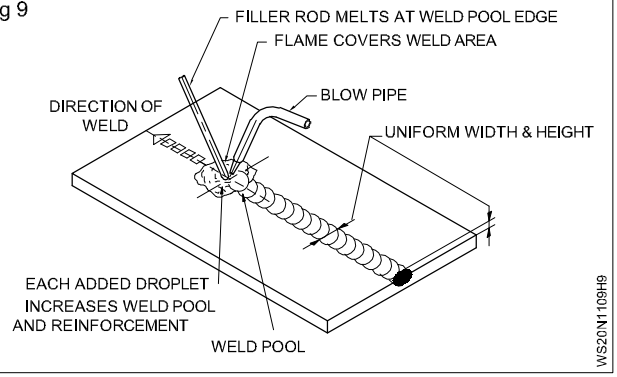


Maintain the flame cone distance to metal surface 2-3 mm.

Move the blowpipe and filler rod in leftward direction, along the punch-marked straight line, to progress the weld. (Fig 9)

Add filler rod in the weld pool to get 0.5 to 1 mm weld reinforcement above the sheet surface.

Fig 9



Maintain constant speed, angles and motion during welding for the blowpipe and the filler rod.

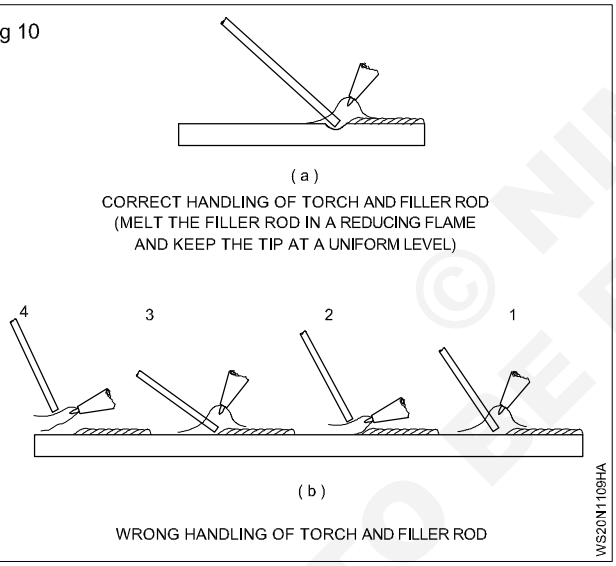
Keep the end of the filler rod within the outer envelope of the flame to avoid its oxidation.

Restarting and stopping of weld

Restarting

Hold the blowpipe nozzle at 80° angle with the cone pointing on the last 3 mm of weld bead deposited i.e. the crater. (Fig 10)

Fig 10



Re-melt the weld bead at crater to form a molten pool, add filler rod and proceed with the deposition.

STOPPING

Reduce the angle of the blowpipe and filler rod as the weld pool reaches the left end to control burn through.

Build up the crater by adding enough filler metal, by dropping a few drops of molten metal at the crater.

Remove the flame slowly but cover the weld pool with the end of the flame's outer envelope to protect it from atmosphere.

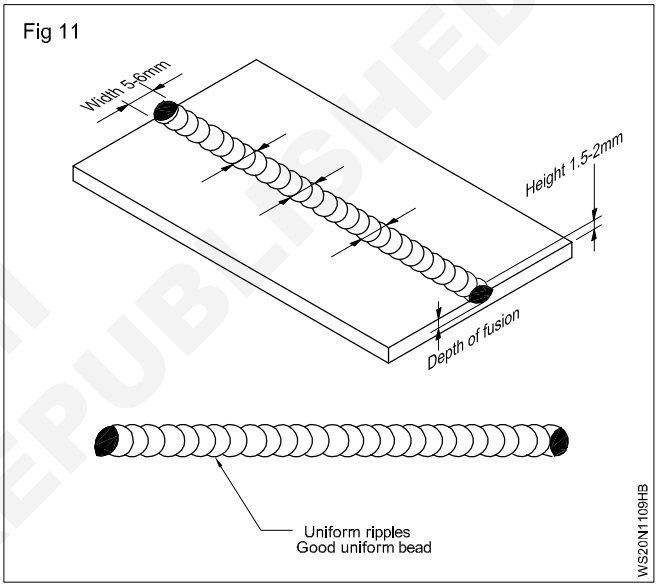
Remove the filler rod end from the weld zone before the weld pool solidifies.

Inspection of the deposited run (Fig 11)

Look for the following on the deposited bead.

Depression at various points on the bead. (This is due to variation in speed of travel of the blowpipe; improper feeding of the filler rod; wrong restarting; splashing of molten pool due to inner cone of flame touching the molten metal.)

Fig 11



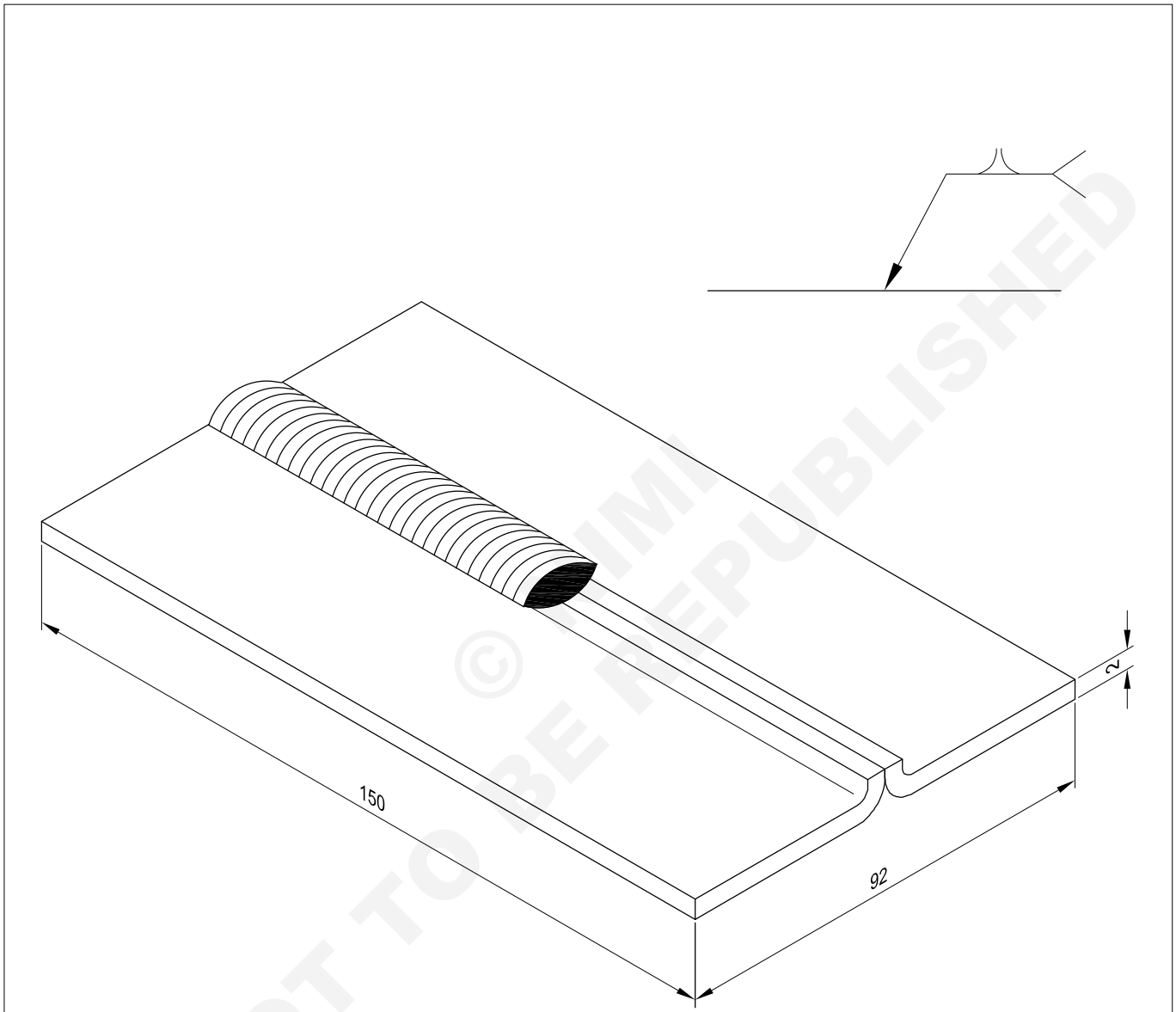
Undercut at the toes of the bead. (This is due to excessive pressure of gases and setting harsh flame; improper manipulation of the blowpipe; improper feeding of the filler rod.)

Concave bead surface. (This is due to harsh flame and excessive pressure of gases; inadequate feed of filler rod.

Porosity. (This is due to improper cleaning of the sheets; rusted filler rod.)

Edge joint on MS sheet 2mm thick in flat position without filler rod

Objectives: At the end of this exercise you shall be able to
- **prepare the job to the given size as per drawing**



2	ISST 50 x 2 - 150		Fe 310 - W			1.1.10
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**EDGE JOINT ON M.S.SHEET 2mm IN FLAT POSITION WITHOUT FILLER ROD**				TOLERANCE ±1	TIME 7Hrs
					CODE NO. WS20N1110E1	

Job Sequence

- Prepare the job pieces as per drawing.
- File the edges of square and ensure through cleaning of the edges.
- Bend the edges of the plates to be joined at 90° to the surface.

The length of the bent portion should be twice of the thickness of the plate.

- Set the gas welding plant, fix nozzle No. 7 and set the gas pressure of 0.15 kg/cm^2 for both gases.
- Select CCMS filler rod 3mm ø for tacking and welding. (If necessary)
- Set neutral flame.
- Clean the tacks and set the job on the welding table in a flat position, over fire brick supports.
- Start the weld at right end of the job.
- Keep the blowpipe at 60° - 70°.
- Fuse the edges uniformly and proceed towards left.

Fuse the bent edges up to the entire surface of the plate.

- Stop at the left end, fill the crater and complete the weld.
- Extinguish the flame, cool the nozzle in water.
- Clean the welded joint and inspect for

– Uniform width and height of bead.

– Uniform ripples.

Skill Sequence

Edge joining on MS plate

Objective: This shall help you to
• join the edge of the MS plate.

Preparation: Prepare the job pieces of size 150×5×2mm by shearing and then filing.

Setting and bending:

Bend the edges of the plates.

Set the prepared job pieces on the welding table and tack at both ends.

Length of the tack weld is 6 mm approximately.

Check the alignment after tacking.

Welding

Start the weld at the right end of the joint.

Use leftward technique.

Maintain uniform travel speed and feed to the flame.

Clean the deposited bead using wire brush.

Use all the safety apparels and gas welding goggles.

Inspection

Inspect the quality of weld by

– Checking the finish of the job.

– Checking the uniformity of width and height of the weld bead in size.

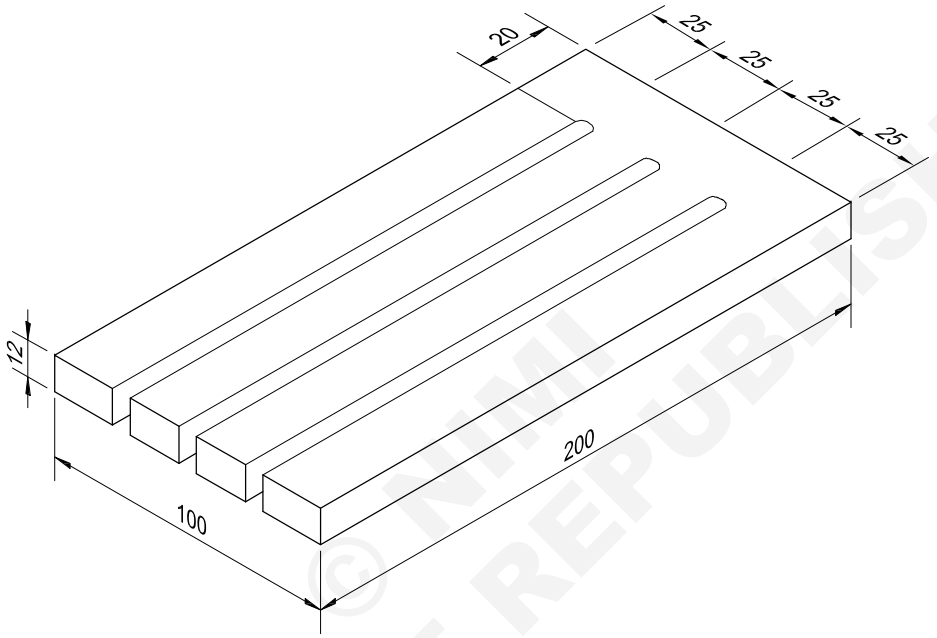
– Checking the uniformity of ripples, fusion and complete penetration.

– Checking that the weld is free from faults such as porosity, undercut, lack of fusion etc.

Marking and straight line cutting of MS plate 10mm thick by gas

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.**



01	100 ISF 10-200	-	Fe310-W	-	-	1.1.11
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:2	**PERFORM MARKING AND STRAIGHT LINE CUTTING OF M.S. PLATE 10mmTHICKNESS BY GAS ACCURACY WITH IN ±2mm (OAGC-02)**				DEVIATIONS	TIME 7Hrs
					CODE NO. WS20N1111E1	

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)

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.

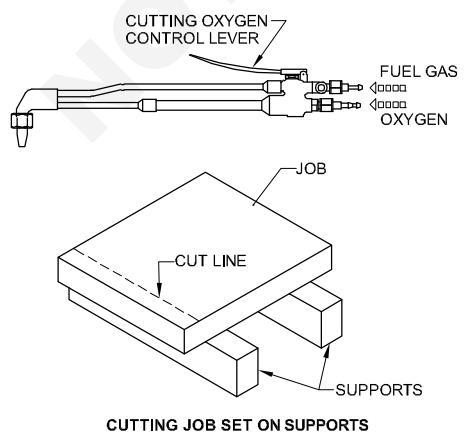
Skill Sequence

Gas cutting

Objectives: This shall help you 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.

Fig 1



CUTTING JOB SET ON SUPPORTS

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.

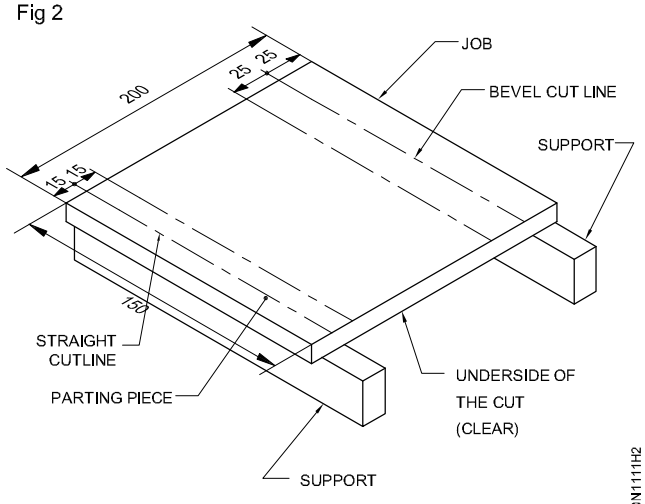
Ensure that the underside of the cutting line is clear and no combustible materials are lying nearby.

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

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/cm^2 for all thickness of plates.

Fig 2



CUTTING JOB SET ON SUPPORTS

TABLE 1

Data for cutting

Diameter of cutting oxygen orifice nozzle	Thickness of steel plate	Cutting oxygen Pressure
(1) mm	(2) mm	(3) kg/cm^2
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

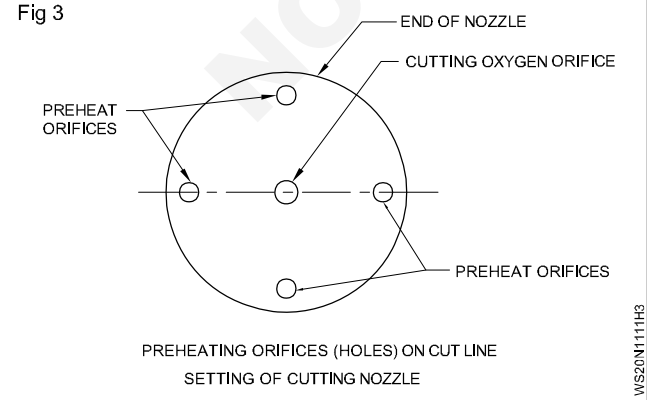
Select ø 1.2 mm (orifice) cutting nozzle for cutting a 10mm thick plate.

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)

Fig 3

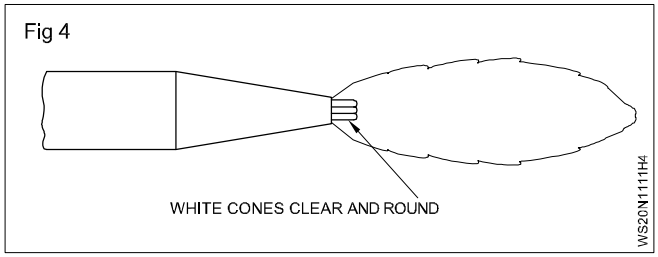


PREHEATING ORIFICES (HOLES) ON CUT LINE
SETTING OF CUTTING NOZZLE

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

Adjust the neutral flame for preheating. (Fig 4)

Fig 4



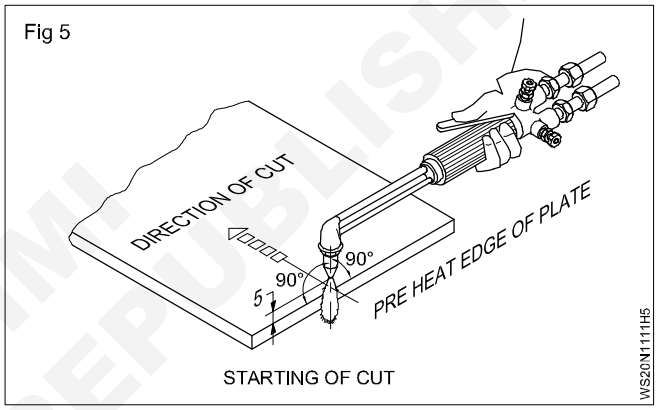
Ensure that the flame adjustment is not disturbed while operating the cutting oxygen lever.

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)

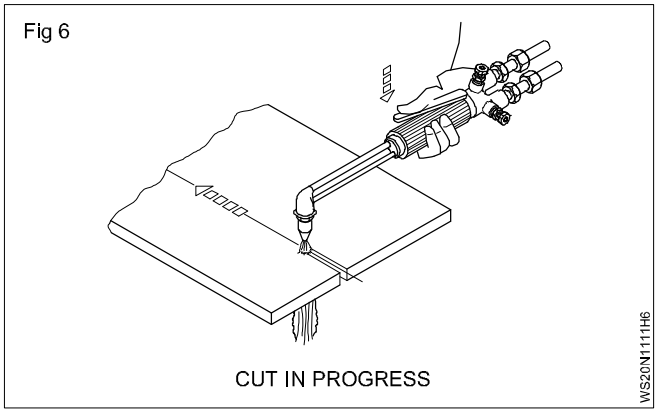
Fig 5



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)

Fig 6



CUT IN PROGRESS

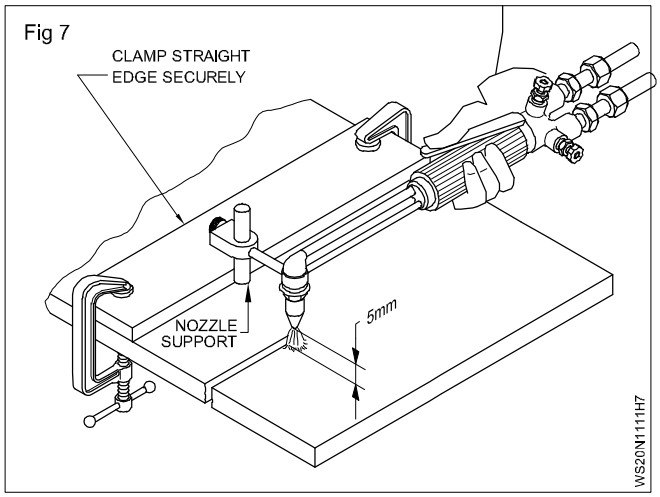
Ensure straight travel without any side-to-side movement.

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)

Fig 7



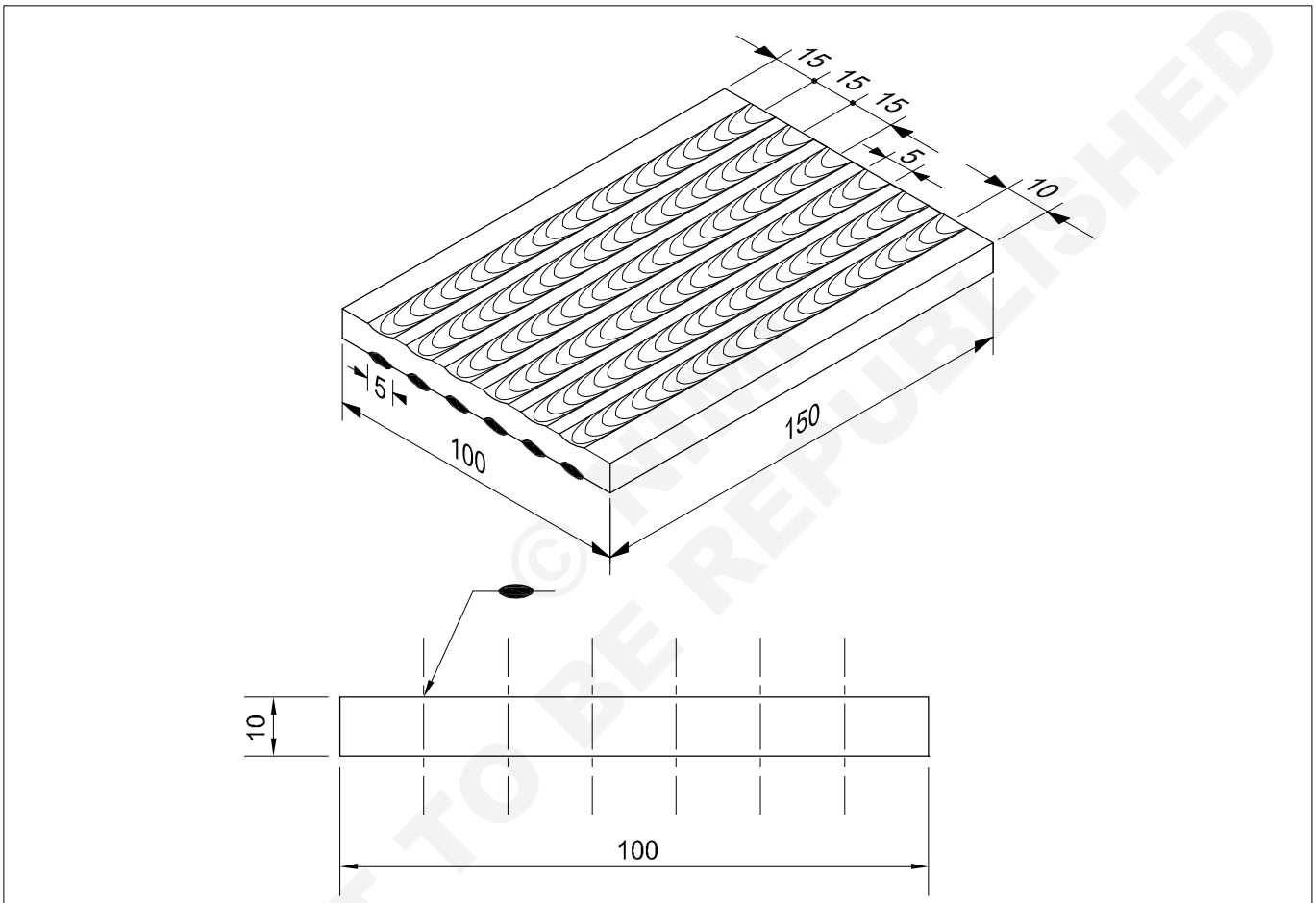
Inspect the cutting for

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

Straight line beads on MS plate 10mm thick in flat position

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

- **prepare and set job pieces for straight line beading**
- **select the electrode, current and polarity for depositing the weld beads**
- **deposit uniform straight bead in flat position by arc welding**
- **maintain constant arc length, electrode angle and travel speed**
- **restart a broken arc and fill the crater properly**
- **remove and clean the slag and spatter from the weld bead using a chipping hammer and wire brush**
- **inspect deposited beads for any surface defects.**



1	100 ISF 10 - 150		Fe 310 - W			1.1.12
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	STRAIGHT LINE BEADS ON M.S.PLATE 10mm THICK IN FLAT POSITION				TOLERANCE ±1	TIME 5 Hrs
					CODE NO. WS20N1112E1	

Job Sequence

- Prepare the plates to size (as per drawing) by Hacksaw cutting and grinding.
- Clean the plate surface (job) with a stainless steel wire brush and remove the burrs by filing.
- Lay out parallel lines on both sides of the job surface as per sketch and mark with a center punch.
- Set the plate on the welding table in a flat position.
- Ensure the plate is contacting well with the welding table and the earth clamp is not loosely connected with the work table.
- Wear protective clothing (safety apparels).
- Use welding goggles.
- Ensure the filter glass of the welding shield is in good condition.
- Fix a 4 mm ø M.S. electrode in the holder.
- Set the welding current to 150 to 160 amps approximately.
- Connect the electrode cable with the transformer welding machine. In case of a DC welding generator or rectifier, connect it to the negative terminal.
- Connect the earth clamp on the right extreme end of the job/work table.
- Start the welding machine.
- Strike the arc on a scrap piece for trial and observe the current setting.
- Ensure the burning of the electrode is normal and the arc is smooth.
- Re-adjust the welding current if necessary.
- Use a short arc.
- Deposit straight line beads on the work piece along the punched line from the left hand end to the other end.
- Hold the electrode at 70° to 80° to the line of weld. Move it along the line of weld and towards the job at uniform speed.
- Restart the bead whenever the arc is broken and ensure to fill the crater.
- Fill the crater at the end of the bead without fail.
- Remove slag from the weld bead using a chipping hammer and clean with steel wire brush.
- Use a chipping screen while Deslagging.
- Inspect deposited beads for:
  - uniform width and height
  - straightness
  - uniform ripples
  - slag inclusion
  - unfilled crater
  - porosity
  - undercut
- Repeat the exercise on the other side of the plate.

Skill Sequence

Straight line bead on MS plate in flat position

Objective: This shall help you to
- **set and weld the straight line beads on MS plate in flat position.**

Prepare a M.S. plate piece 100×150×10 using a hacksaw and file.

Mark straight line, punch the line keeping 15mm distance in between. (Fig 1)

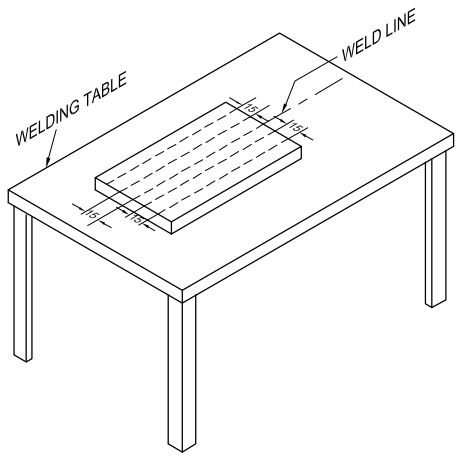
Set the job on the welding table in a flat position with the punched surface facing up. (Fig 1)

The bottom surface of the job should be perfectly clean to get good electrical contact between the job and the welding table.

Always follow the current range according to the diameter of the electrode, as given in the electrode packet by the electrode manufacturer.

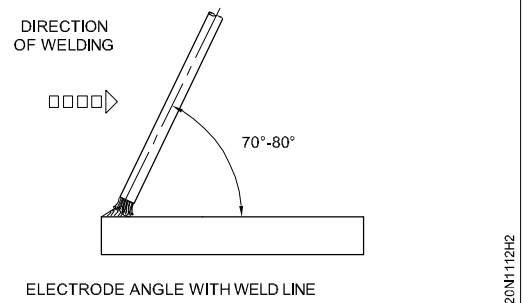
Check for proper melting of the job and electrode on a scrap metal piece.

Fig 1



Hold the electrode at an angle of 70° to 80° with weld line/ punched line. (Fig 2)

Fig 2



When a DC welding machine is used connecting the earth cable at the right end of the job or work table will help to deposit the weld metal at the correct place in the joint.

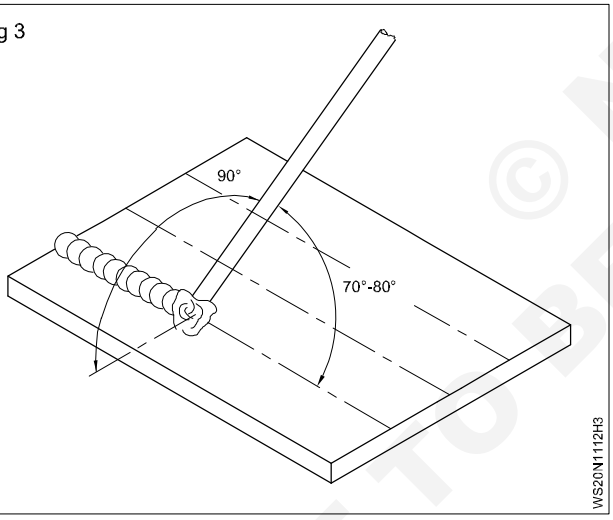
Deposit straight line beads taking the punched lines as a guide maintaining:

– the medium arc length (L) (i.e. equal to dia. of electrode used (d). If a DC welding machine is used then use of a short arc length will help to reduce the deviation of the molten metal from its intended path.

– correct travel speed (approximately 150 mm per minute)

– correct electrode position/angles. (Fig 2 and 3)

Fig 3



The electrode should be moved towards the job to maintain a gap between the tip of the electrode and the molten pool. (Fig 4)

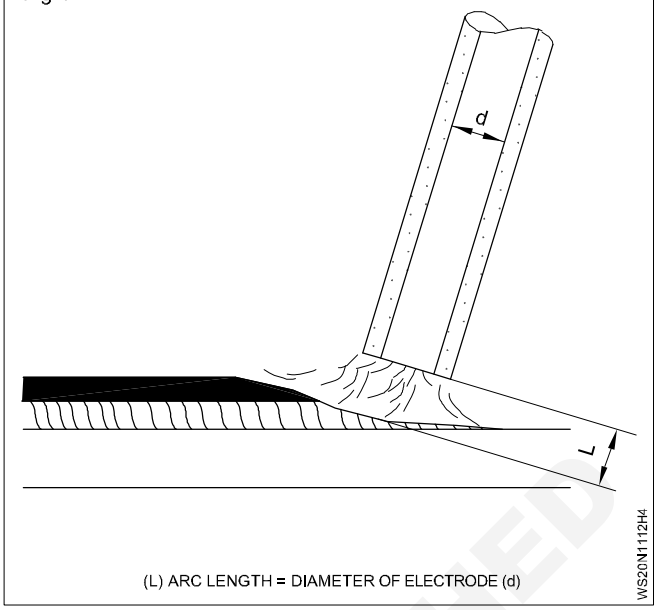
Welding screen glasses should be clean enough to see the arc action on the molten pool and punched line mark.

Listen to the arc's steady sharp crackling sound while welding. It indicates uniform burning of the electrode.

Adjust the travel speed by watching the electrode melting rate and flowing through the molten pool to form the deposited metal. The uniform travel speed of the electrode along and towards the line of the weld gives a uniform bead.

Whenever the arc is broken a depression called crater is formed at the breaking point and this crater has to be filled

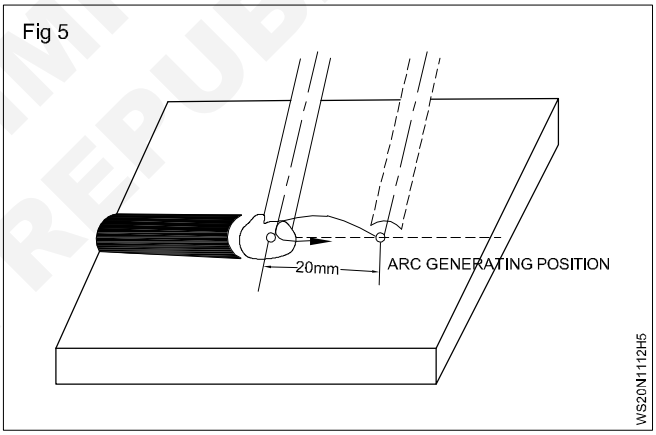
Fig 4



first while restarting the arc. So clean the crater and generate an arc at about 20mm ahead of the crater and return to the crater at a faster rate.

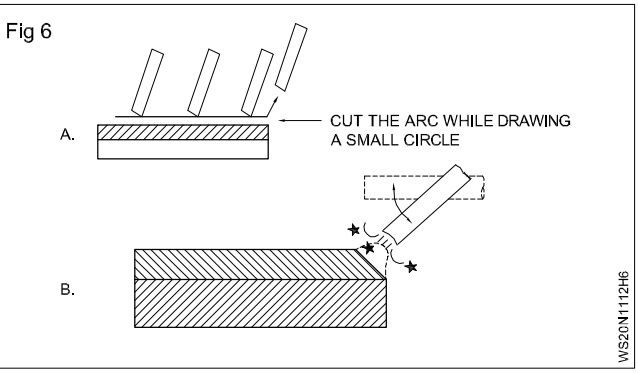
Build the deposit so that it fills the crater, then move the electrode ahead. (Fig 5)

Fig 5



Also after completion of each bead fill the crater as follows. (Fig 6)

Fig 6



Build the deposit on the crater so that it is the same level as the welding bead.

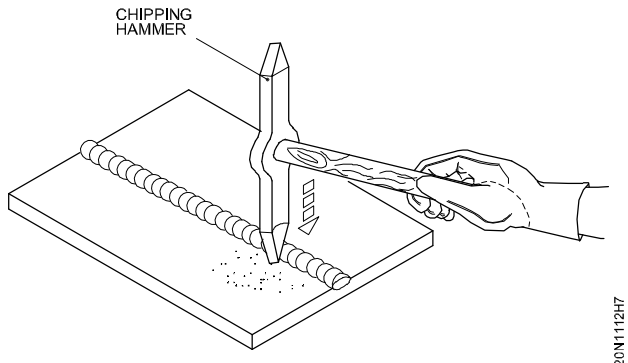
– Let the arc length be shorter at the end of the run and draw a small circle 2 to 3 times.

– Repeat Off and On the arc at the end.

Fill the crater.

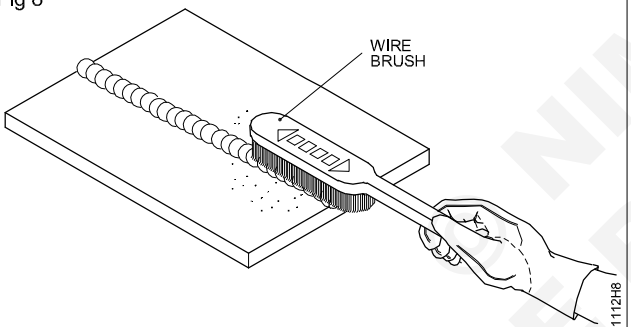
Remove the slag and spatters from the weldment using a chipping hammer and wire brush, so that the metal surface of the bead is exposed for checking for any defects. (Figs 7 and 8)

Fig 7



CHIP OFF THE SLAG

Fig 8



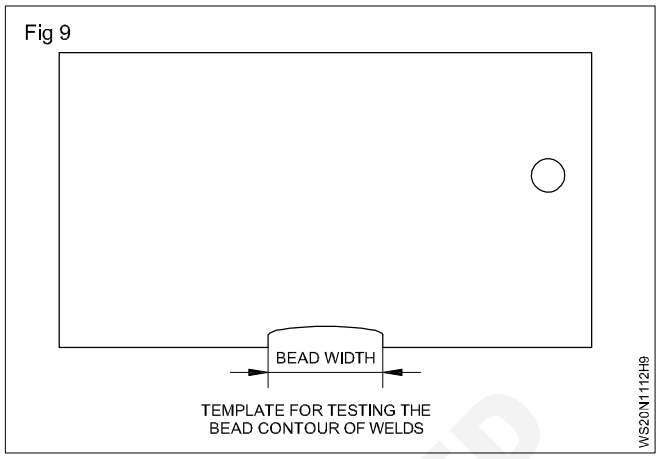
REMOVE ALL SLAG AND SPATTER

Determine the causes for the above weld defects and use the remedial/prevention methods in further deposits.

Check the deposited beads and note any variation in the:

– width and height using a template (Fig 9)

Fig 9

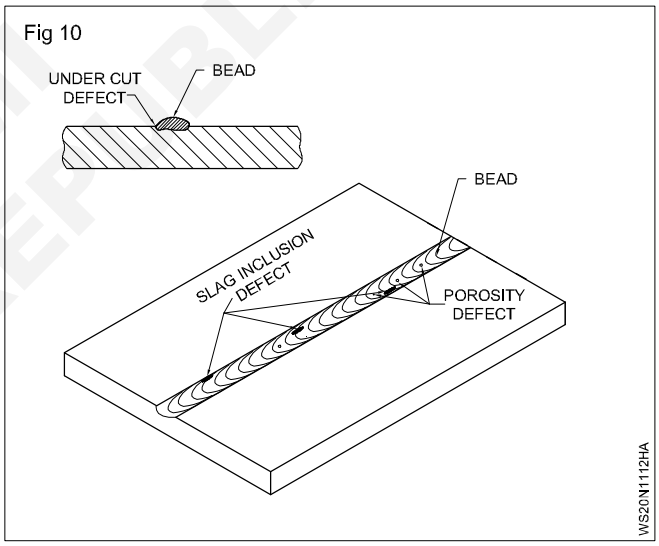


– depth of fusion

– straightness of the run

– check for surface defects such as slag inclusion, surface porosity, undercut, improper bead profile etc. (Fig 10)

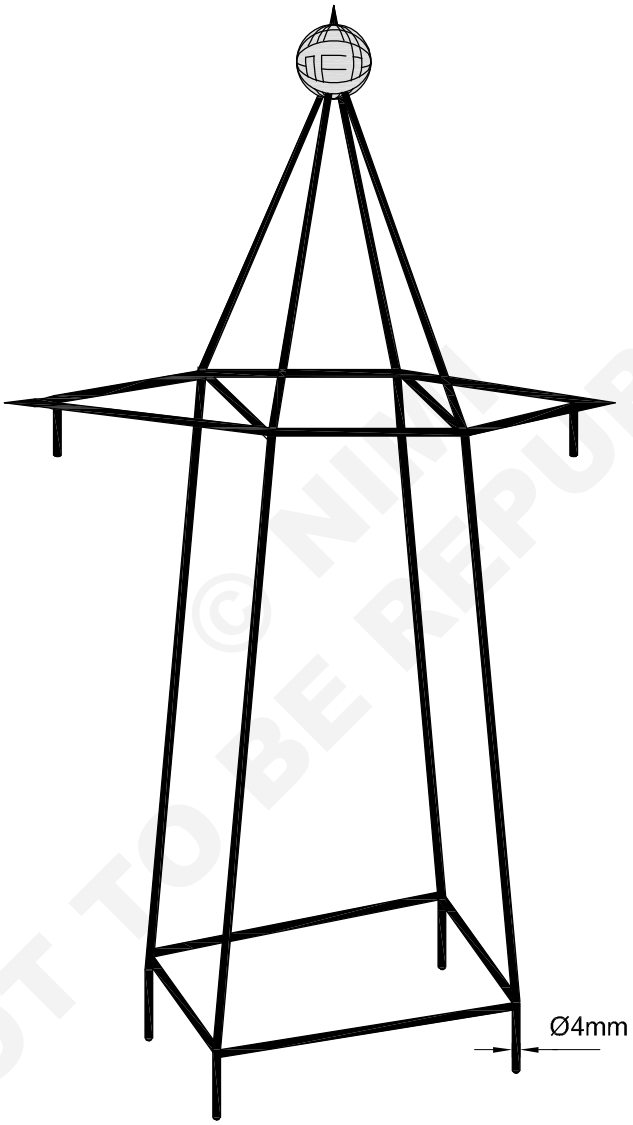
Fig 10



Small protype of power transmission tower (skelton) fabrication from MS rod of 4mm

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

- **preparing and setting up job (or) work piece make the transformation tower**
- **selection of electrode current and polarity for welding**
- **examine for defects.**



1	Ø4mm M.S ROD AS REQUIRED		Fe 310 - W			1.1.13
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	SMALL PROTOTYPE OF POWER TRANSMISSION (SKELETON)				TOLERANCE ±1	TIME 5 Hrs
					CODE NO. WS20N1113E1	

Job Sequence

- Cut the M.S rod with hack saw frame and take the requiered size
- connect the electrode cable with the transformer welding machine. Connect the earth clamp on the right extreame end the job / work table.
- Wear protective clothing.
- careful assembly of the welding machine and it's accessories.
- Fix 2.5mm m.s Electrode in the holder
- Set the welding current to 60-90 Amps Approxmately

Skill sequence

Small protype of power transmission tower (skelton) fabrication from MS rod of 4mm

Objectives: At the end of this exercise you shall be able to
- **preparing and setting up job (or) work piece make the transformation tower.**
- **selection of electrode current and polarity for welding**
- **examine for defects.**

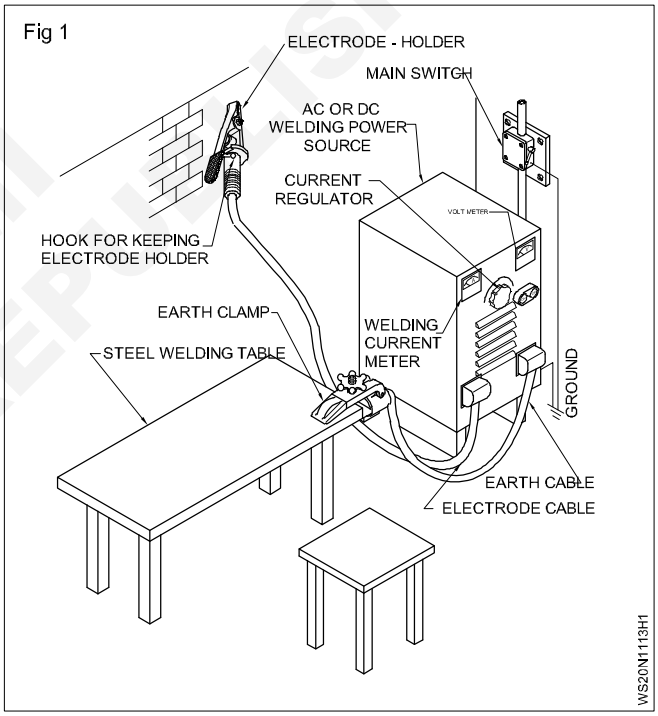
Set the prepared work job on the work plate form as shown in Figure.

Then do the tag welding at the workpeice juction using the electrode.

Place the tag weld in the correct position at regular intevals.

Finish welding and inspect defects.

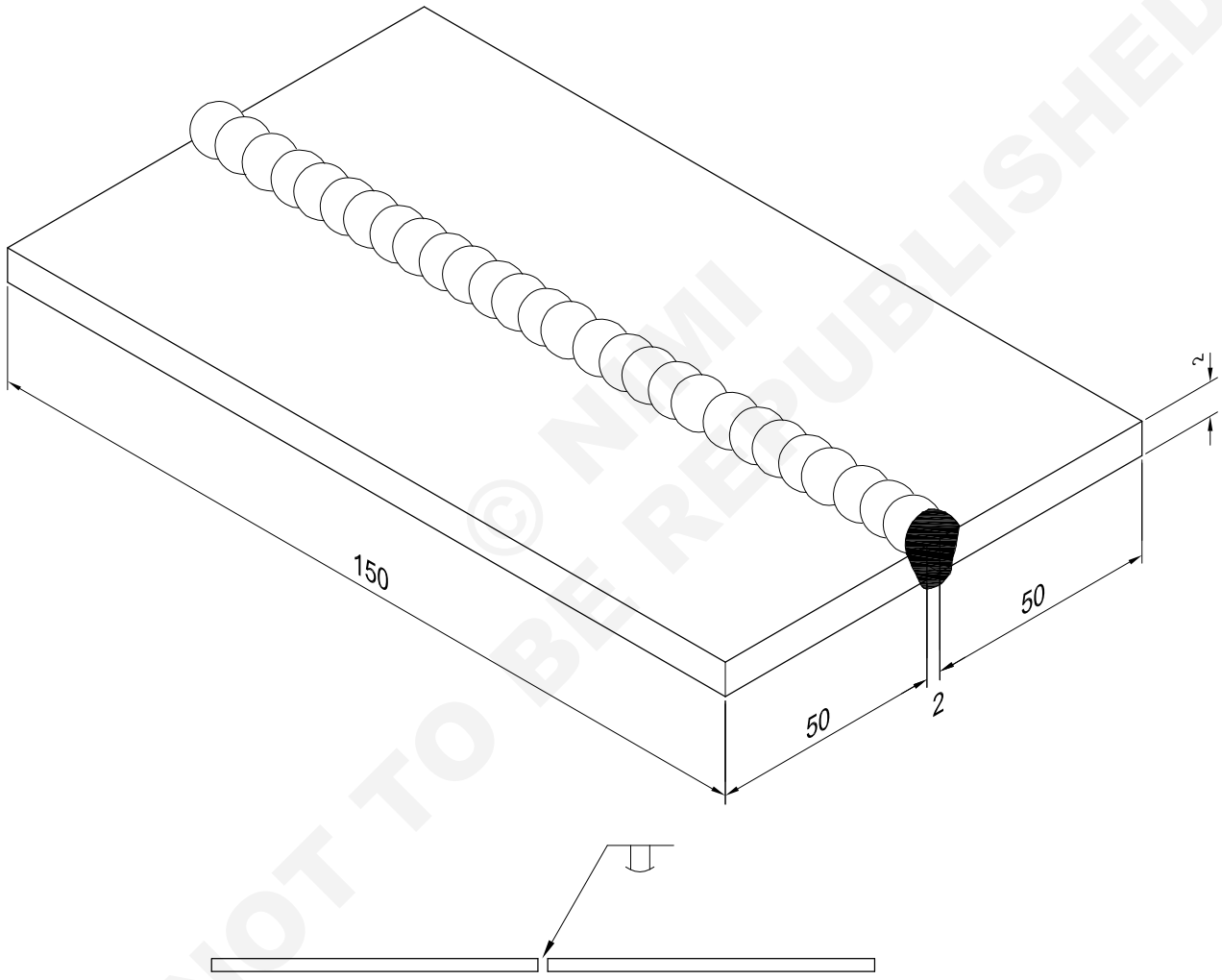
Fig 1



Square butt joint on MS sheet 2 mm thick in flat position

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.**



2	ISST 100 x 2 - 150		Fe 310 - W			1.1.14
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	BUTT WELD - SQUARE BUTT JOINT ON M.S SHEET 2mm IN FLAT POSITION (1G)				TOLERANCE ±1	TIME 5 Hrs
					CODE NO. WS20N1114E1	

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/cm^2 for both gases.
- Select C.C.M.S. filler rod 3 mm ø for tacking and welding.

Wear safety apparels and gas welding goggles.

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

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.

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

Objective: This shall help you 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.

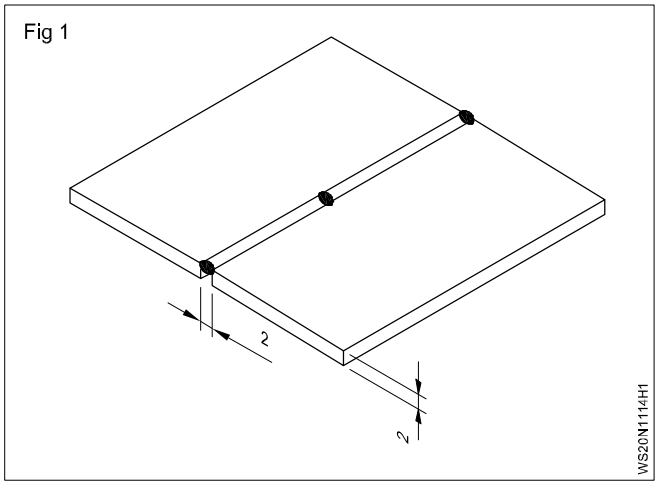
Tack-weld the joint at equal intervals to hold them together, maintaining the alignment. (Fig 1)

Ensure that the

– distance between the tack-welds is 75 mm.

– length of the tack-weld is 6 mm.

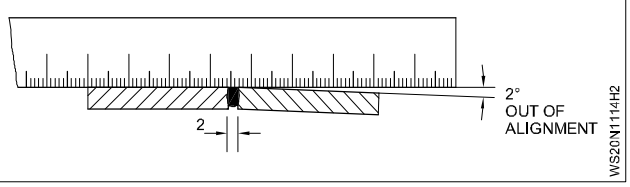
Fig 1



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

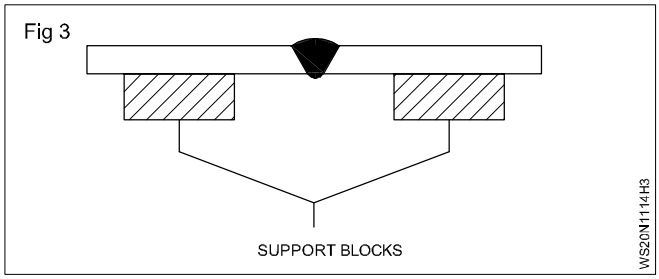
Check the alignment after tacking, and reset, if the sheets are out of alignment. (Fig 2)

Fig 2



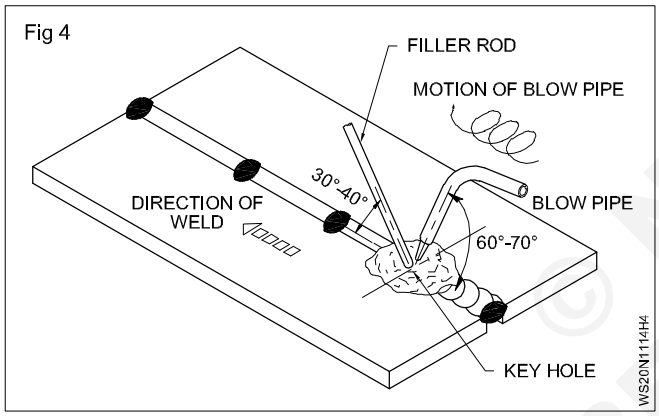
Welding: Keep free space under the joint for complete penetration. (Fig 3)

Fig 3



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

Fig 4



Weld a well fused uniform bead with complete penetration using leftward technique.

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.

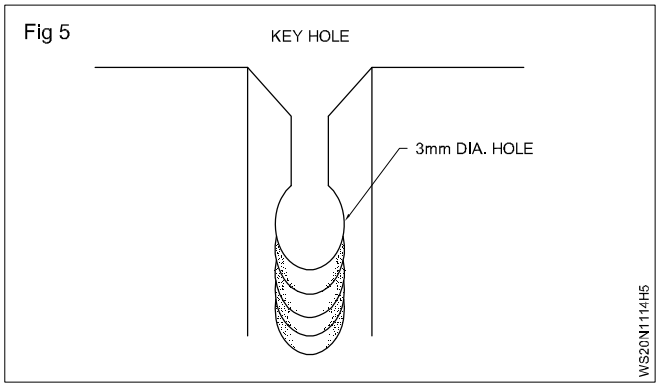
Maintain a keyhole which is a clear indication that the melting is taking place up to the bottom of the root of the joint ensuring better root penetration. (Fig 5)

Clean the deposited bead using wire brush.

Inspect the quality of weld by:

– checking the finish of the job

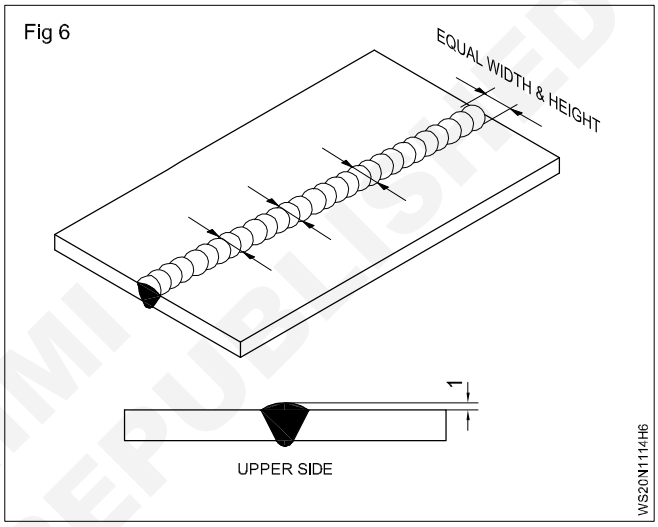
Fig 5



– checking the alignment (remove distortion if required)

– checking the uniformity of width and height of the weld bead in size (Fig 6)

Fig 6



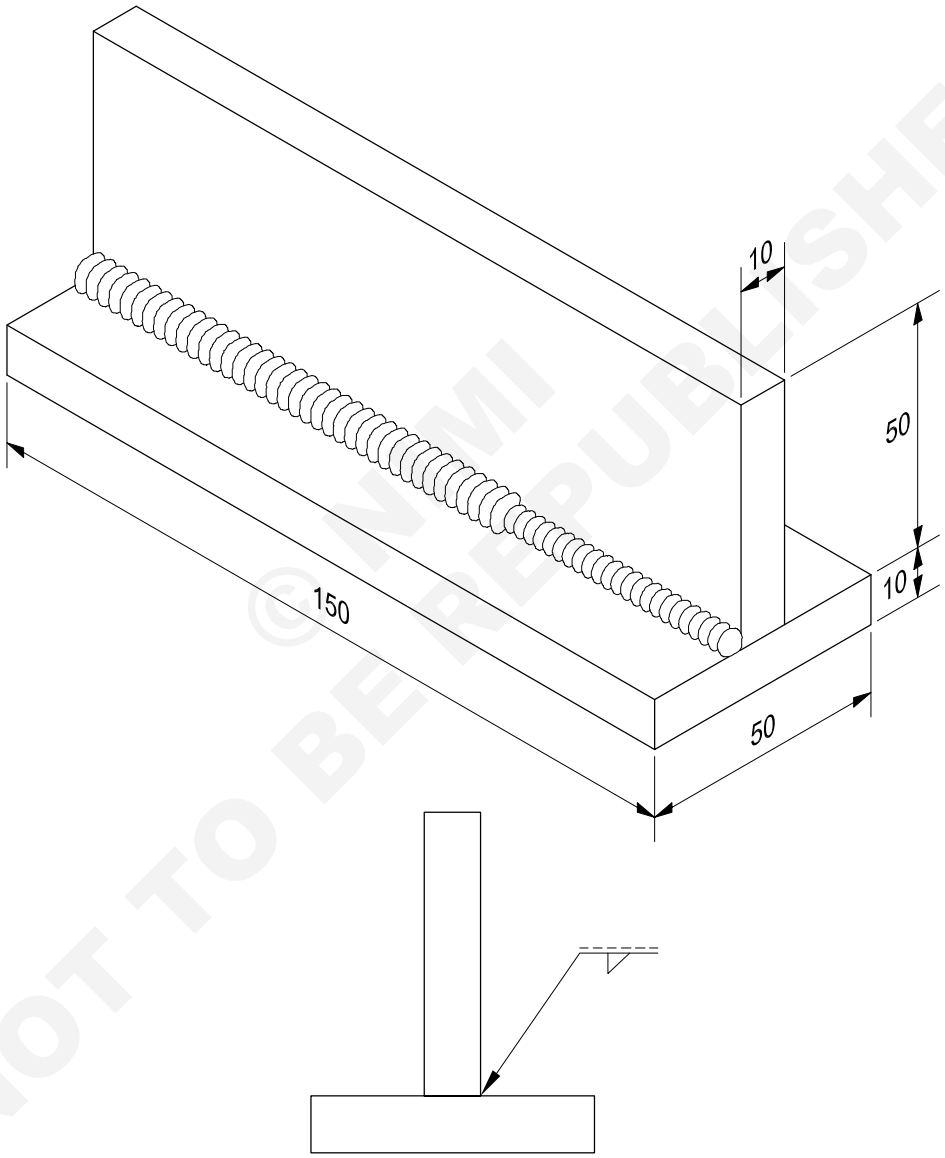
– checking the uniformity of the ripples, fusion and complete penetration (Fig 7)

– checking that the weld is free from faults such as porosity, undercut, lack of fusion, unfilled crater etc.

Fillet “T” joint on MS plate 10mm thick in flat position (1F)

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

- **set and tack plate pieces in alignment as tee joint and by keeping distortion allowance**
- **set the ‘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.**

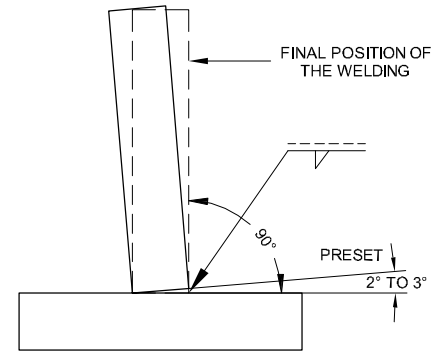


2	50 ISF 10 - 150	-	Fe 310 - W	-	-	1.1.15
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**FILLET "T" JOINT ON M.S PLATE 10mm THICK IN FLAT POSITION.(1F) - (SMAW-04)**				TOLERANCE ±1	TIME 10Hrs
					CODE NO. WS20N1115E1	

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°.
- 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.

Fig 1



- 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

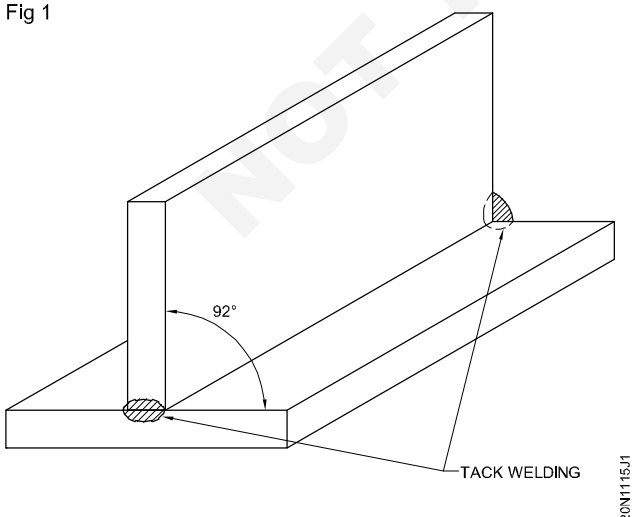
Fillet 'T' joint in flat position (1F)

Objective: This shall help you 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.

Fig 1



SETTING AND TACKING A TEE JOINT

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)

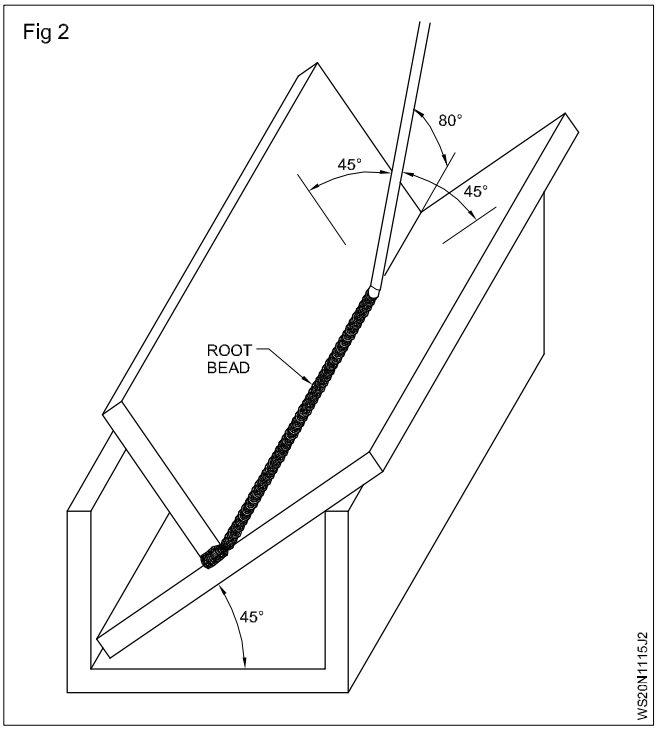
The electrode angle of 45° will help to fuse both plates equally and the 80° angle will help to get a good root penetration.

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 2



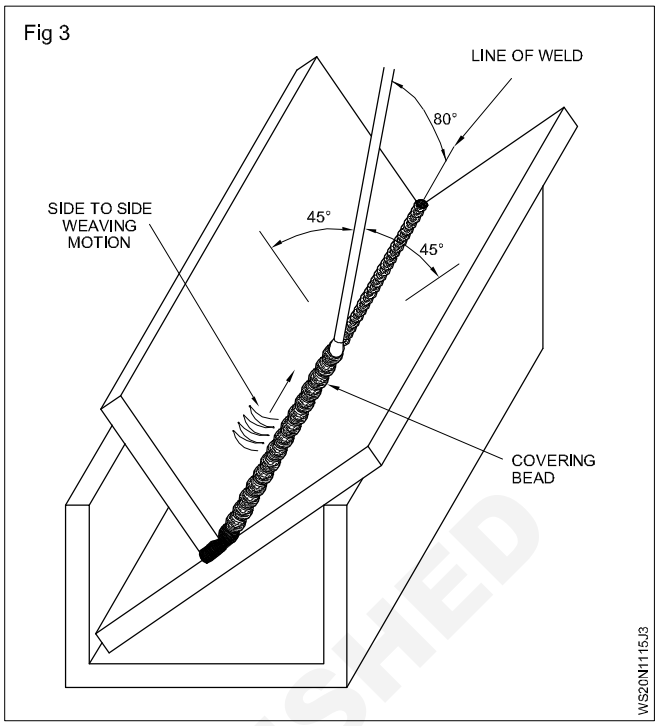
Maintain the same electrode angle as in the root bead.

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.

Fig 3



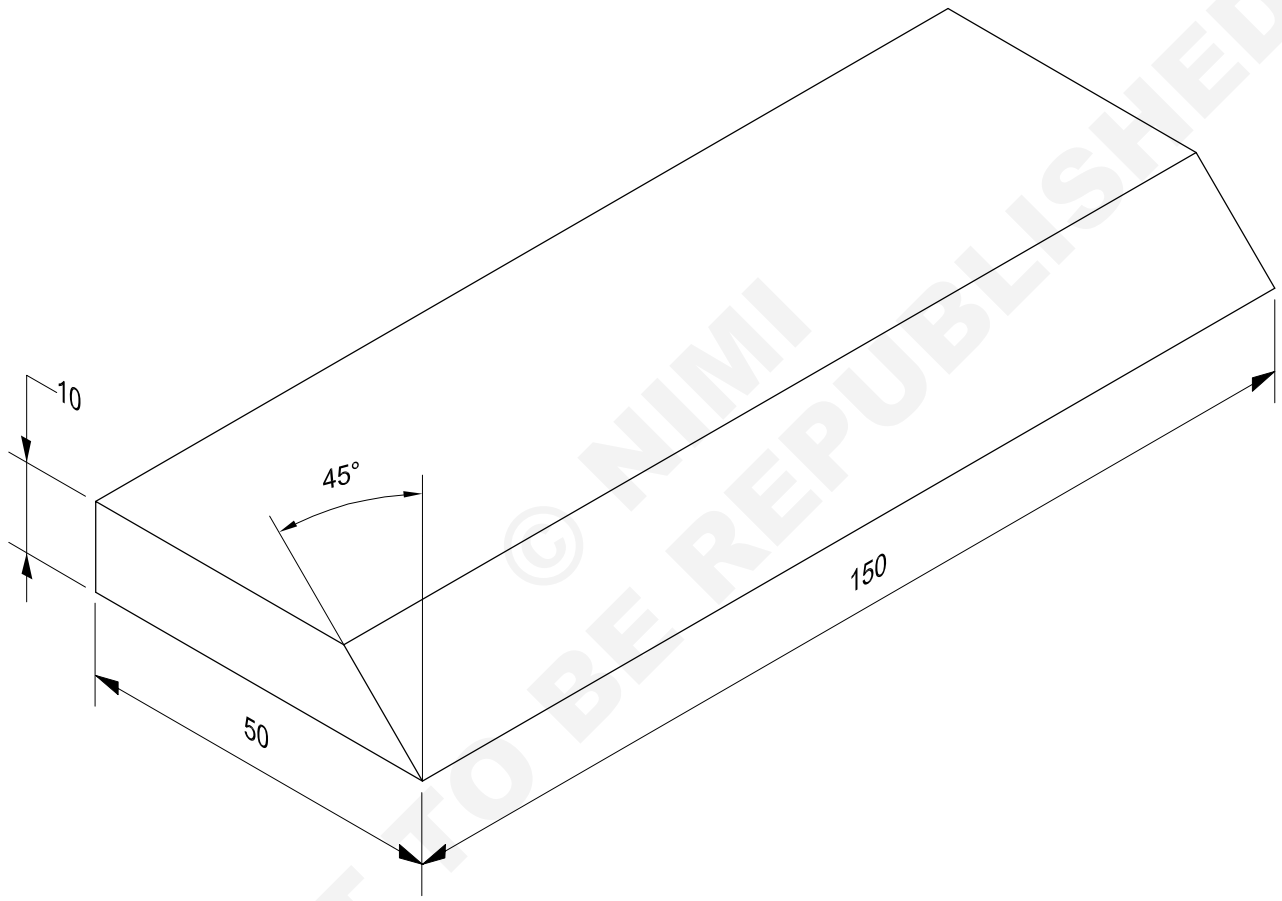
Inspection of fillet weld

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

Beveling of MS plates 10mm thick 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 bevel cut**



2	100 ISF 10-150	-	Fe310-W	-	-	1.2.16
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS	BEVELING OF M.S PLATE 10mm THICK CUTTING BY GAS CUTTING	DEVIATIONS	TIME 10Hrs
		CODE NO. WS20N1216E1	

Job Sequence

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

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

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

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.

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.

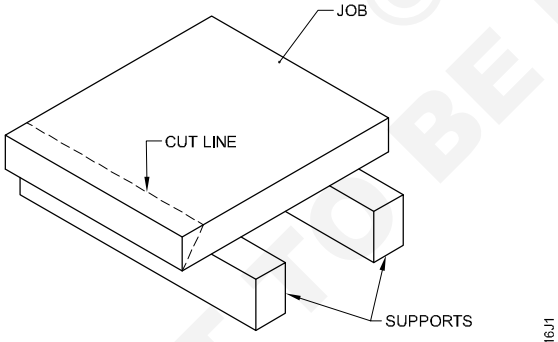
Skill Sequence

Bevel cutting by hand (Oxy-acetylene)

Objectives: This shall help you to
- **set the work piece for bevel cutting**
- **gas cut bevel surfaces by hand**
- **inspect the bevel cut.**

Setting the job (Fig 1)

Fig 1



SETTING JOB ON SUPPORTS

Set the job on a rigid table.

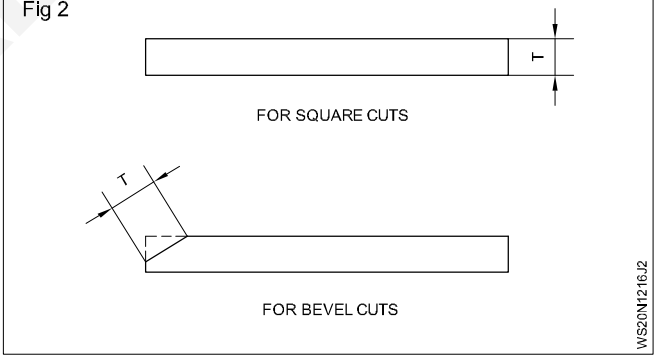
Ensure the underside of the cut line is clear.

Adjustment of the cutting flame.

Select a cutting nozzle as per the length of the bevel. (Fig2)

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

Fig 2



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

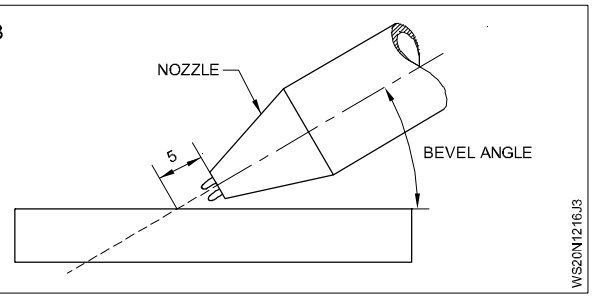
Bevel cutting

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

Preheat the starting point to a cherry red color.

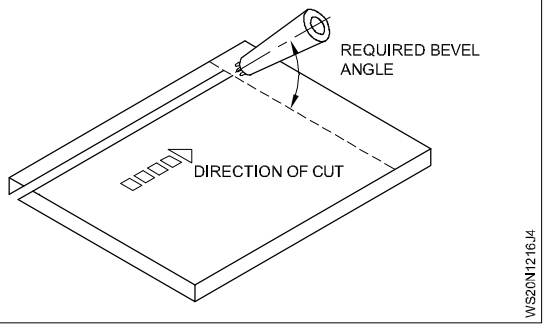
Distance between the work piece and the nozzle tip should be about 5mm to avoid backfire. (Fig 3)

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 4



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

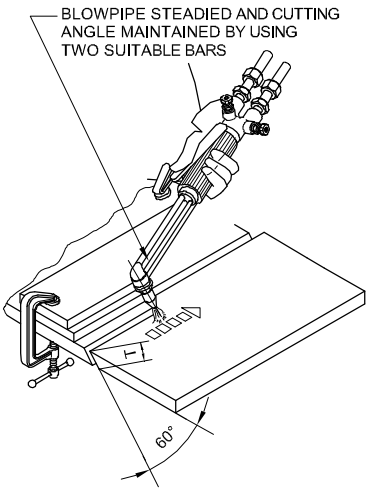
If possible, fix suitable straight bars to the cutting job to ensure a straight cut and angle maintenance. (Fig 5)

TABLE 1

Data for cutting

Diameter of cutting oxygen orifice nozzle	Thickness of steel plate	cutting oxygen pressure
(1) mm	(2) mm	(3) mm
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

Fig 5

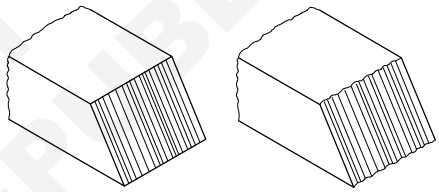


Inspection of bevel cut

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.

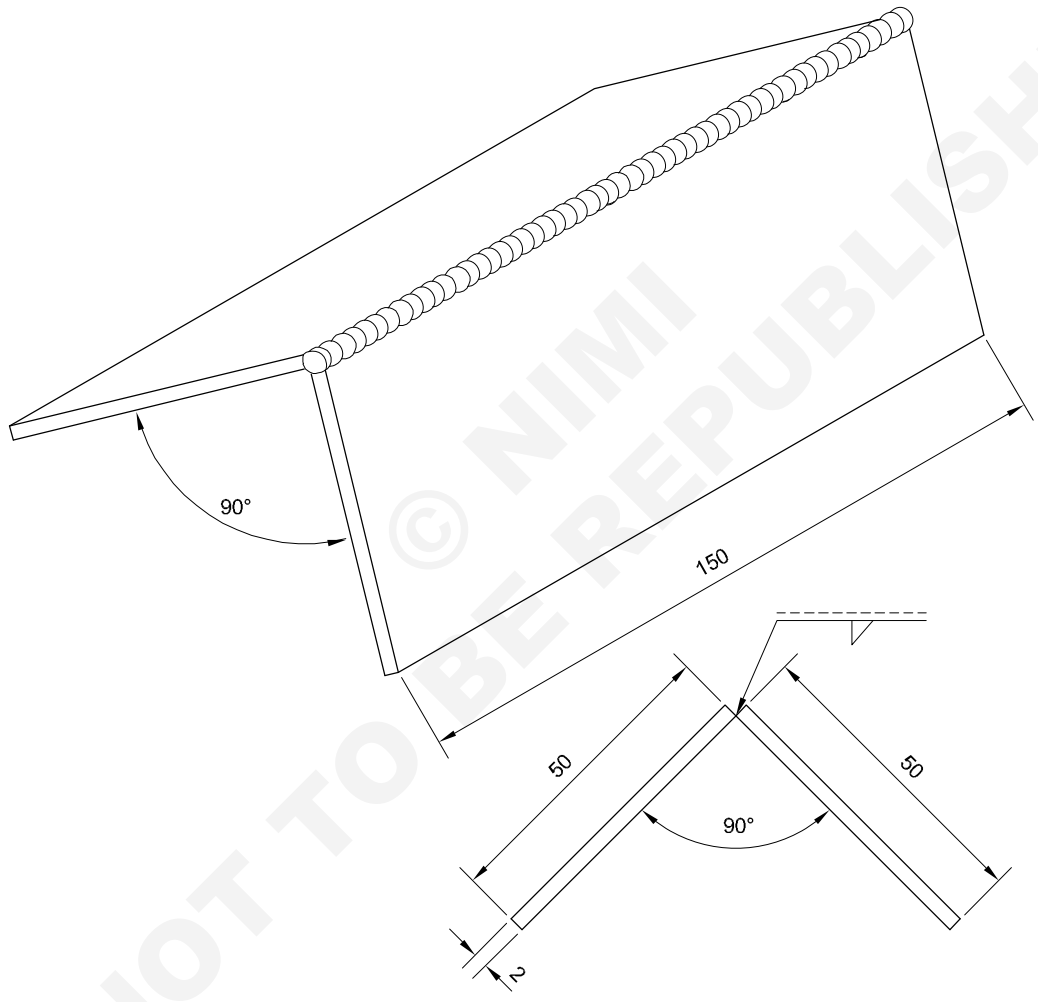
Fig 6



Open corner joint on M.S. sheet 2 mm thick in flat position

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

- **set and tack weld the job to form an open corner joint with the recommended root gap**
- **select a proper filler rod, nozzle size, and gas pressure**
- **weld the open corner joint by leftward technique**
- **manipulate the blow pipe and filler rod to get proper fusion of edges and root penetration**
- **clean and inspect (open corner joint) weldment for weld defects.**



2	ISST 50 x 2 - 150	-	Fe 310 - W	-	-	1.2.17
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	OPEN CORNER JOINT ON M.S. SHEET 2mm THICK IN FLAT POSITION (1F)	TOLERANCE ±0.5	TIME 9 Hrs
		CODE NO. WS20N1217E1	

Job Sequence

- Prepare the edges of the sheets to be joined by filling.
- Set the sheets as outside corner joint by keeping at 90° angle between the members with a uniform root gap of 1.5mm between the edges.
- Fix nozzle No. 5 and adjust the gas pressure to 0.15kg/ sq.cm. for both gases.
- Select C.C.M.S. filler rod 1.6 mm dia.
- Wear all safety clothing and use the gas welding goggle.
- Set natural flame, tack at both ends of the joint and at the center by fusing the edges adding filler rod.
- Check the correct alignment of the joint pieces with a try square, clean the tacks, and reset if needed.

Use tongs for holding hot pieces.

- Keep the tacked joint on the welding table in a flat position.
- Hold the blowpipe and filler rod at an angle of 60° to 70° and 30° to 40° respectively with the weld line, start welding from the right hand edge of the joint, move towards the left hand side using the leftward technique.
- Keep the flame at the root of the joint, fuse both the edges uniformly, then dip the filler rod in the molten pool, like a 'piston like' motion, steadily move and give slight circular motion to the blowpipe.

Maintain 1 to 1.5 mm distance between the flame cone and the molten pool to avoid backfire, and to obtain good fusion of the root, use the key-hole technique.

Add filler metal at the top edge of the molten pool as required to build up the weld.

Synchronize the rate of travel and addition of filler metal to obtain a slightly convex bead with proper root penetration.

- Stop welding at the left hand edge of the joint, after filling up the crater.
- Extinguish the flame, cool the nozzle and keep the blowpipe at a safe place.
- Clean the welded joint and inspect for:
  - uniform ripples with slightly convex bead with correct throat thickness.
  - uniform width and height of bead
  - uniform penetration of bead on the reverse side of the joint near the root (indication of root fusion).

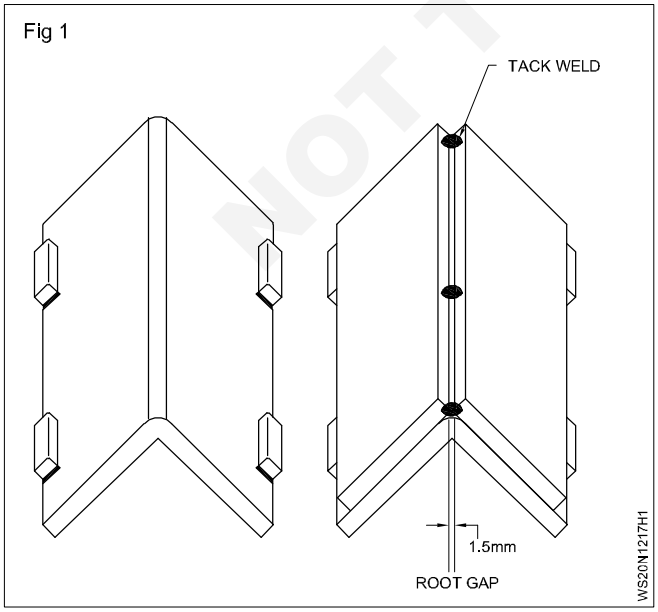
Skill Sequence

Open corner joint in flat position

Objective: This shall help you to
- **prepare and weld open corner joint in flat position.**

Set the job pieces prepared with square edges in correct position using angle iron support. (Fig 1)

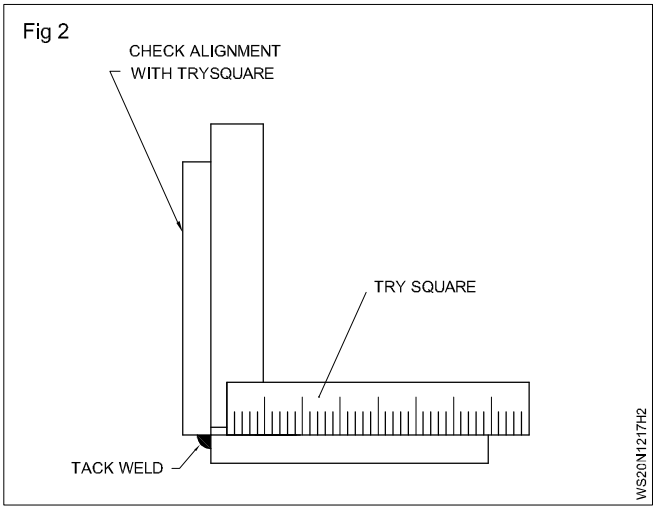
Fig 1



Tack-weld the pieces at correct intervals in correct sequence, with 1.5 mm root gap.

Check the alignment of the tacked pieces and reset, if required. Use a try square. (Fig 2)

Fig 2



Fusion welding on open corner joint

Make uniform bead with correct penetration by:

– holding the blowpipe and filler rod in correct position (Figs 3 and 4)

Fig 3

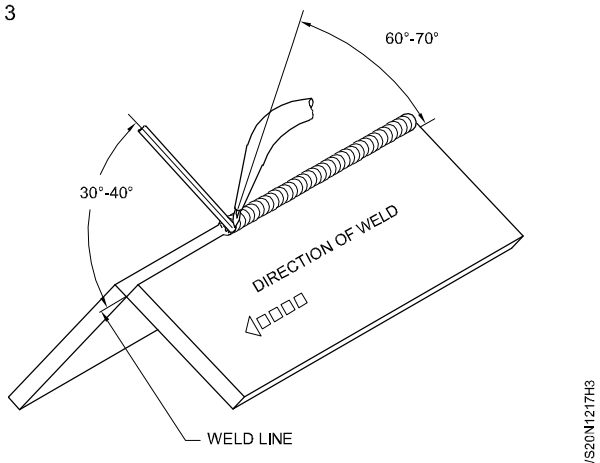
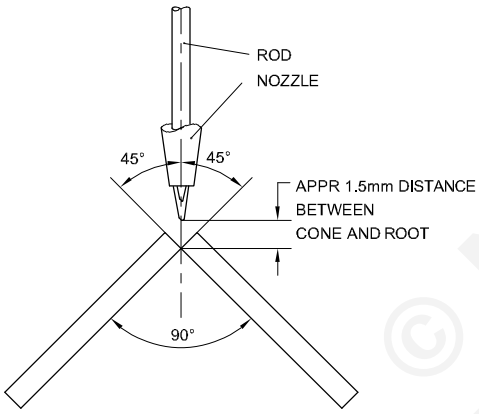


Fig 4



– maintaining uniform travelling speed

– fusing the edges with the keyhole formation to get full penetration. (Fig 5)

– ensuring the top edges of the sheets do not melt excessively.

Inspect the open corner welded joint for:

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

– uniform ripples with equal width and height of bead (Fig 6)

Fig 5

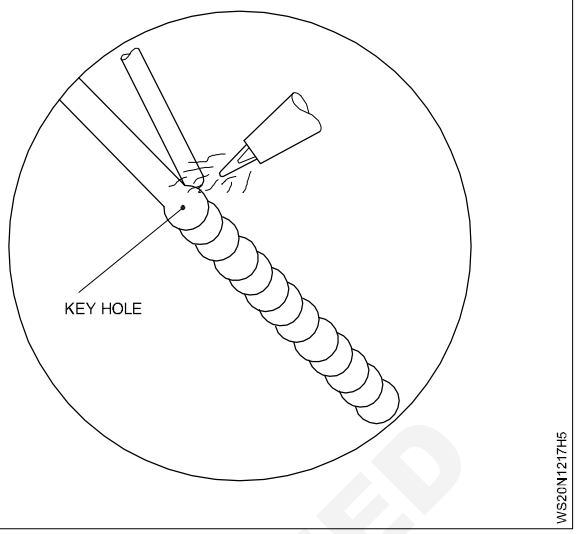
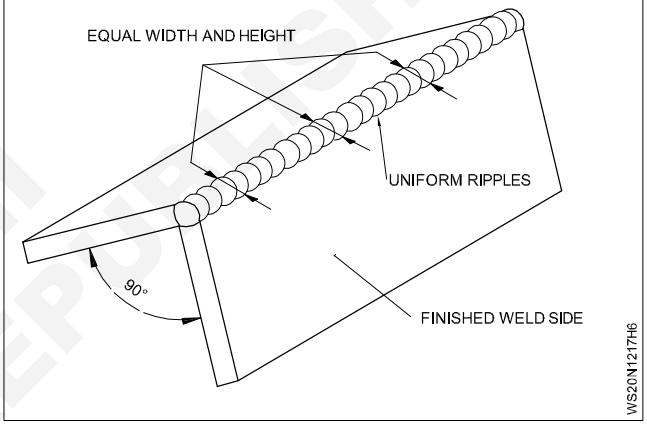
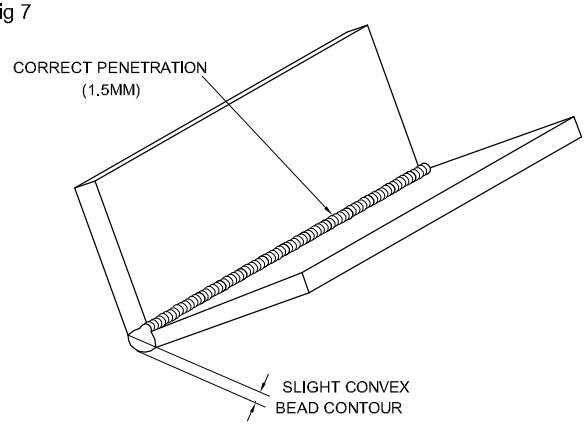


Fig 6



– slight convex bead with weld penetration at the root of the joint. (Fig 7)

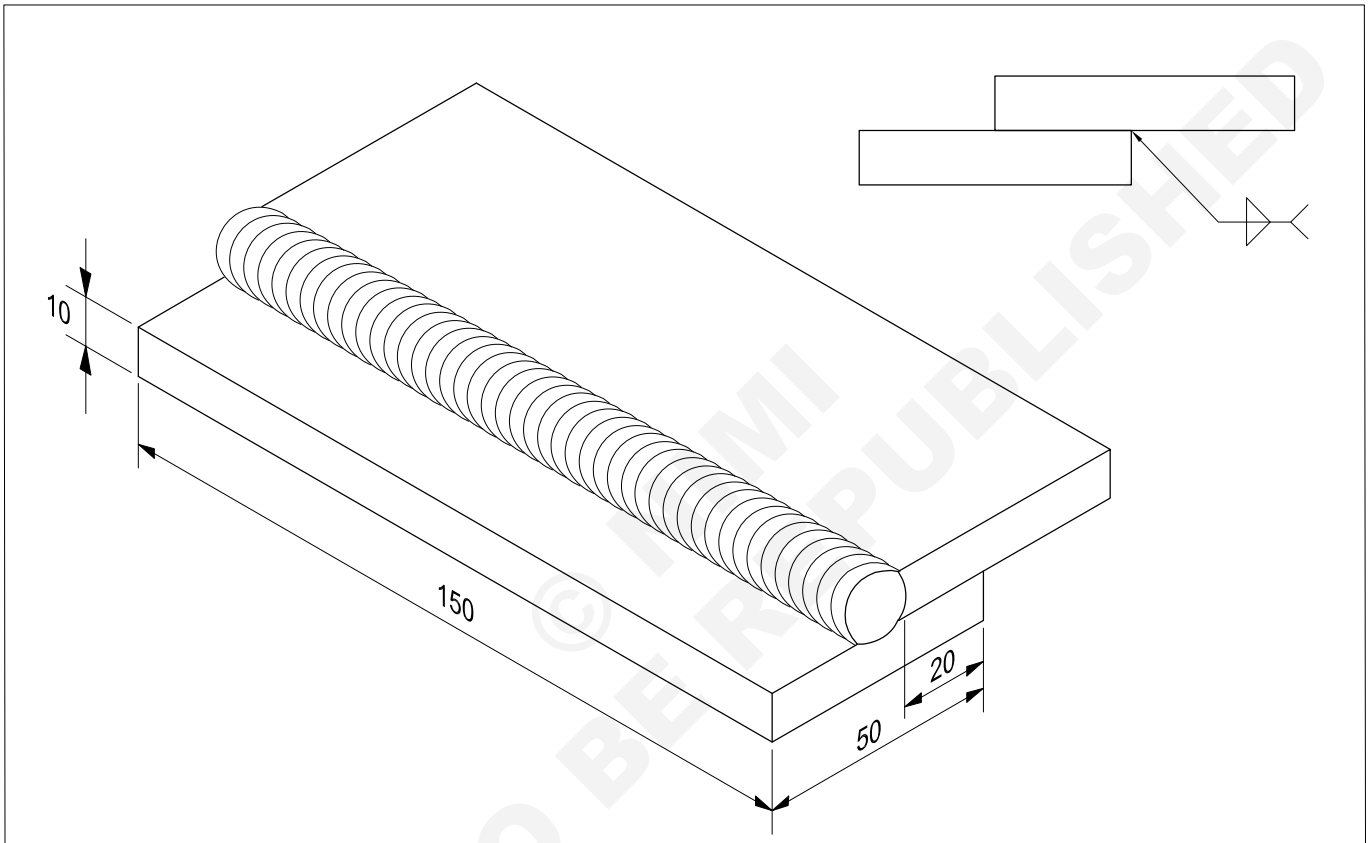
Fig 7



Fillet lap joint on MS plate 10mm thick in flat position (1F)

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.**



2	50 ISF 10 - 150		Fe 310 - W			1.2.18
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : NTS	**FILLET LAP JOINT ON M.S PLATE 10mm THICK IN FLAT POSITION (1F)**				TOLERANCE ±1	TIME 6Hrs
					CODE NO. WS20N1218E1	

Job Sequence

- 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.

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.

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.

Prevent the upper edge of the plate from melting off.

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

Use a weld gauge to check the fillet size.

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

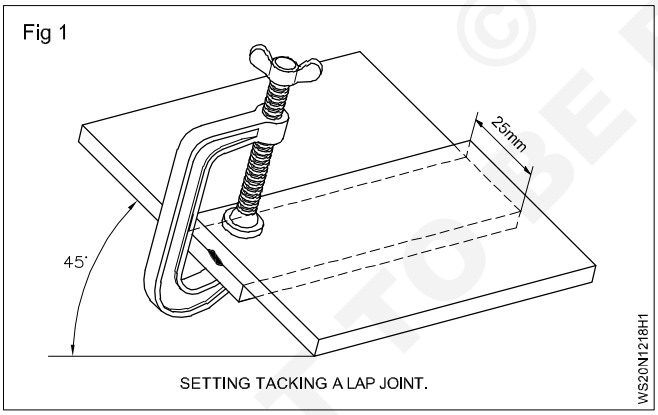
Skill Sequence

Lap fillet joint in flat position

Objective: This shall help you to
- **prepare and weld lap fillet joint in flat position.**

Setting and tacking the lap joint (Fig 1)

Fig 1



SETTING TACKING A 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. (Fig 1) Ensure the 2 lapping surfaces are perfectly cleaned and they contact each other properly. Use a 3.15mmø MS electrode with 120 amp current for tacking.

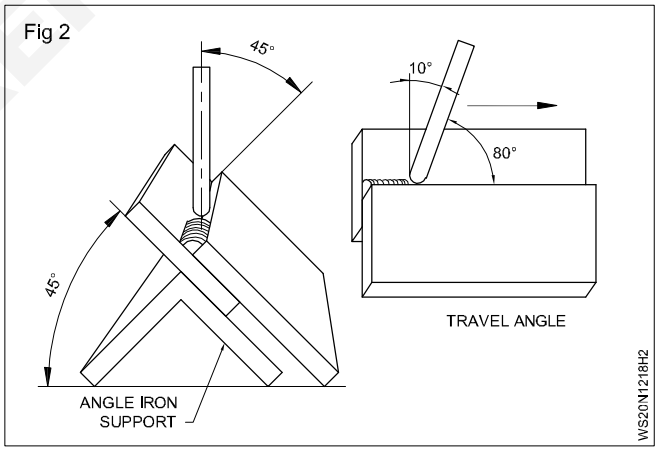
Set the joint in a flat position using angle iron (Fig 2).

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)

Fig 2



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 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.

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

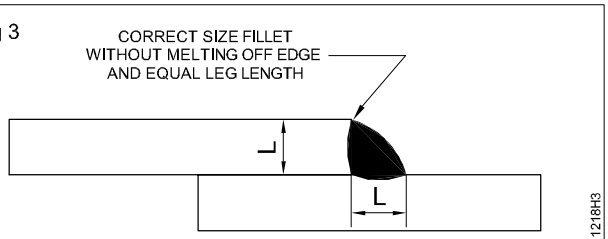
Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

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

– 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 3

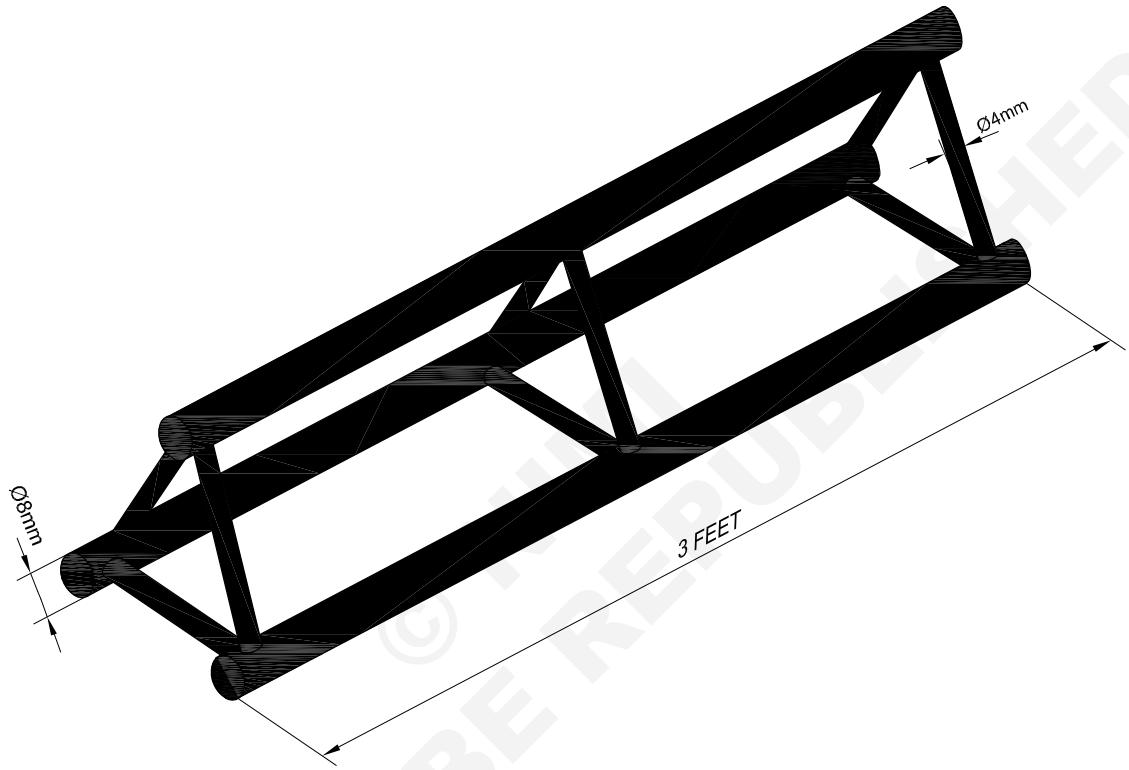


INSPECTION OF LAP FILLET WELD

Triangular beam fabrication from 8mm & 4 mm dia M.s rod with GMAW length 3 feet.

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

- **preparing and setting up job (or) workpiece to make triangular beam fabrication**
- **selection of current,voltage,polarity for welding**
- **inspecting for defect's.**



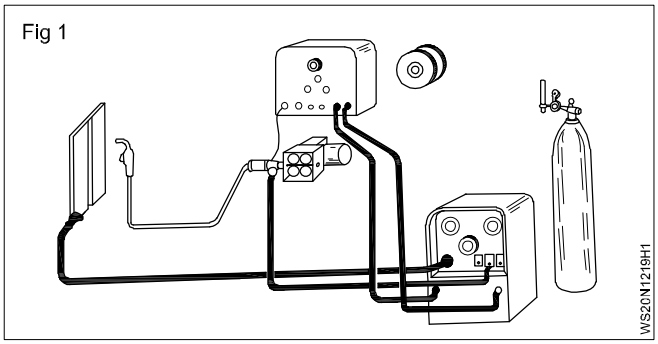
-	Ø 8mm - 3 FEET		Fe 310 - W			1.2.19
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	TRIANGULAR BEAM FABRICATION				TOLERANCE ±1	TIME : 9Hrs
					CODE NO. WS20N1219E1	

Job sequence

Triangular beam fabrication from 8mm & mm dia M.s Rod with GMAW welders

GMAW machine & accessories : (Fig 1)

Fig 1

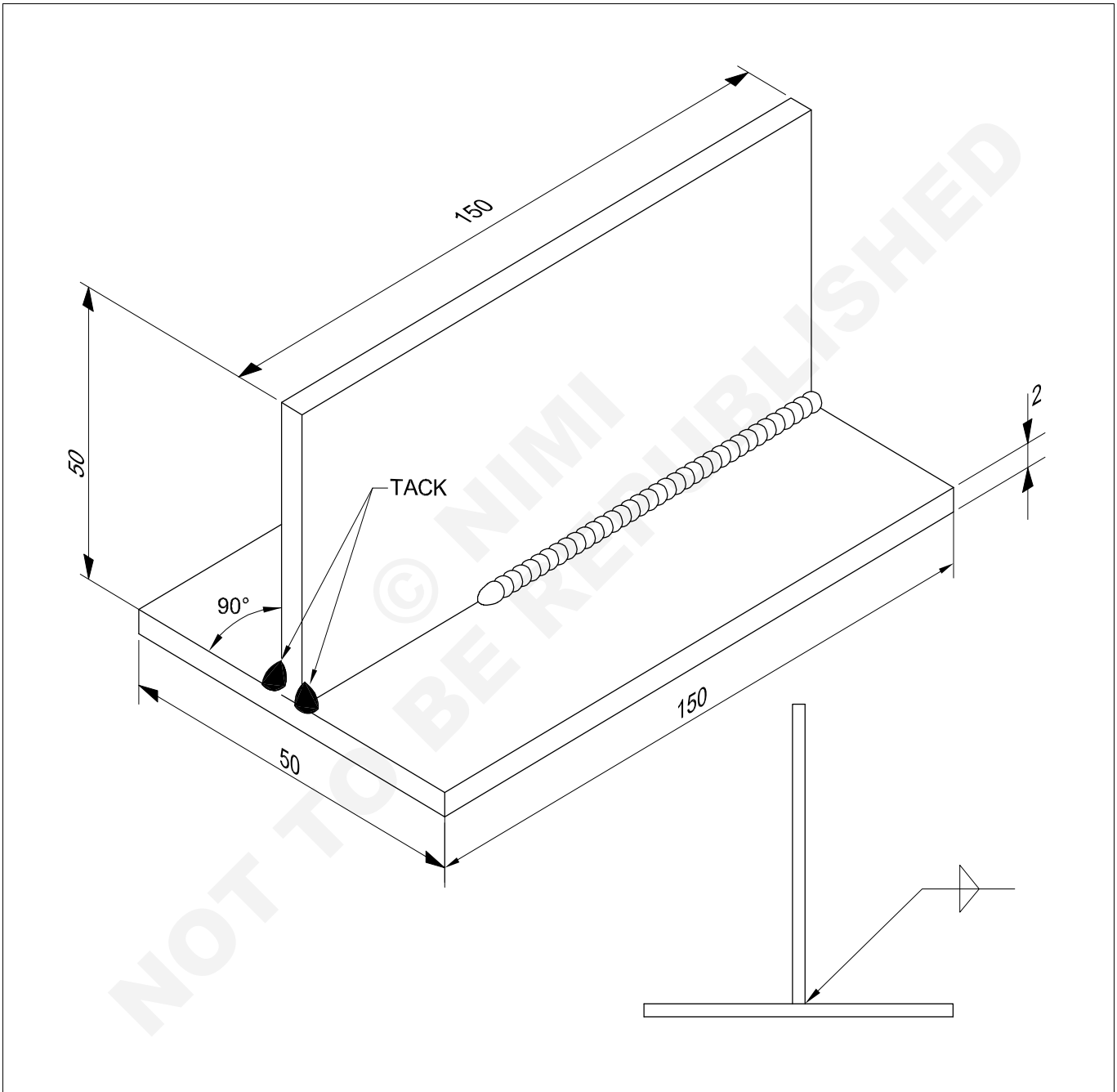


- Cut the M.s rod with a hack saw frame & take the required size
- Prepare the job to size as per deawing
- Wear protective clothing
- set the work piece (job) on the work table in flat position
- Fox 0.8 mm diameter wire spool inposition,lock it up and pull the wire through the guide tube, rollers, spiral and contact tip of the torch.
- Start the welding machine connect the torch to the positive termind of the machine
- Connect the co_2 gas header to the electrical supply 5 - 10 mins before starting of the weld.
- Set the arc voltage at 19 - 21 volt as required for dip transfer mode & current range 60 - 90 Amps.

Fillet 'T' joint on M.S. sheet 2mm thick in flat position (1F)

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

- **set and tack the job to form 'T' fillet joint and manipulate the blow pipe and the filler rod properly**
- **weld a 'T' fillet joint using recommended filler rod and nozzle size.**



1	ISST 50 x 2 - 150		Fe 310 - W			1.2.20
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**FILLET "T" JOINT ON M.S. SHEET 2mm THICK IN FLAT POSITION (1F)**				TOLERANCE ±0.5	TIME : 8 Hrs
					CODE NO. WS20N1220E1	

Job Sequence

- Prepare job pieces as per drawing.
- Clean the surface and edges of the sheets to be welded.
- Set the sheets in the form of a 'T' joint on the welding table.
- Wear safety apparels and gas welding goggles.
- Set the gas welding plant, fix nozzle No. 5 and set pressure at 0.15 kg/cm for both gases.
- Set the neutral flame, tack at both ends of the joint also in the center with a 1.6 mm C.C.M.S. rod.
- Check the alignment of the joint with a try square and clean the tacked portion.
- Keep the job on the welding table in a flat position.
- Start welding with the leftward technique and melt the right hand end of the joint.
- Fuse the area to be welded (i.e. equally the part of the horizontal sheet and the vertical sheet) and apply the filler rod in the molten pool to form a fillet weld at the joint.
- Maintain correct travel speed, manipulate the blowpipe and filler rod to produce a uniform weld bead.
- Stop the weld at the left hand end of the joint after filling up the crater at the end of the weld.
- Extinguish the flame, cool the nozzle and place the blowpipe at its place.
- Clean the weldment and inspect for defects in the fillet weld.

Visual inspection

- Slight convexity, uniform width, uniform ripples indicate a good weld bead. A weld without undercut, overlap, porosity, etc. will ensure a good quality weld.
- Weld on the other side of the joint for more practice.

Skill Sequence

Fillet weld 'T' joint on MS sheet 2.00mm in flat position

Objective: This shall help you to
- **prepare and fillet weld 'T' joint on MS 2.00mm in flat position.**

'T' fillet joints are used extensively in industry i. e., fabrication of underframes, vertical supporters for oil and water containers and other similar structural work.

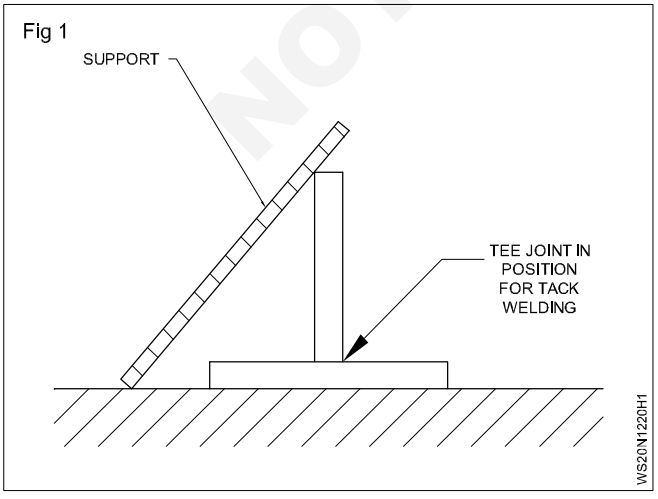
It is an economical joint with very little edge preparation but difficult to weld without defects (i.e. unequal leg length, undercut, etc.) unless the operator gets proper practice.

Root penetration must be obtained completely and undercut is to be avoided.

Setting and tacking the job pieces

Place the pieces on the welding table as 'T' joint.

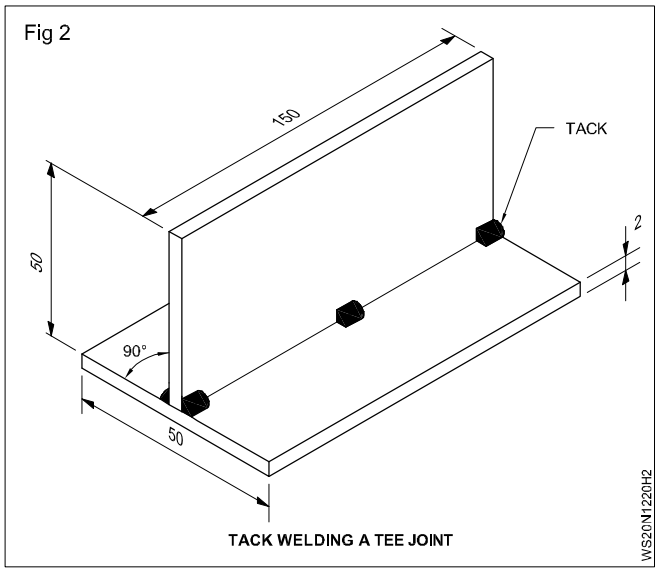
Hold the pieces in position using support. (Fig 1)



Ensure the vertical piece is perpendicular to the horizontal piece without gap of the joint.

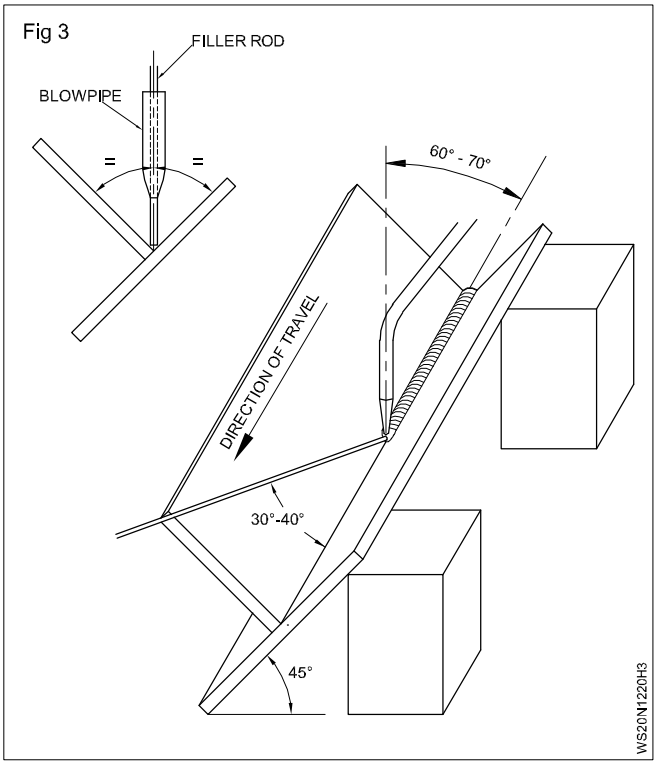
Check with a try square for perpendicularity.

Tack weld the joint at both ends (Fig 2) on one side of the joint.



Welding of fillet 'T' joint in flat position (Fig 3)

Place the tack welded in flat position by tilting and supporting it. (Fig 3)



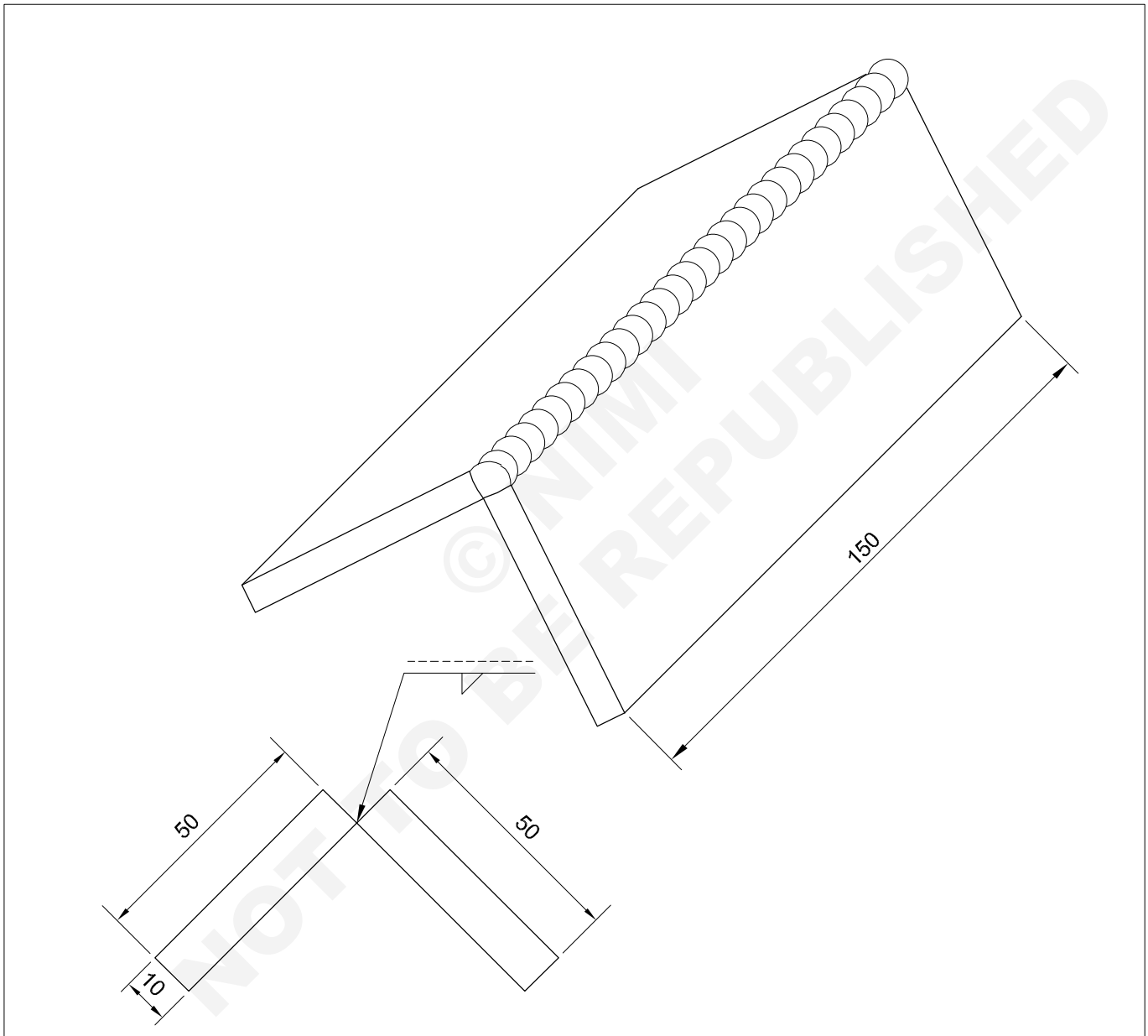
Start welding at the right hand end of the joint by fusing the tack weld and the parent metal to form a molten pool. Keep the blowpipe in the leftward direction at an angle of 60° to 70° and the filler rod at an angle of 30° to 40° to the line of travel. The blow pipe and filler rod should be held at 45° between the 2 surfaces of the joint. This will ensure root penetration. Watch the molten metal closely to make sure that both pieces melt uniformly. Change the angle of the blowpipe if the pieces do not melt uniformly. When the molten pool is formed add the filler rod in the center 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 penetrati on at the root and into both sheets, and to produce a fillet weld of equal leg length.

Open corner joint on MS plate 10mm thick in flat position (1F)

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.**



2	50ISF10 - 150	-	Fe 310 - W	-	-	1.2.21
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**OPEN CORNER JOINT ON M.S PLATE 10mm THICK IN FLAT POSITION (1F)**	TOLERANCE ±1	TIME 8Hrs
		CODE NO. WS20N1221E1	

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.

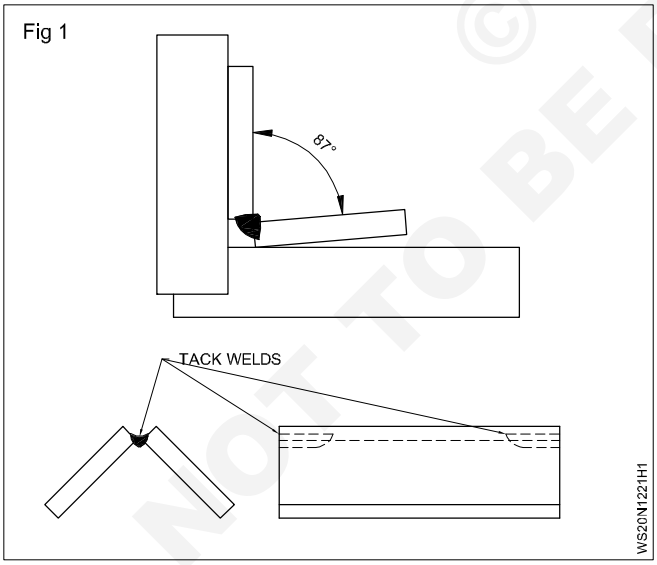
Skill Sequence

Open corner joint on MS plate 10mm thick in flat position (1F)

Objective: This shall help you 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)

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 betwSet he plates is kept at 87° to control the distortion.

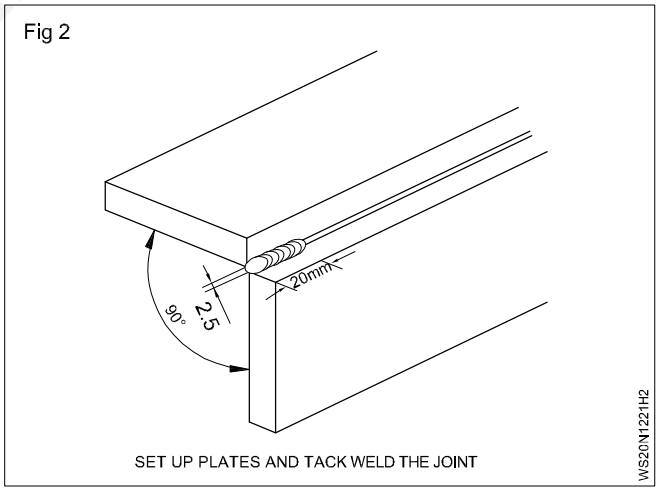
The angular distortion is normally taken as 1° per run.

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.

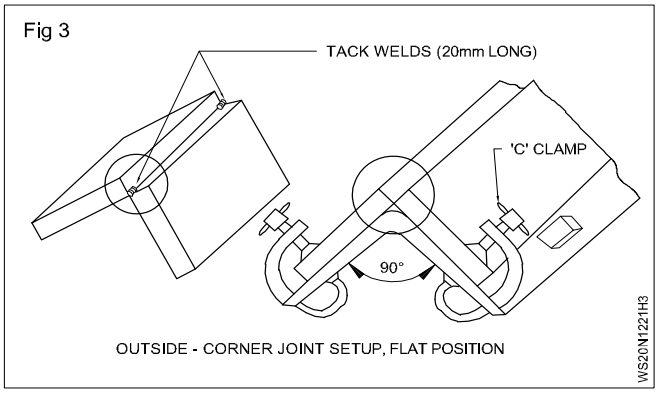
Tack weld the corner joint from inside using a MS electrode ø 3.15mm and 100 - 110 amps current range. Tack weld at both ends with max tack length of 20mm each. (Fig 2)

Fig 2



SET UP PLATES AND TACK WELD THE JOINT

Fig 3



OUTSIDE - CORNER JOINT SETUP, FLAT POSITION

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.

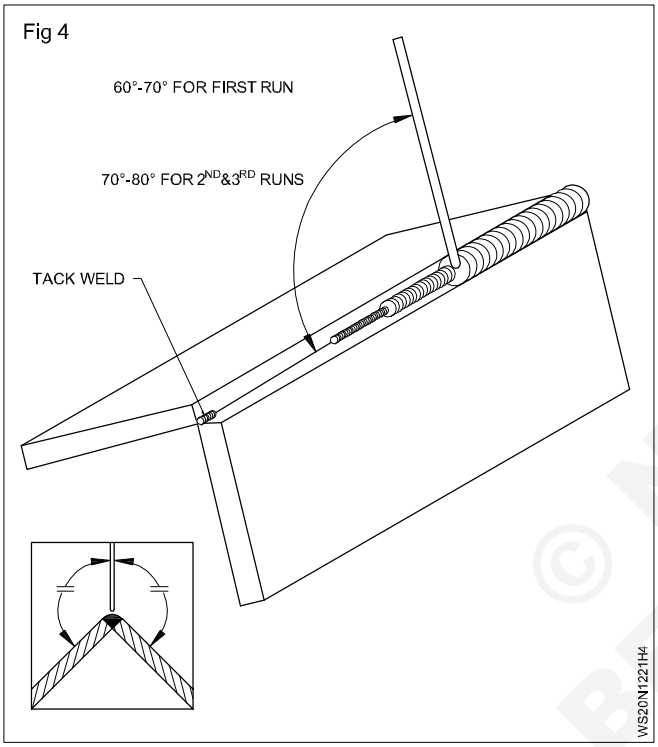
Deposit root run in the bottom of the corner by

– using a M.S. electrode ø3.15 and welding current 110 to 120 amps.

– maintaining a slightly short arc

– positioning the electrode vertically between the edge and 60° - 70° with the weld line. (Fig 4)

Fig 4



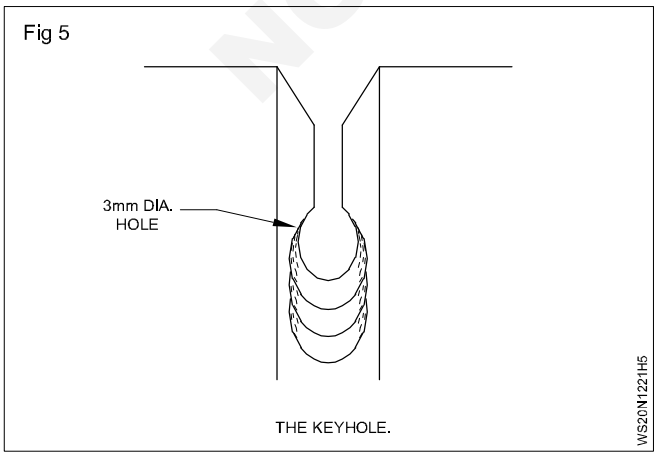
– forming a keyhole near the weld crater of the tack weld to ensure complete penetration. (Fig 5)

– 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.

Fig 5



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)

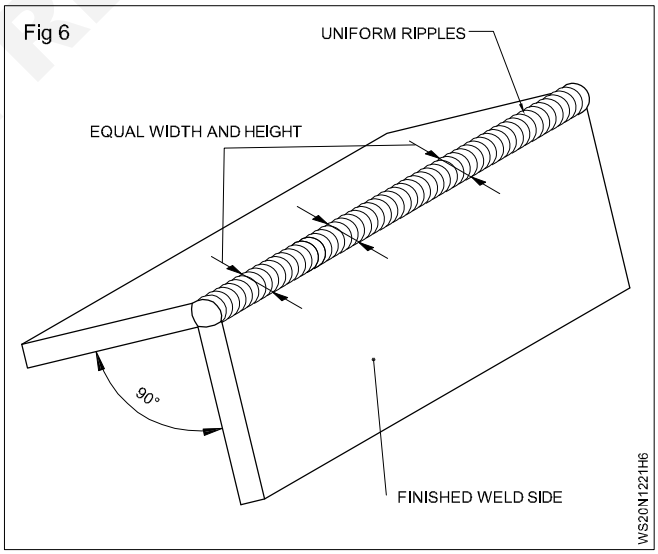
Each movement of the weave from one side to the other will deposit more metal, and that takes more time.

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)

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.

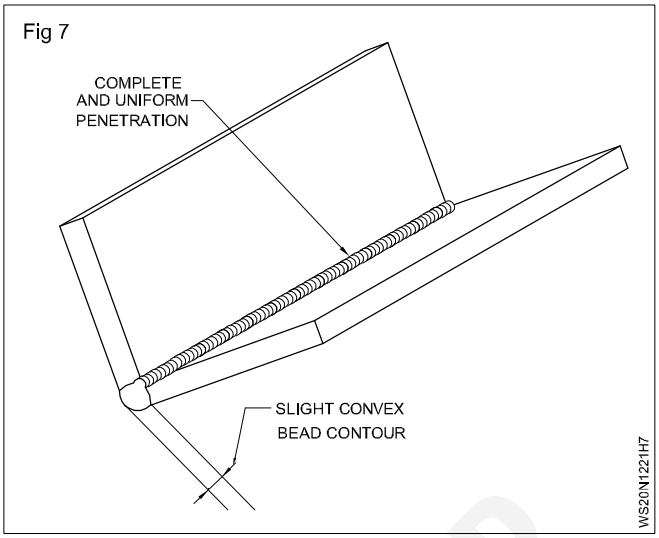
Edges of welds: Good fusion, no undercut, no overlap.

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.

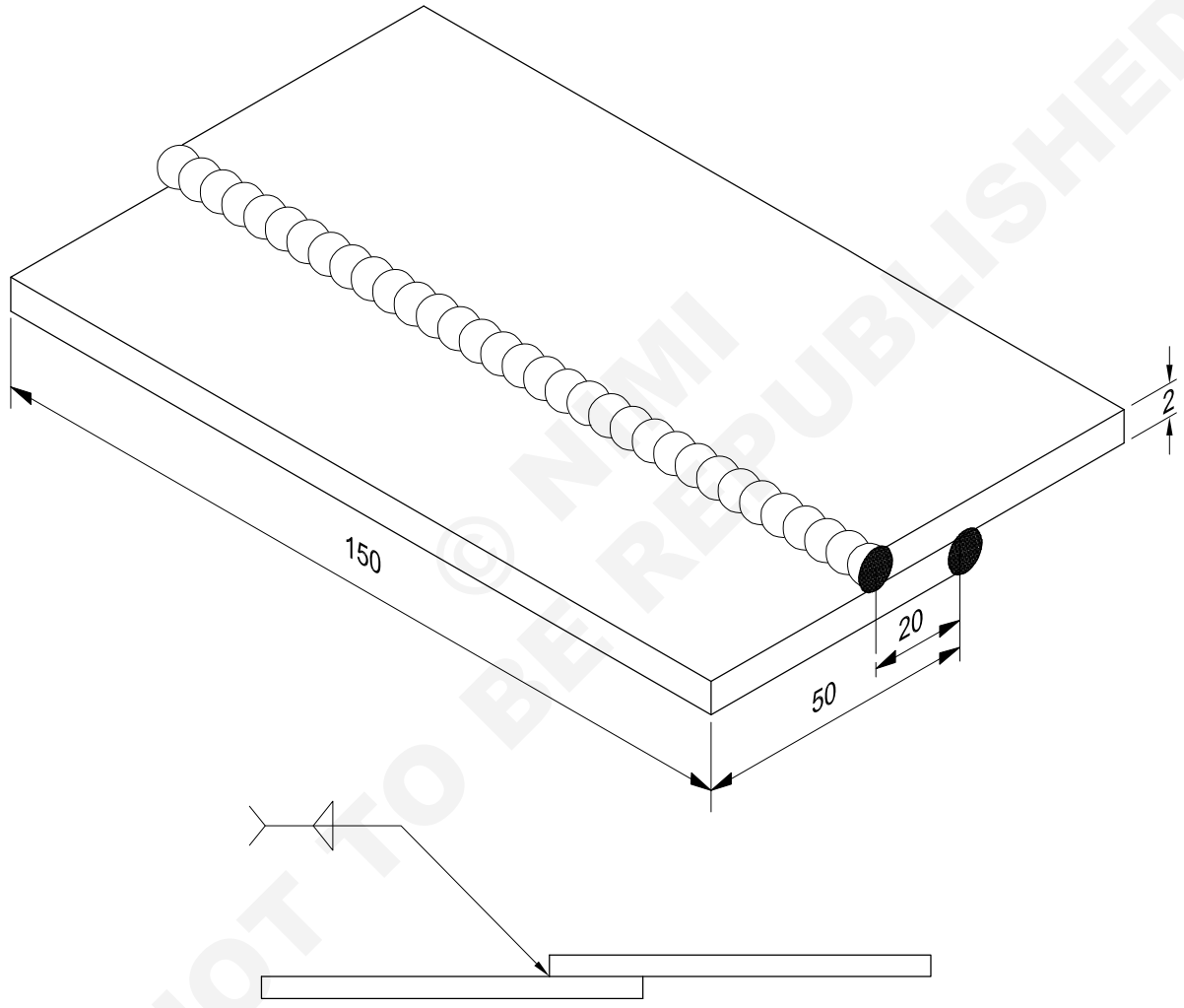
Fig 7



Fillet lap joint on MS sheet 2mm thick in flat position (1F)

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.**



2	ISST 50 x 2 - 150		Fe 310 - W			1.2.22
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FILLET LAP JOINT ON M.S.SHEET 2mm THICK IN FLAT POSITION (1F)	TOLERANCE ±1	TIME 10Hrs
		CODE NO. WS20N1222E1	

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.

Wear safety apparels and use gas welding goggles.

- Set the neutral flame.
- Tack the pieces at both ends and also in the center 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.

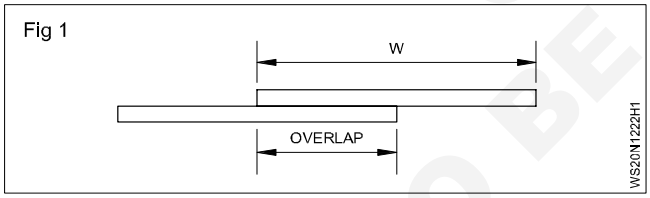
Weld the job from the other side also following the same steps.Repeat the exercise till you get good results.

Skill Sequence

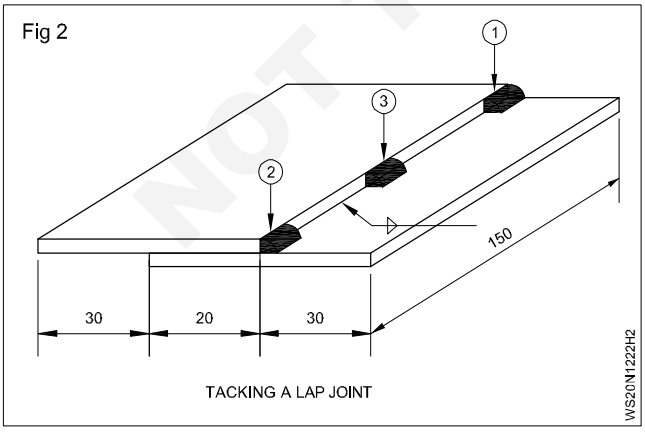
Lap weld joint on MS sheet 2.00 mm in flat position

Objective: This shall help you 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)



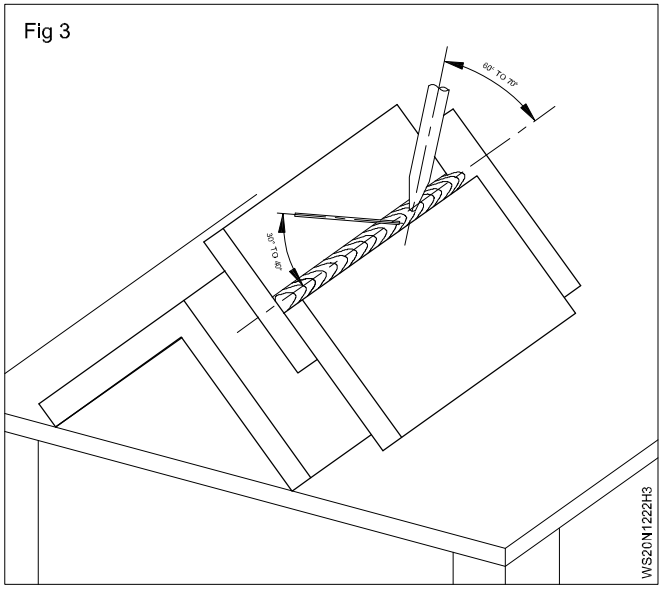
Place the tack welds at correct locations. (Fig 2)



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

– proper positioning of the joint (Fig 2)

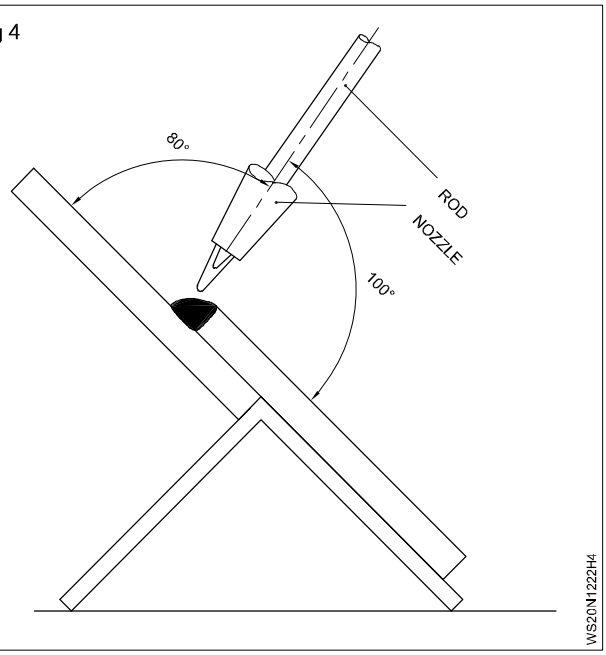
– proper angle of the blowpipe and filler rod (Figs 3 & 4)



– proper manipulation of the blowpipe and filler rod.

– using leftward welding technique.

Fig 4



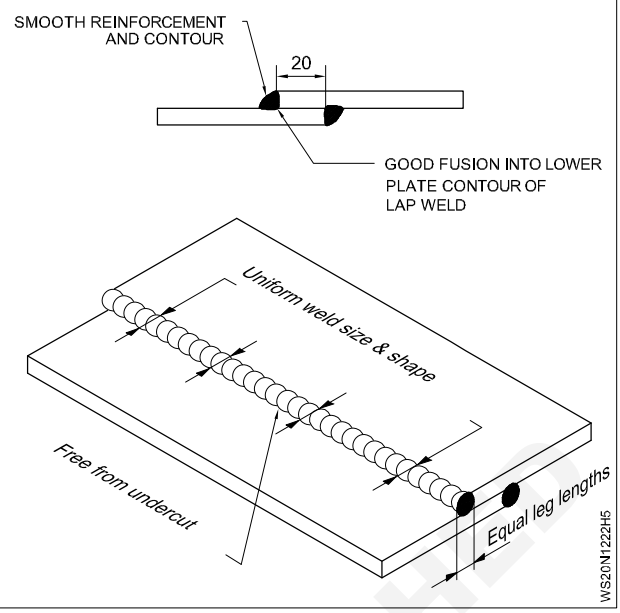
Avoid movement of blow pipe flame nearer to the edge of the top plate. This will avoid edge of the plate melted off defect.

– 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.

Fig 5



– equal leg length

– no undercut at the toe of weld

– no fusing of the top plate edge to undersize

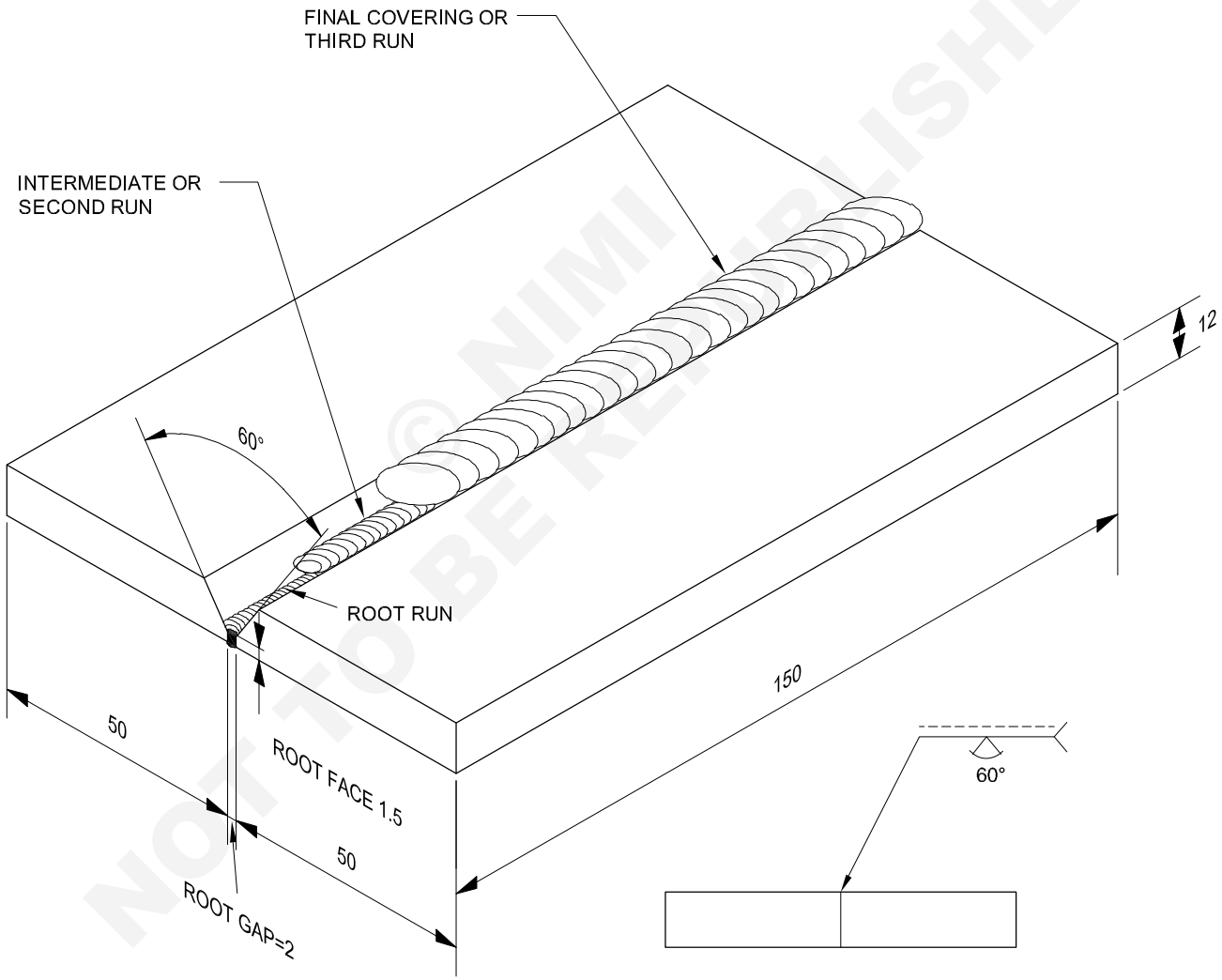
– smooth ripple appearance

– proper crater filling.

Single "V" butt joint on MS plate 12mm thick in flat position (1G)

Objectives : At the end of the excercise 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.**



4	50 ISF 12 - 150		Fe 310 - W			1.2.23
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**SINGLE "V" BUTT JOINT M.S. PLATE 12mmTHICK IN POSITION FLAT POSITION (1G)**				TOLERANCE ±1	TIME :10 Hrs
					CODE NO. WS20N1223E1	

Job Sequence

- Straight cut two 12mm 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.
- 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

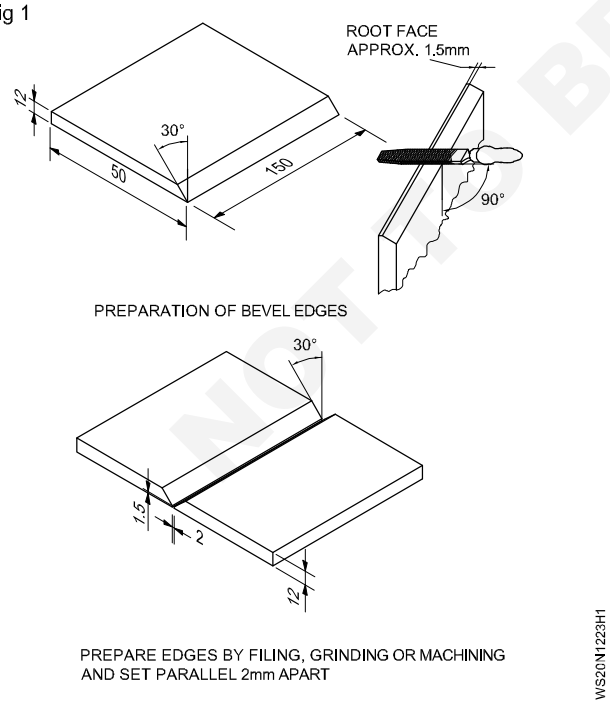
Welding of single 'V' butt joint MS plate 12mm thickness in flat position

Objective: This shall help you to

- **weld single V butt joint MS plate 12mm in flat position (1G).**

Preparation of the pieces (Fig 1)

Fig 1



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

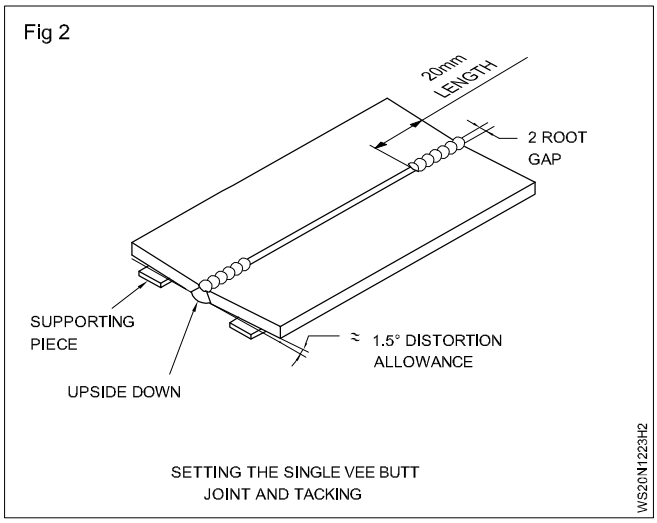
Grind the bevel edges to remove oxide deposits on the bevel.

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.

Fig 2



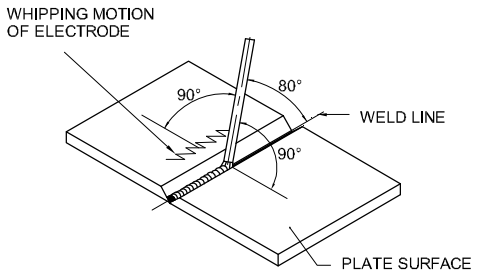
Tack-weld on both ends. (20mm long)

Ensure safety apparels are worn.

Place the joint in flat position after tacking.

Deposition of root bead (Fig 3)

Fig 3



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

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.

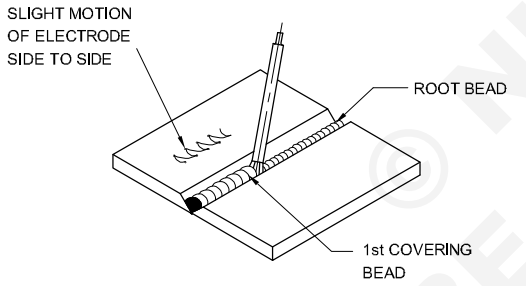
Keep the electrode angle (as shown in Fig 3) at 80° to the line of weld.

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

Clean the root bead, and observe penetration.

Deposition of hot pass & covering beads (Fig 4)

Fig 4



ELECTRODE MOTION IN DEPOSITING
1st COVERING BEAD

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.

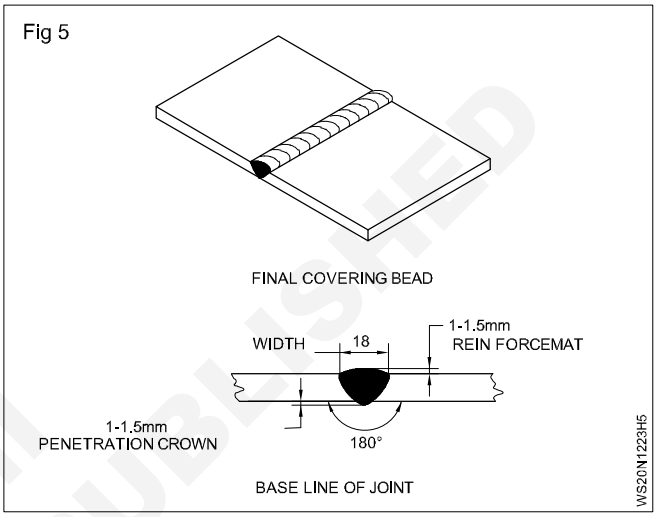
Ensure the electrode angle is the same as it was for the root bead.

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

Rectify possible defects, if any.

Deposition of final/covering bead (Fig 5)

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

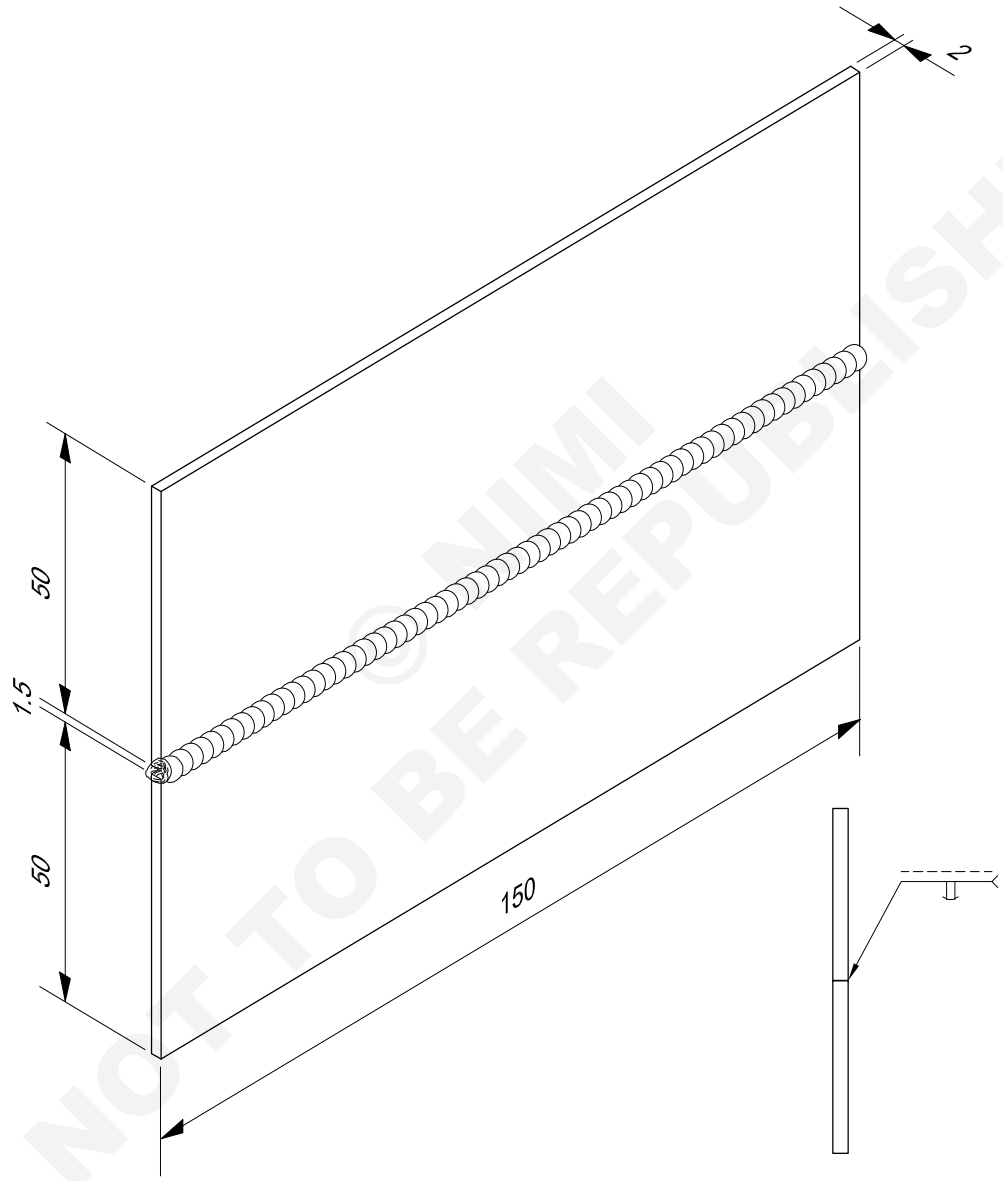
Clean the welded joint thoroughly from both sides.

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

Square butt joint on MS sheet 2mm thick in horizontal position

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.**



2	ISST 50 x 2 - 150	-	Fe 310 - W	-	-	1.2.24
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SQUARE BUTT JOINT ON M.S SHEET 2mm THICK IN HORIZONTAL POSITION (2G)	TOLERANCE ±0.5	TIME :10 Hrs
		CODE NO. WS20N1224E1	

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/cm^2.
- 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)

Objective: This shall help you 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)

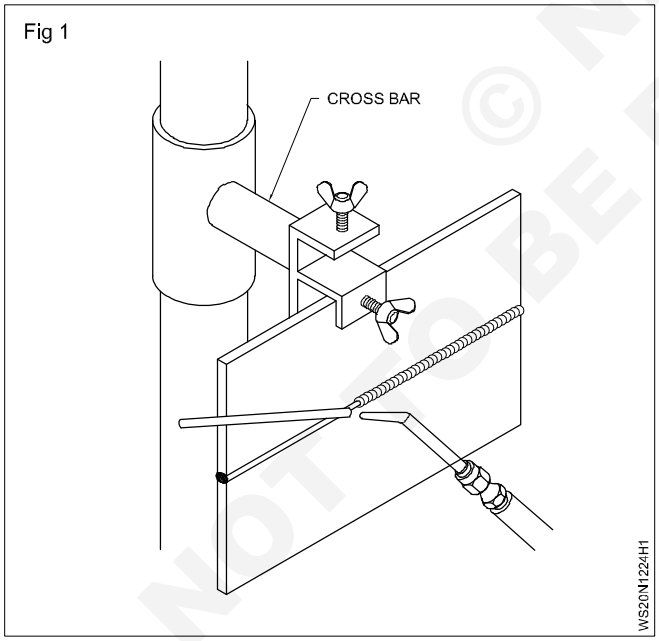
Adjust the pressure of oxygen and that of acetylene at 0.15 kg/cm^2.

Set a soft neutral flame.

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

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

Fig 1



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

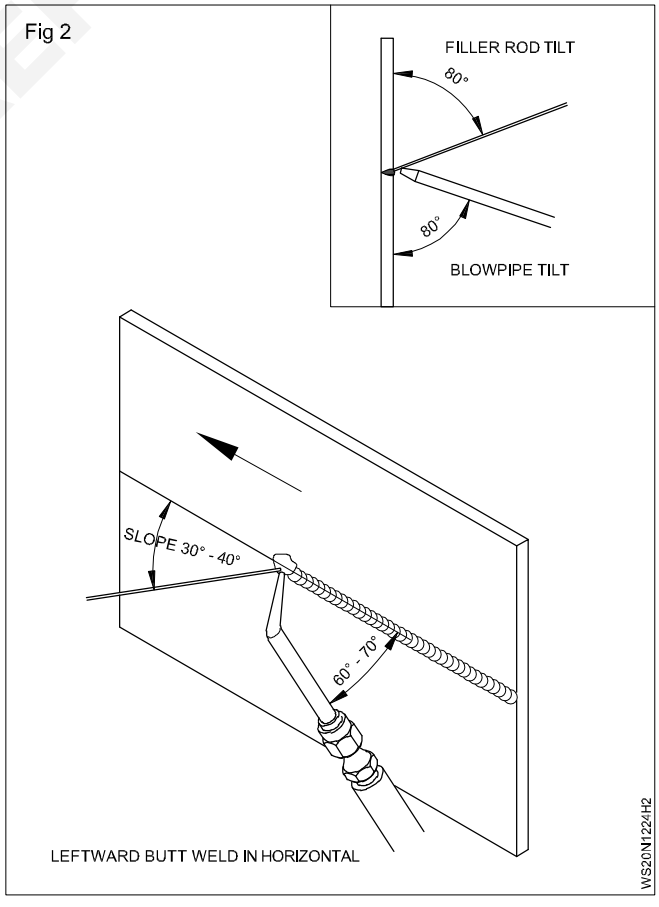
Hold the blowpipe at 60° to 70° and the filler rod at 30° to 40° to the line of weld. Deposit the bead from the right end of the joint by giving a circular motion to the blowpipe and proceed towards the left end.

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.

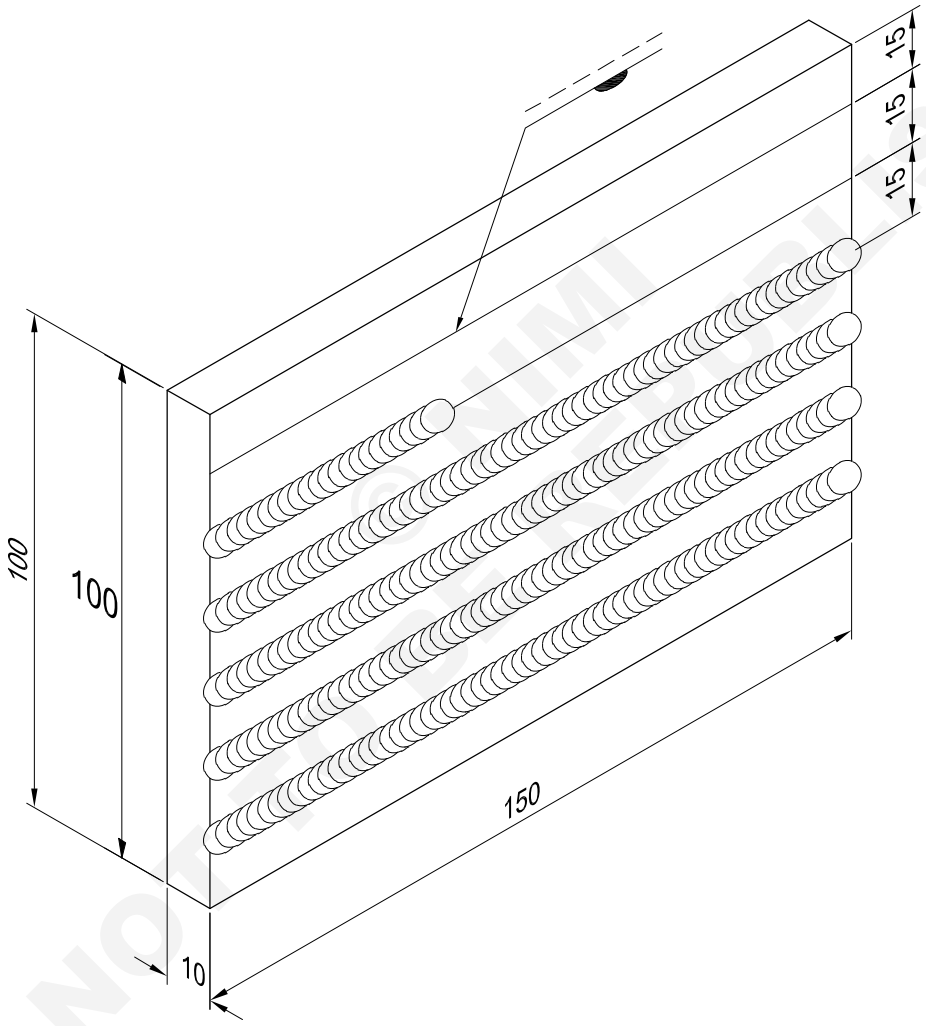
Fig 2



Straight line beads and multi layer practice on M.S. plate 10mm thick in horizontal position

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

- **select the electrode, current, polarity and arc length suitable for welding in horizontal position**
- **deposit uniform straight line beads in horizontal position**
- **control the molten metal and slag by the manipulation of the electrode angle**
- **prevent sagging of weld metal.**



1	100 ISF x 10 - 150	-	Fe 310 - W	-	-	1.2.25
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	STRAIGHT LINE BEADS ON M.S PLATE 10mm THICK AND MULTIPASS PRACTICE IN HORIZONTAL POSITION	TOLERANCE ±1	TIME : 8 Hrs
		CODE NO. WS20N1225E1	

Job Sequence

Preparation

- Mark and cut the plate as per drawing. Clean the surface and file the edges before punching the lines.
- Scribe lines and make punch marks as per job drawing.
- Select a 3.15mm electrode and set 110 amps and use DCEN. Set the job in a horizontal position.
- To avoid sagging molten metal, use a short etc.
- Convex bead will trap slag.
- Start at left hand side of the plate hold the electrode pointing upward at angle of 70° to 80° to the surface of base metal. Use a travel angle 70° to 80° to weld direction.
- Remove the slag with a chipping hammer and clean the bead with a wire brush.

Inspection of bead

- Inspect the bead weld for surface defects like undercut, slag inclusions, overlap etc.

Skill Sequence

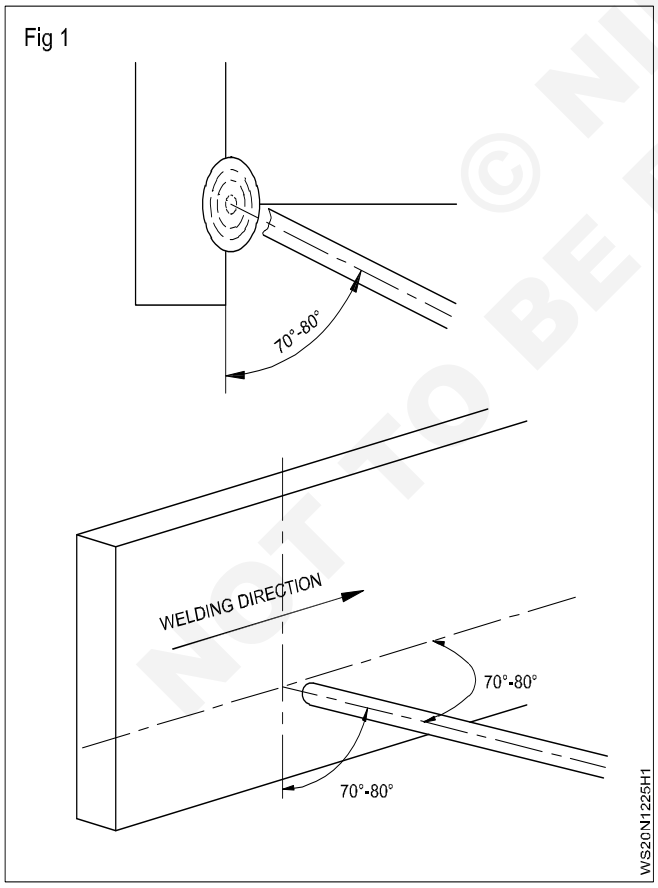
Weld straight line bead on MS plate 10mm in horizontal position

Objective: This shall help you to
• prepare and weld straight line bead on MS plate 10mm in horizontal position.

Making a bead on plate weld in the horizontal position is very much like making it in a flat position.

But the angle of electrode should be held at an angle to the surface and inclined to the line of travelling as shown in the (Fig 1).

Fig 1

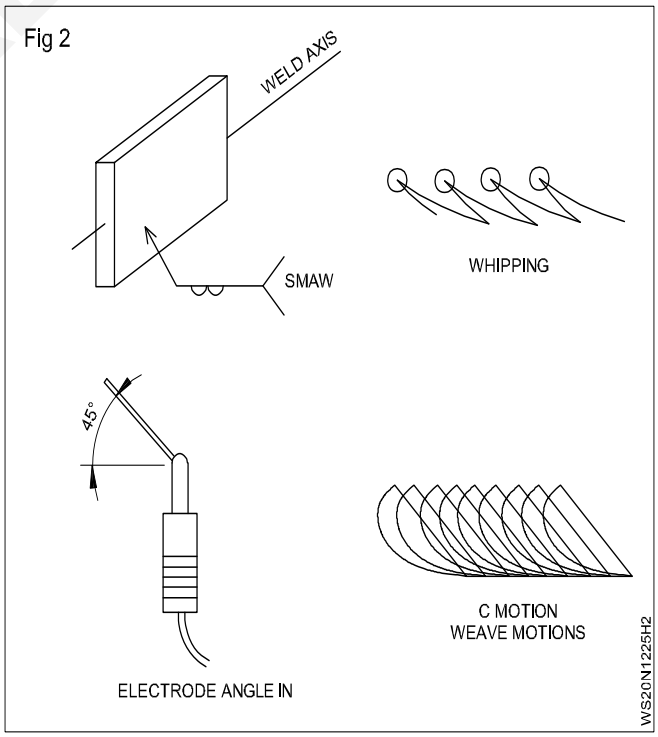


Reduce the current to get faster cooling. This helps to avoid overhanging of weld puddle at the bottom side of the plate.

Use a faster travel speed and maintain weld puddle size not larger than the coating diameter of the electrode.

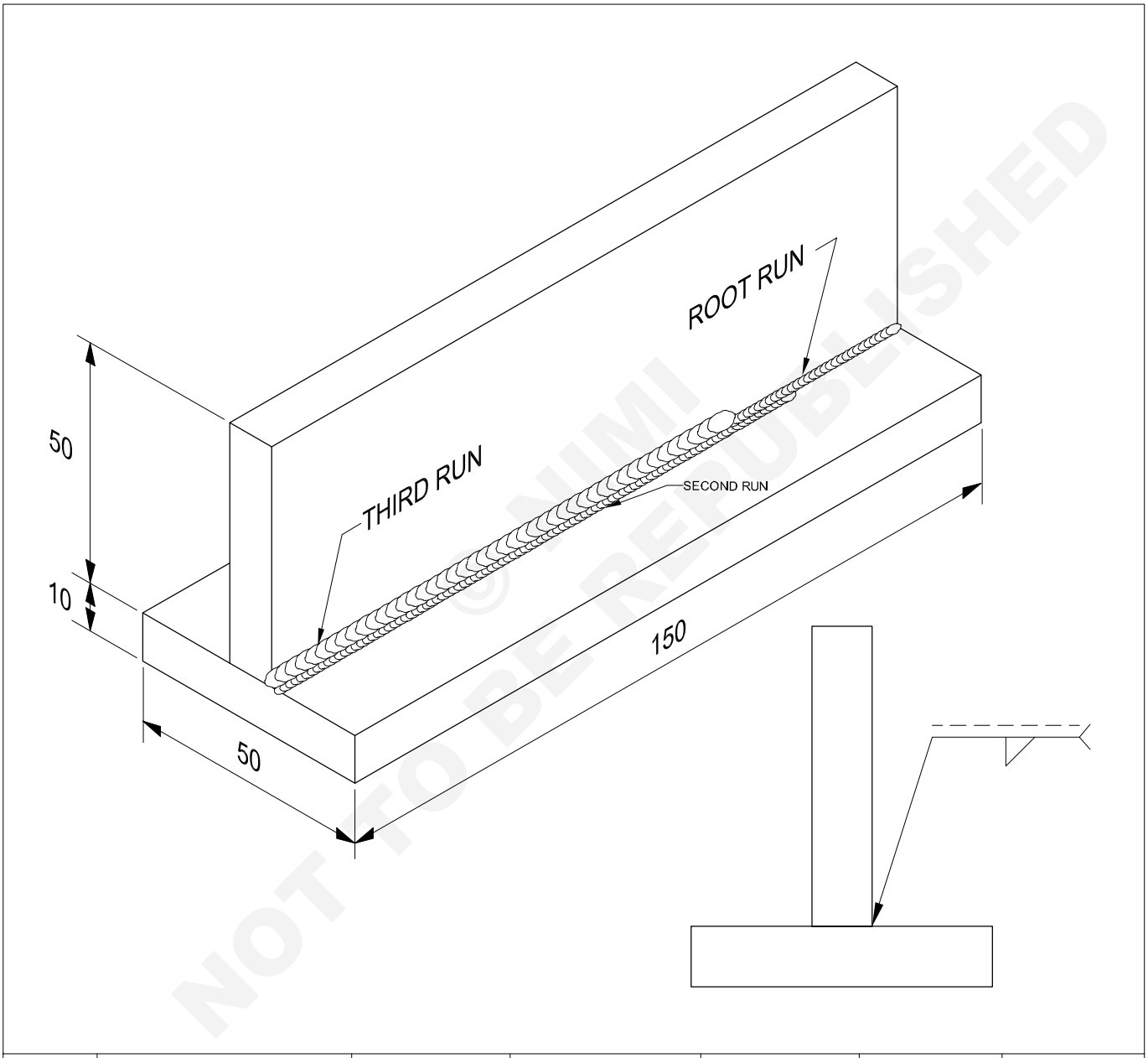
Move the electrode to the right with a slight whipping motion or a "C" motion as shown in (Fig 2). This helps to cool the puddle slightly, solidify faster and avoid sagging of bead. While using "C" motion pause at the upper left of the "C". (Fig 2)

Fig 2



Fillet - 'T' joint on MS plate 10mm thick in horizontal position - (SMAW-09)

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.**

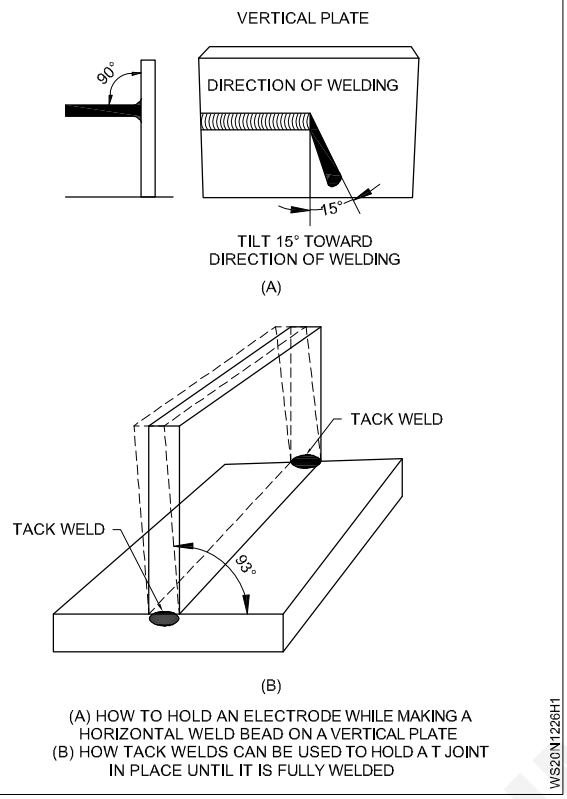


2	50 ISF x 10 - 150		Fe 310 - W			1.2.26
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**FILLET 'T'- JOINT ON M.S PLATE 10mm THICK IN HORIZONTAL POSITION (2F)**				TOLERANCE ±1	TIME : 8 Hrs
					CODE NO. WS20N1226E1	

Job Sequence

- Prepare and clean the plates as given in

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

- 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.
- 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

Objective: This shall help you 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)

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).

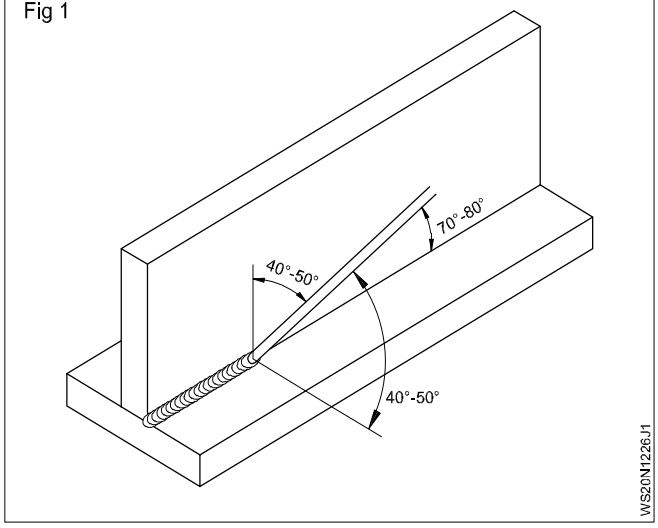
Maintain a short arc to get uniform fusion and proper root penetration.

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

Deposit second run with a 4 mm 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. (As in Fig 2.)

This second run has to be deposited partly covering the root run and partly on the bottom plate.(Fig 4)

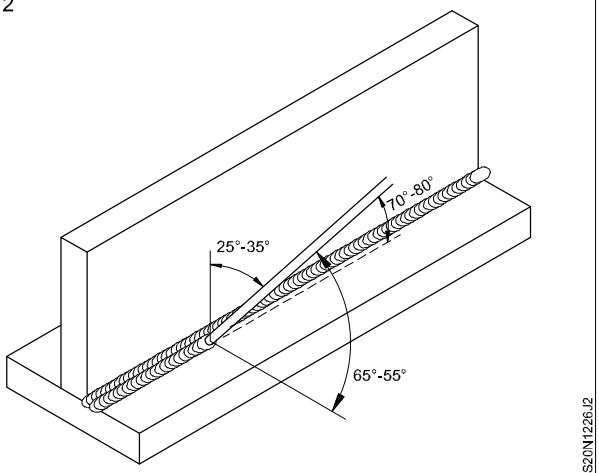
Fig 1



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

Deslag and clean the weld bead.

Fig 2



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.

Deslag and clean the weld bead.

Fig 3

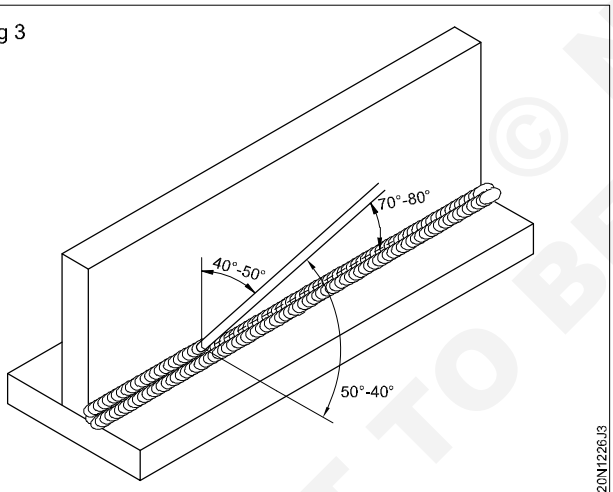
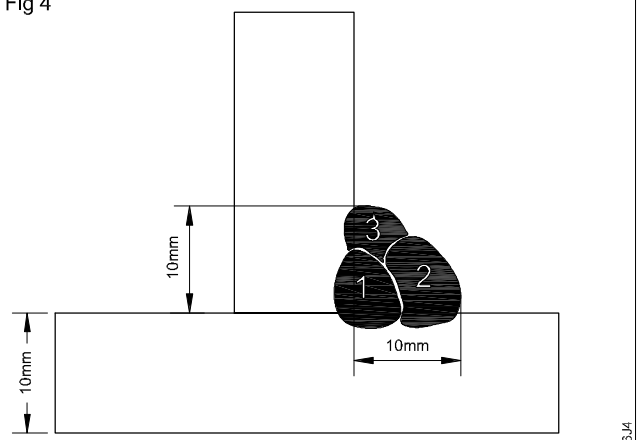


Fig 4



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

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

Inspection of T joint

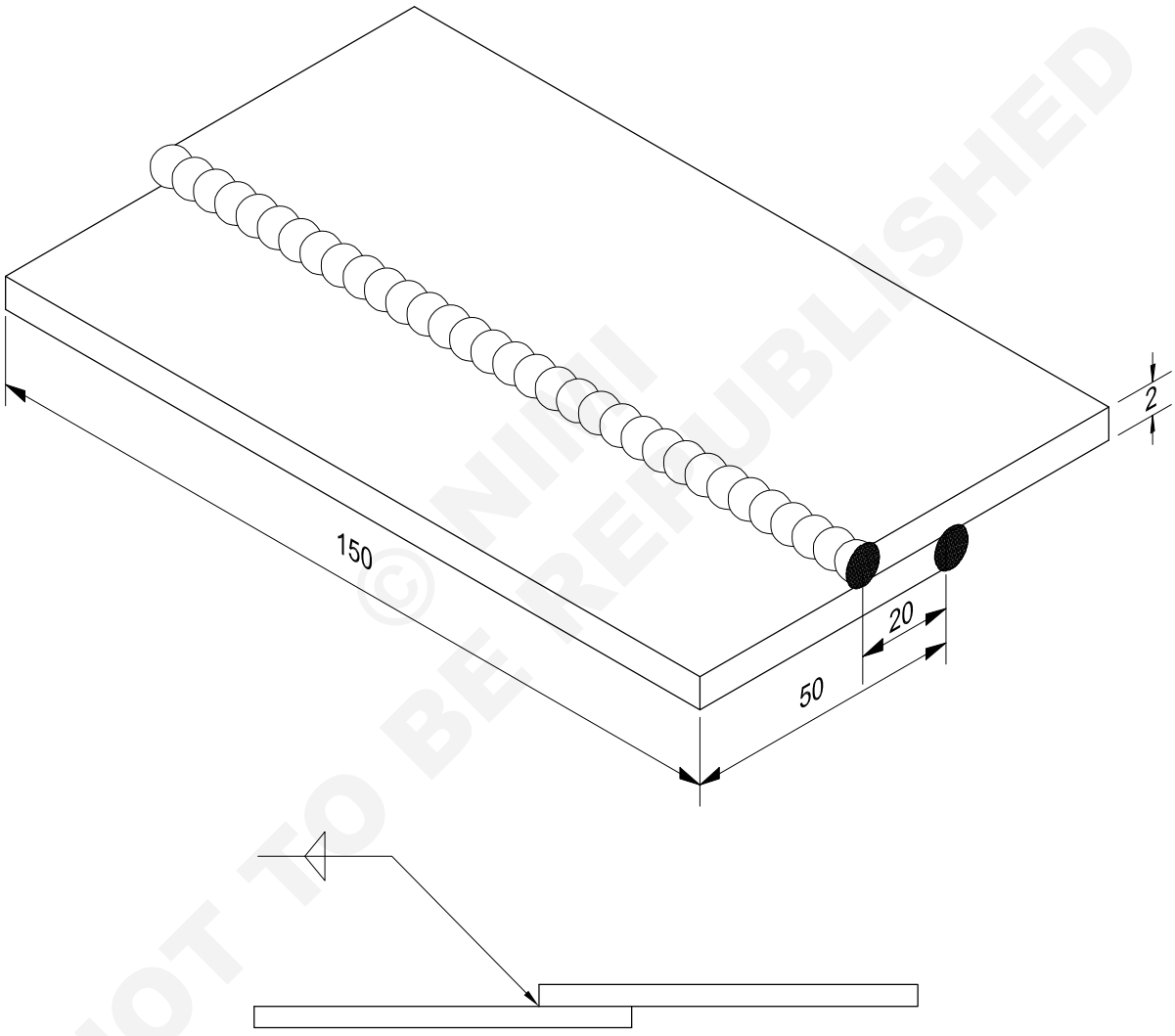
Inspect the fillet weld for equal leg length and correct size.

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

Fillet - lap joint on MS sheet 2mm thick in horizontal position (2F)

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.**



2	ISST 50 x 2 - 150	-	Fe 310 - W	-	-	1.2.27
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**FILLET - LAP JOINT ON M.S.SHEET 2mm THICK IN HORIZONTAL POSITION (2F)**	TOLERANCE ±1	TIME
		CODE NO. WS20N1227E1	

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/m^2.
- 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)

Objective: This shall help you 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/cm^2.
- 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.

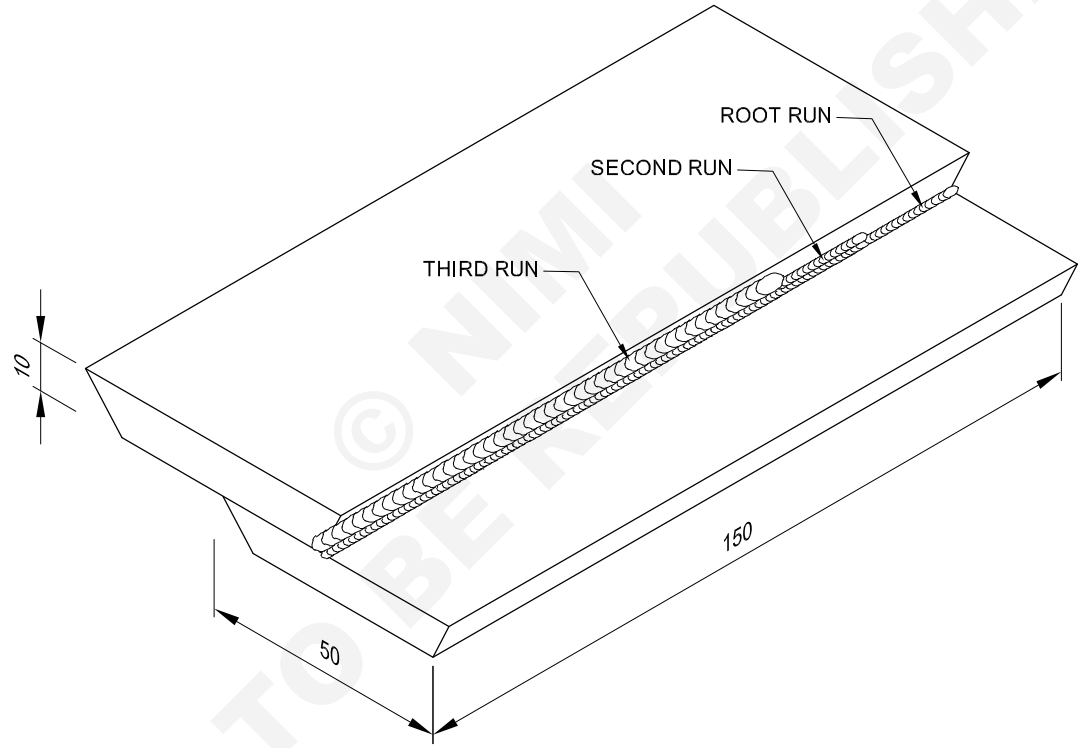
– No undercut at the toe of weld.

– Smooth ripple appearance.

– Proper crater filling.

Fillet lap joint on MS plate 10mm thick in horizontal position (2F)

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.**



2	50 ISF x 30 - 150	-	Fe 310 - W	-	-	1.2.28
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FILLET LAP JOINT ON M.S PLATE 10mm THICK HORIZONTAL POSITION (2F)	TOLERANCE ±1	TIME
		CODE NO. WS20N1228E1	

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 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.
- 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 (2F)

Objective: This shall help you 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.

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

Inspection of Tee joint

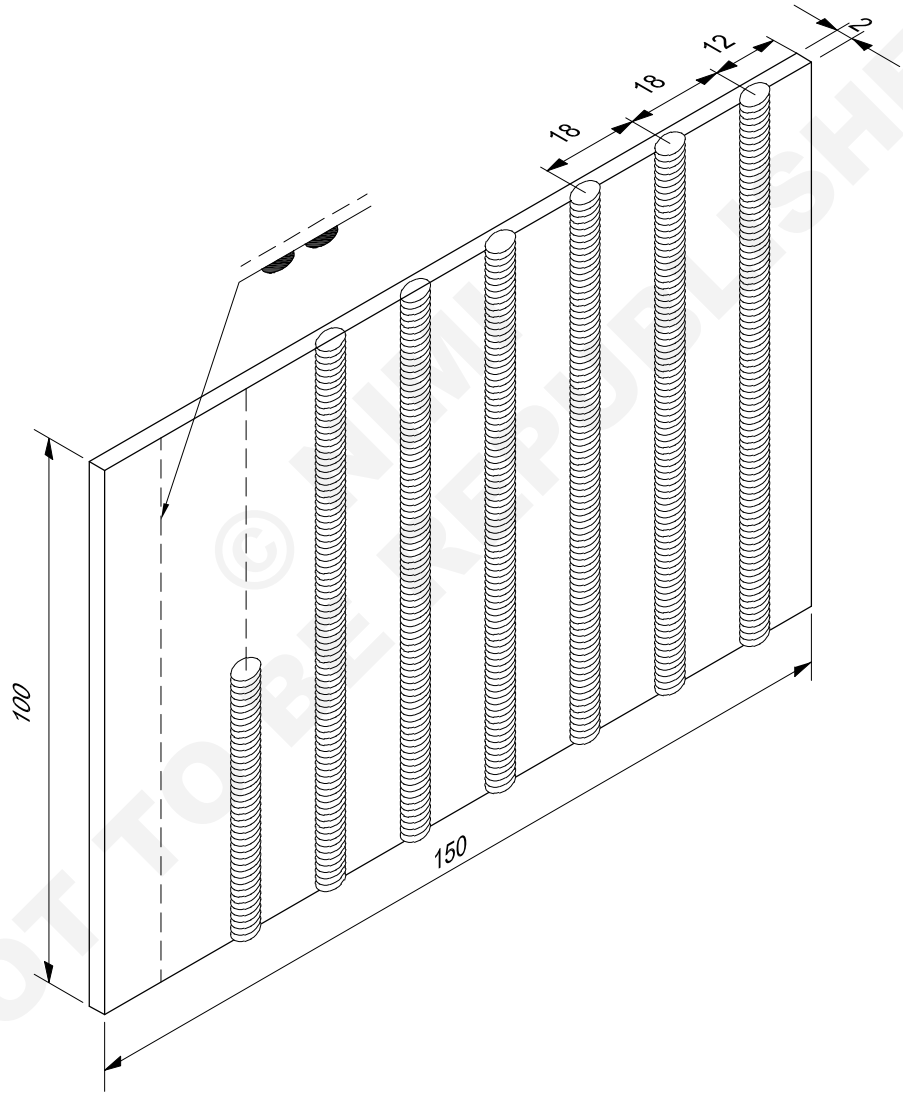
Inspect the fillet weld for equal leg length and correct size.

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

Fusion run with filler rod in vertical position on 2mm thick MS sheet (OAW-10)

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

- **prepare the job as per drawing**
- **fix the job in vertical position in the weld positioner**
- **select the nozzle and filler rod size and the gas pressure**
- **manipulate the blowpipe and filler rod maintaining proper angle**
- **deposit bead in vertical position in upward direction along a straight line**
- **clean and inspect the bead visually and identify the defects.**



1	ISST 100 x 2 - 150	-	Fe 310 - W	-	-	1.2.29
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**FUSION RUN WITH FILLER ROD IN VERTICAL POSITION ON 2mm THICK M.S SHEET (OAW-10)**	TOLERANCE ±1	TIME
		CODE NO. WS20N1229E1	

Job Sequence

- Prepare the sheet as per drawing and scribe straight lines and punch mark them as per the sketch.
- Clean the surface of the sheet.
- Fix the marked sheet on the weld positioner or vertical welding jig in vertical position at a convenient height.
- Select No. 5 size nozzle and fix it to the blow pipe.
- Select 1.5mm dia. CCMS rod and set 0.15 kg/sq.cm pressure for the gases.
- Follow necessary safety precautions.
- Light the blowpipe and set neutral flame.
- Hold the blow pipe at 75° and the filler rod at 30 - 40° to the line of weld. The angle between the blow pipe nozzle and filler rod and the sheet surfaces should be at 90°.
- Deposit the weld bead starting from the bottom most point of a punched line and moving upwards along the line.
- Ensure the melting of the base metal and the filler rod are kept as minimum as possible.
- Maintain proper angles for the blow pipe and filler rod.
- Move the blow pipe and filler rod without any side to side movements along the marked line at a uniform speed in upward direction.
- Do not allow the inner cone of the flame to come in contact with the molten metal (puddle) to avoid back fire.
- Complete depositing the weld bead up to the top end of the line and ensure to fill the crater.
- Ensure to avoid undercut defect by proper manipulation of the blow pipe and the filler rod.
- Clean the bead and visually inspect for any surface / external defect.
- Repeat the exercise on the other punch marked lines for more practice.

Skill Sequence

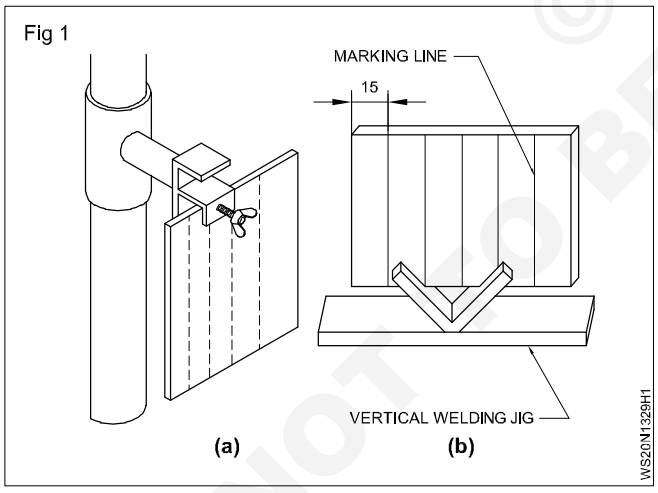
Fusion run with filler rod, 2mm MS sheet in vertical position

Objective: This shall help you to

- **prepare and carry out fusion run with filler rod in 2mm MS sheet in vertical position.**

Job setting: Fix the job in vertical position. (Figs 1A or B) at a level from the ground based on your height.

Fig 1

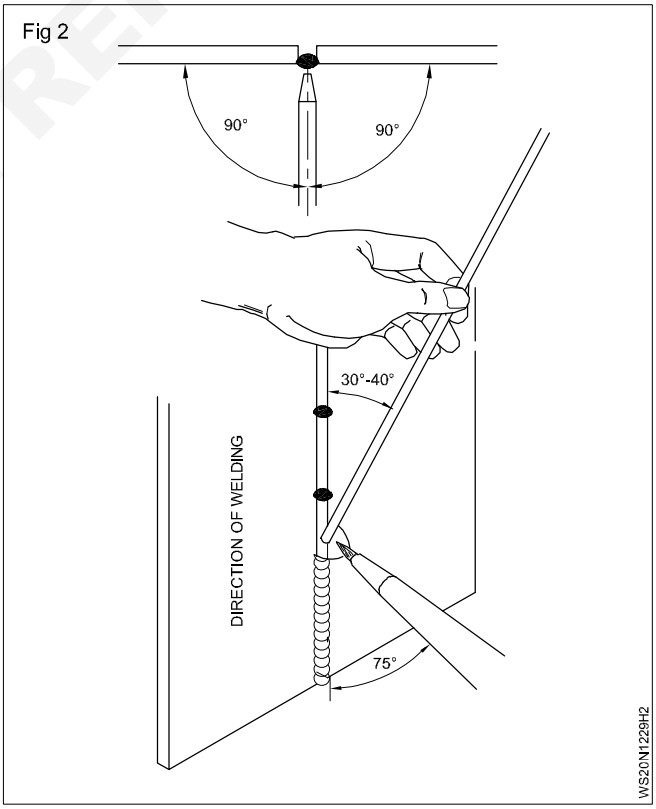


Fix nozzle No. 5 and select a CCMS rod 1.5mmø.

Welding technique: Deposit the weld in vertical upward position.

Maintain the angle of the blowpipe at 75° and the filler rod at 30° - 40°. (Fig 2)

Fig 2

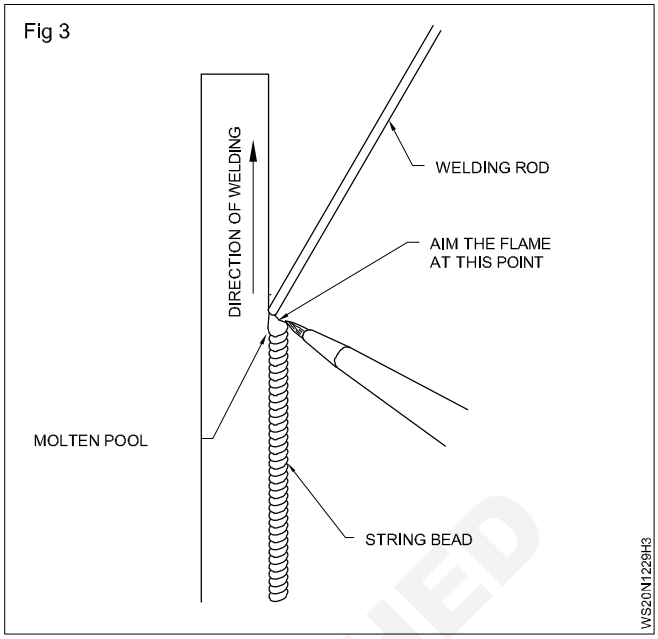


Control the molten pool without giving any circular motion to the blowpipe. (Fig 3)

Take due care that the weight of the blow pipe and hoses do not pull your hand downwards while the deposition of weld metal progresses upwards.

Inspect the weld bead for surface defects like undercut, poor bead appearance due to sagging of weld metal, excessive reinforcement, wavy weld deposit etc.

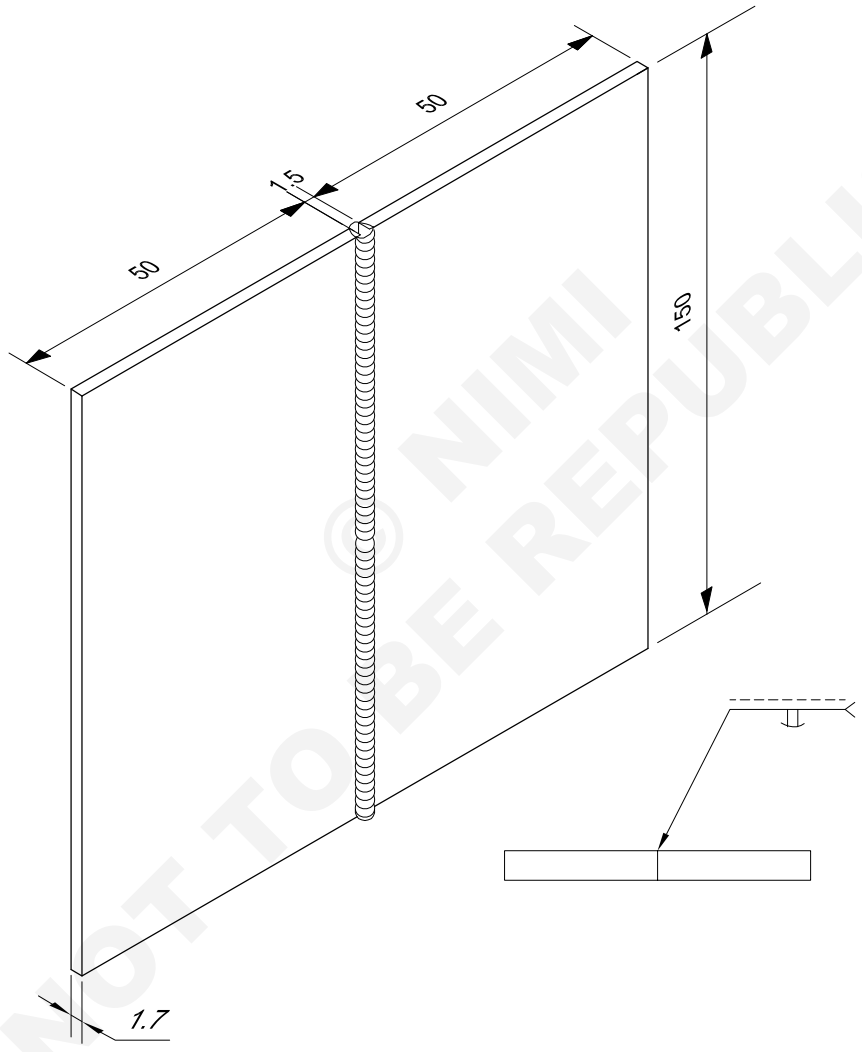
Fig 3



Square butt joint on MS sheet 2mm thick in vertical position

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.**



2	ISST 50 x 2 - 150	-	Fe 310 - W	-	-	1.2.30
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SQUARE BUTT JOINT ON M.S.SHEET 2mm THICK IN VERTICAL POSITION (3G)	TOLERANCE ±0.5	TIME
		CODE NO. WS20N1230E1	

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/cm^2.
- 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 center.
- 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

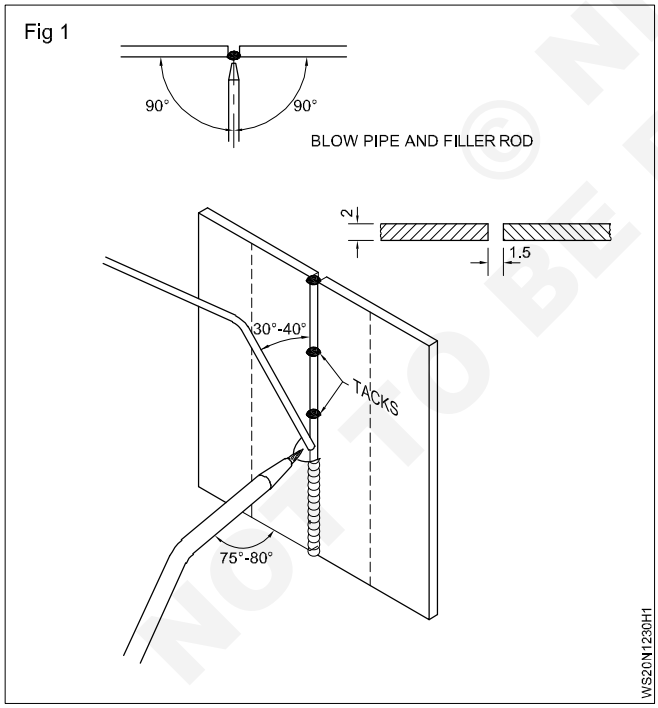
Square butt joint on MS sheet 2mm in vertical position

Objective: This shall help you to

- **prepare and weld square butt joint on MS sheet 2mm in vertical position.**

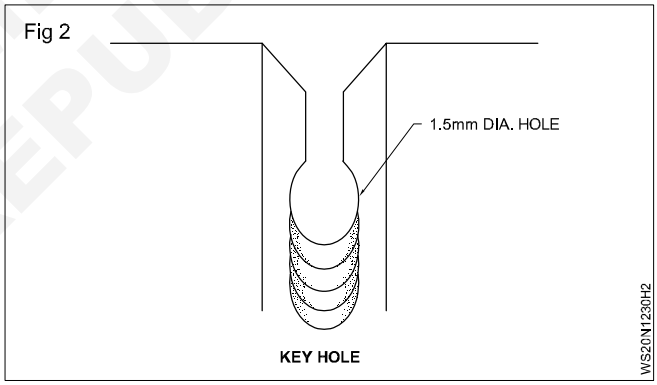
Tack the two sheets together as a square butt joint and fix the job in vertical position. (Fig 1)

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.

Fig 2



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.

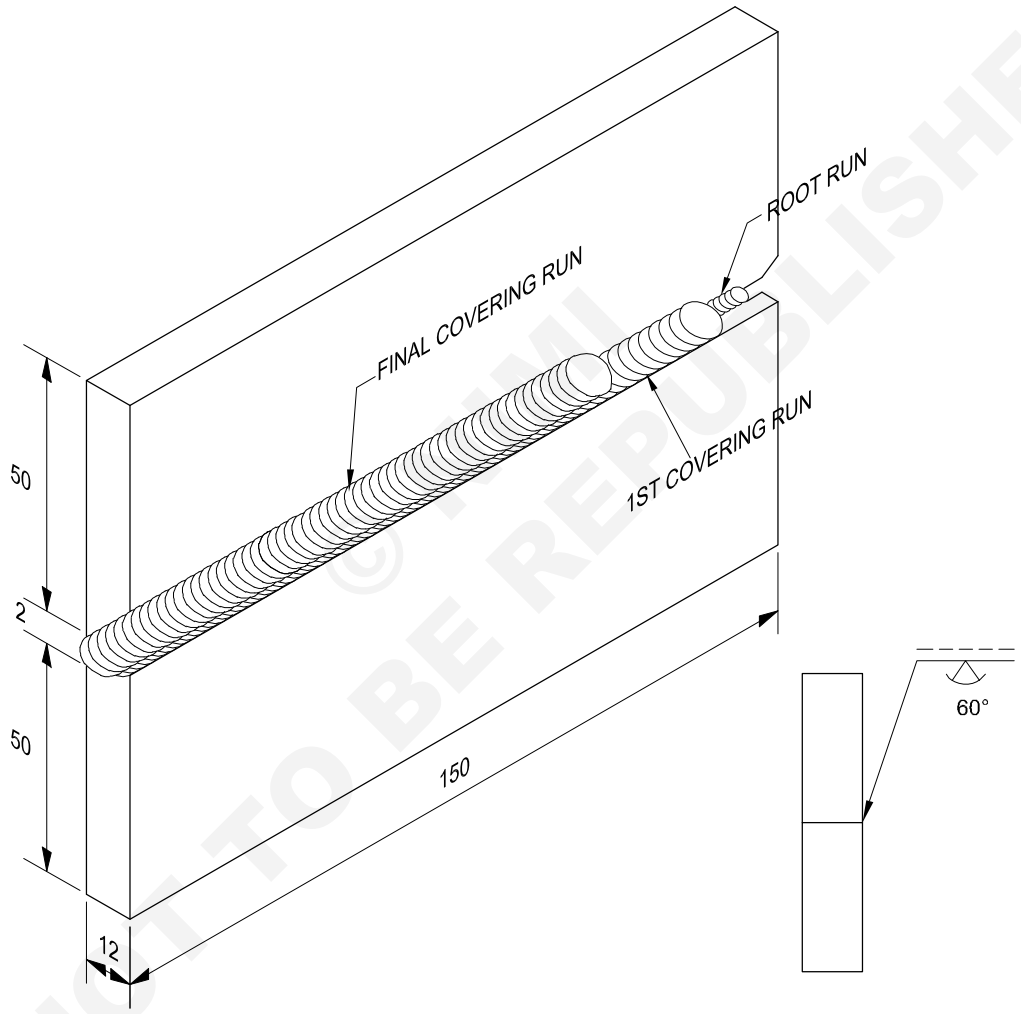
End the weld at the top of the joint and ensure to fill the crater.

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.

Single "V" butt joint on MS plate 12mm thick in horizontal position (2G)

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.**



2	50 ISF 12 - 150	-	Fe 310 - W	-	-	1.2.31
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SINGLE "V" BUTT JOINT ON M.S PLATE 12mm THICK IN HORIZONTAL POSITION (2G)	TOLERANCE ±1	TIME
		CODE NO. WS20N1331E1	

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.

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

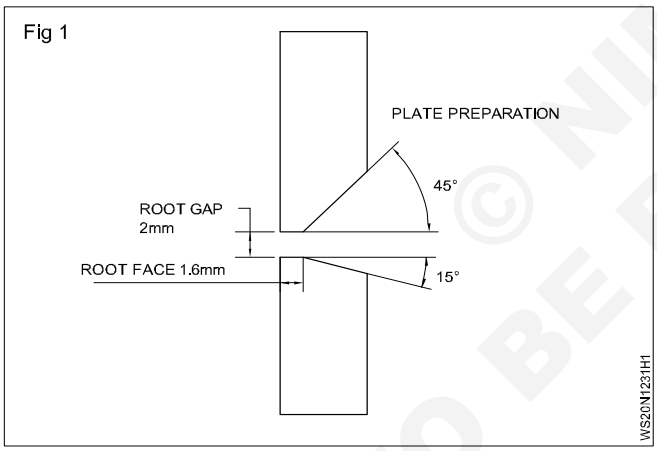
Single 'V' butt joint on MS plate 12mm thick in horizontal position

Objective: This shall help you 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)

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 on both ends.

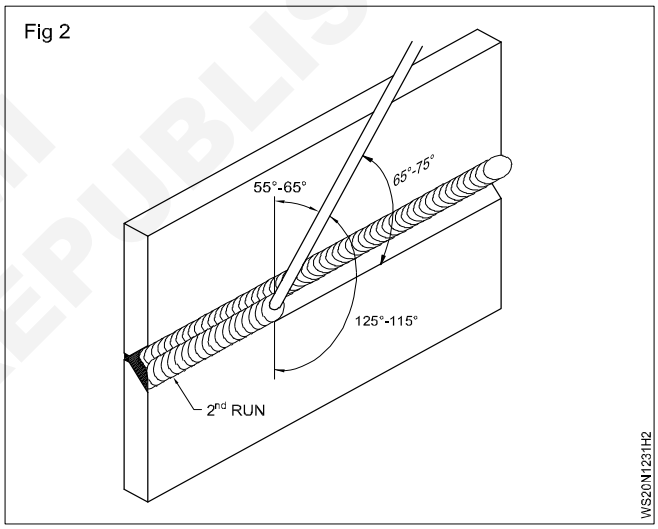
This type of beveling is used specially for welding single 'V' butt joint in horizontal position to deposit the metal against the effect of gravity.

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.

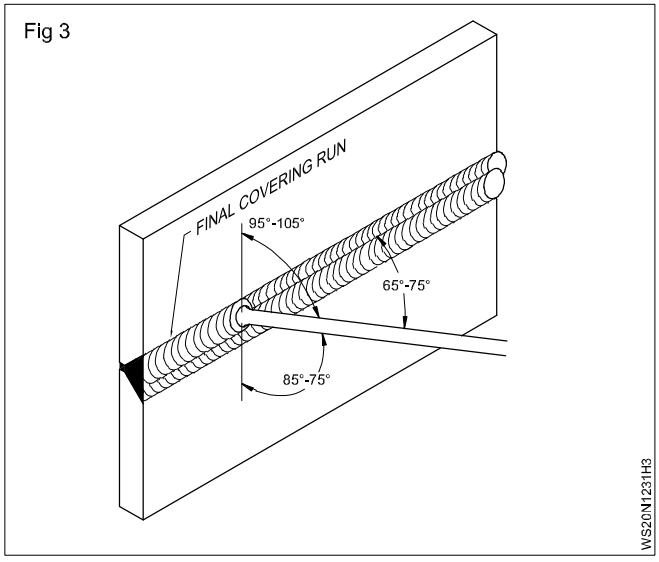
Deposit the 2nd run by reducing the electrode angle to the upper vertical plate 55° to 65° using slight weaving motion. (Fig 2)

Fig 2



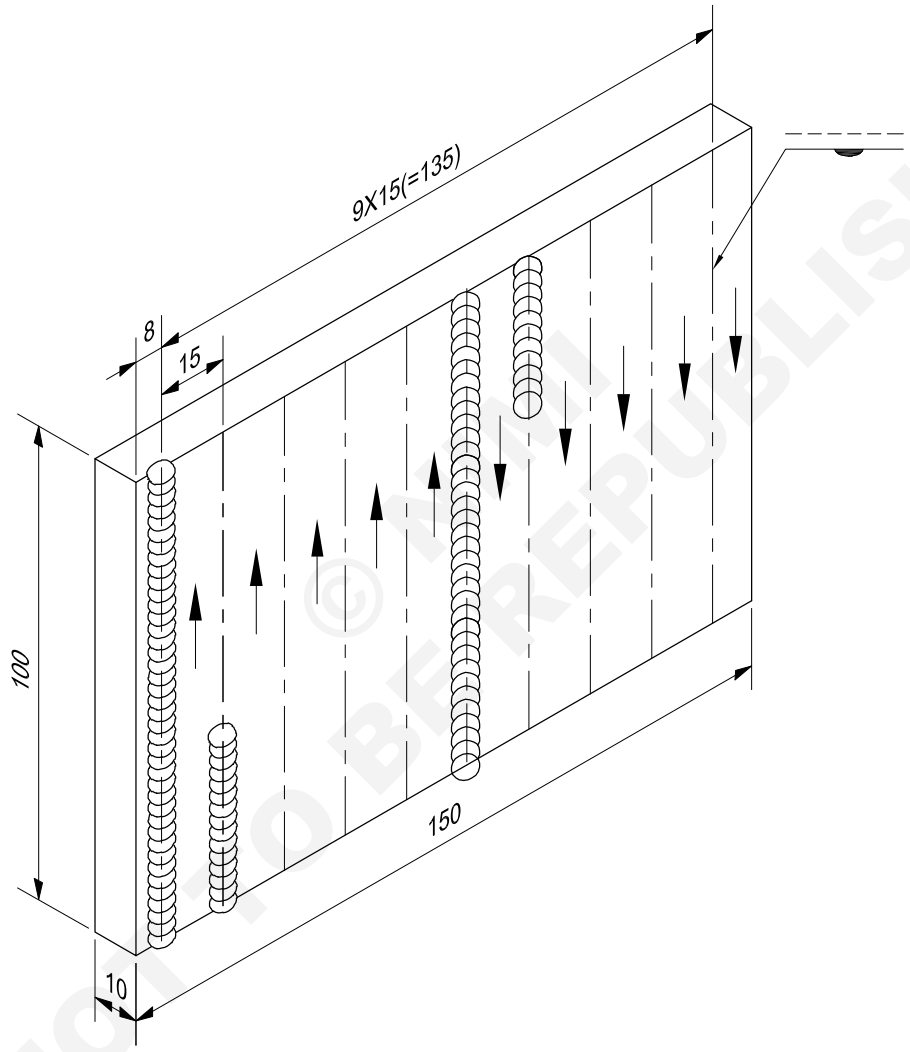
Deposit the 3rd run by increasing the electrode angle 95° to 105° to the upper vertical plate using slight weaving motion. (Fig 3) Deposit the outer edge of the upper fusion face and the junction of the 2nd run.

Fig 3



Weaved beads on MS plate 10mm thick in vertical position (SMAW-12)

Objectives: At the end of this exercise you shall be able to
- **fix the jobs in vertical position using positioner**
- **select the electrode, current, polarity and arc length**
- **deposit bead with uniform width on the surface of the plate in upward and downward direction**
- **clean and inspect the welds for bead uniformity and surface defects.**



1	100 ISF 10 - 150	-	Fe 310 - W	-	-	1.2.32
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS	WEAVED BEADS ON M.S. PLATE 10 mm THICK IN VERTICAL POSITION	TOLERANCE ±1	TIME
		CODE NO. WS20N1232E1	

Job Sequence

Vertical upward

- Cut the MS plate 10mm thick to size.
- Mark straight lines as per drawing and punch mark the lines.
- Position the plate vertically by the fixture at a convenient height.
- Set the current 100 amps suitable for 3.15mm electrode to deposit the bead vertically upwards.
- Wear safety apparels.
- Strike the arc and deposit the straight line bead in vertical position till the weld reaches the top edge.
- Fill the crater by striking and breaking the arc at the top end of the bead.
- Repeat the upward welding for another 4 beads.

Vertical downward

- Strike and maintain a long arc at the starting point on the top edge of the 6th line.
- Move the electrode downwards reducing the arc length to a short arc.
- Ensure to keep the molten slag away from the molten pool by holding the electrode at proper angle.
- Maintain a faster speed of travel of the electrode downwards than the speed used for upward welding.
- Stop the downward movement of the electrode for 1 or 2 seconds at the bottom edge of the bead to fill the crater.
- Deslag and clean the beads.
- Repeat the downward welding for another 4 beads.
- Check the size, shape and ripples of all the beads and also check for surface defects.

Skill Sequence

Weaved bead on MS plate 10mm thick in vertical position

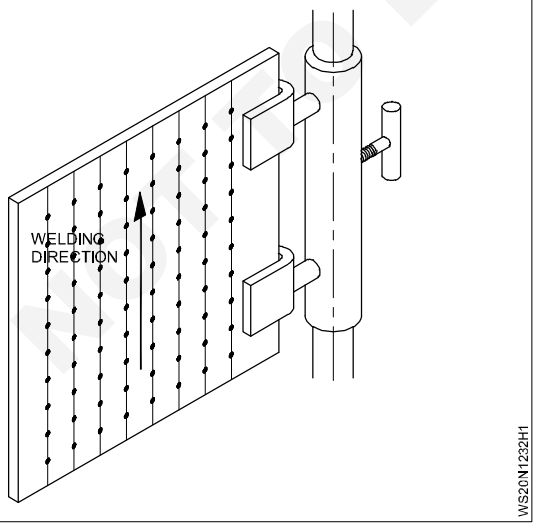
Objectlives: This shall help you to
• prepare and make weavers bead on MS plate of 10 m,m thick in veertical position

Preparation

Cut the plate to size by gas cutting, grind the edges to square and remove burrs by filing or by grinding. After cleaning the surface, mark and punch a straight line. 5 lines are to be used for vertical upward and 5 lines for vertical downward.

Fix the plate in vertical position. (Fig 1)

Fig 1

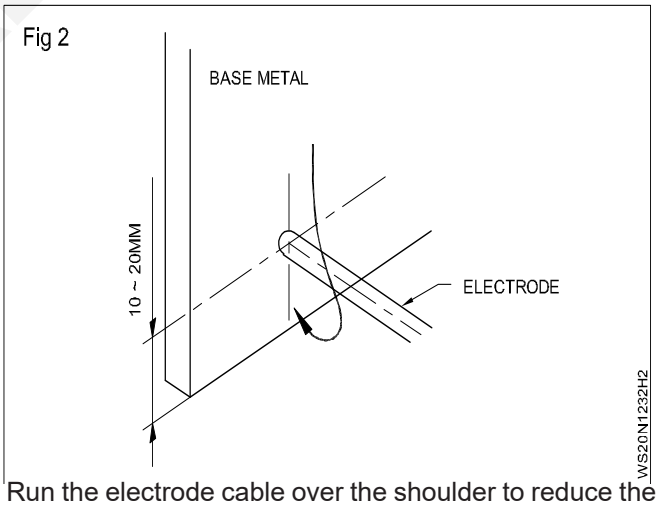


Vertical Up

Use a 3.15 mm dia. electrode with 100 amps current; use less current than in flat position welding for the same thickness of plate so as to maintain a small molten pool.

Deposit straight line bead in vertical position with an electrode movement slightly sideway, and in a steady upward direction. (Fig 2)

Fig 2



Run the electrode cable over the shoulder to reduce the strain on the hand while moving the electrode holder in the upward direction.

Maintaining the angle of electrode 80° to the line of weld. (Fig 3) and ensure uniform speed of welding in the vertical direction.

Maintain a short arc to get uniform fusion and to protect the weld metal rolling down due to gravity. (Fig 4)

Deslag and clean the weld bead.

Avoid long arc length.

Fig 3

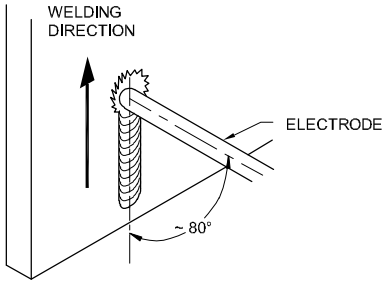
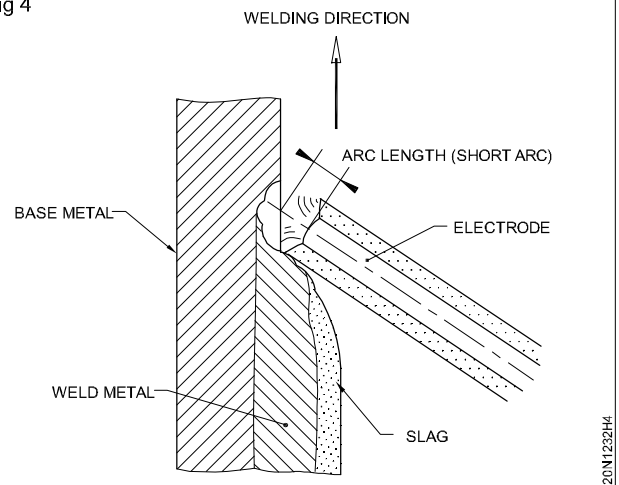


Fig 4

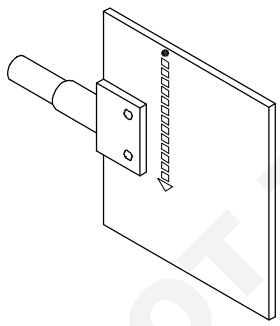


Vertical Down

Select an electrode of 3.15 mm dia. designed for welding vertically downwards, and set a current of 100 amps. Use straight polarity in the case of DC machines.

Start welding at the top of the work piece along the 6th marked line. (Fig 5)

Fig 5



Keep the electrode at right angle to the work piece, holding it slightly below the horizontal as shown in Fig 6.

Adjust the welding speed to get good fusion on the surface. Use a short arc. The welding speed should be faster than the speed used for vertical up welding.

Adjust the electrode angle to control the slag. If the slag is flooding the crater, the electrode must be held at a steeper angle as shown in (Fig 7). Weld up to the bottom end of the work piece.

Fig 6

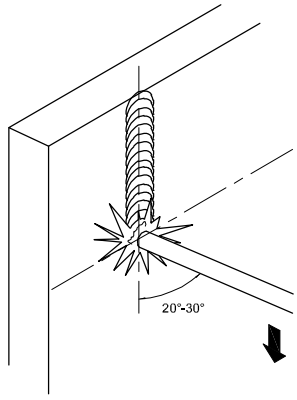
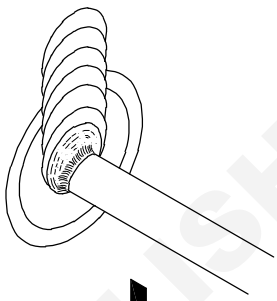
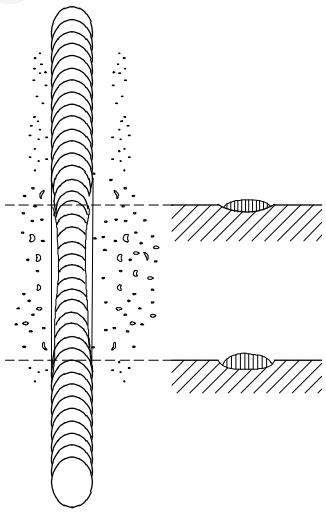


Fig 7



Check the weld for: (Fig 8)

Fig 8

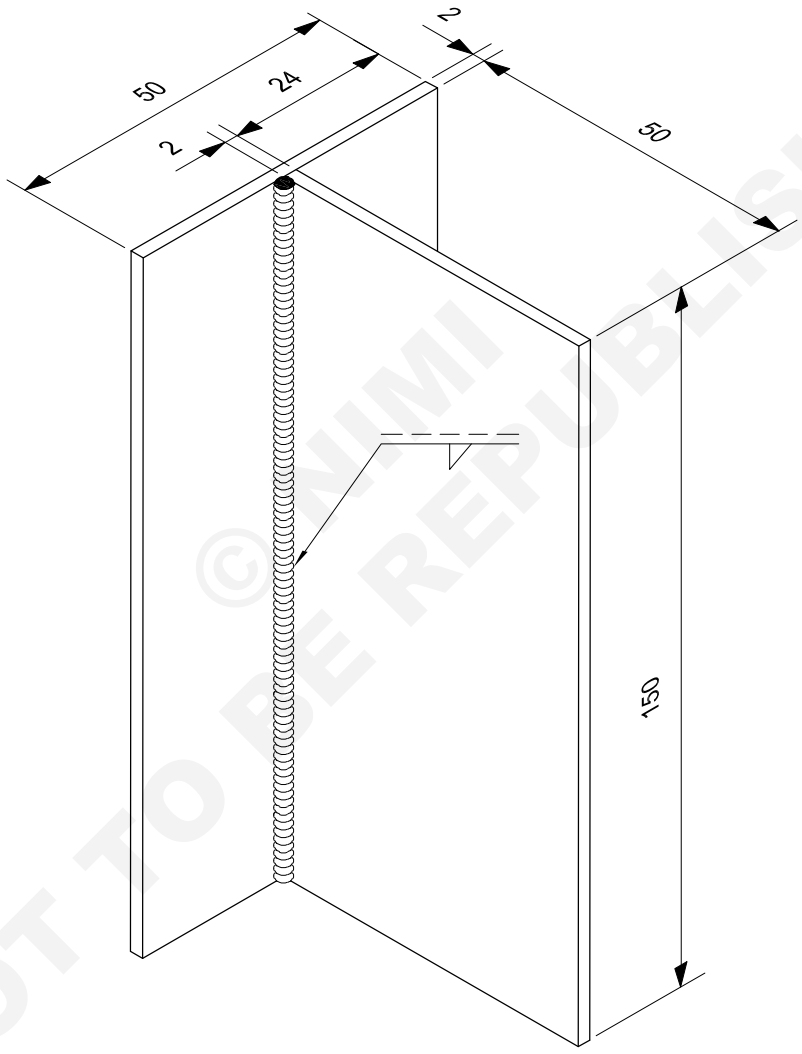


– Good weld size, shape and ripple formation
– no undercuts
– straight runs
– slag inclusions.

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

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.**



2	ISST 50 x 2 - 150	-	Fe 310 - W	-	-	1.2.33
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS	FILLET 'T' JOINT ON M.S SHEET 2mm THICK IN VERTICAL POSITION (3F)	TOLERANCE ±0.5	TIME
		CODE NO. WS20N1233E1	

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/cm^2.
- 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

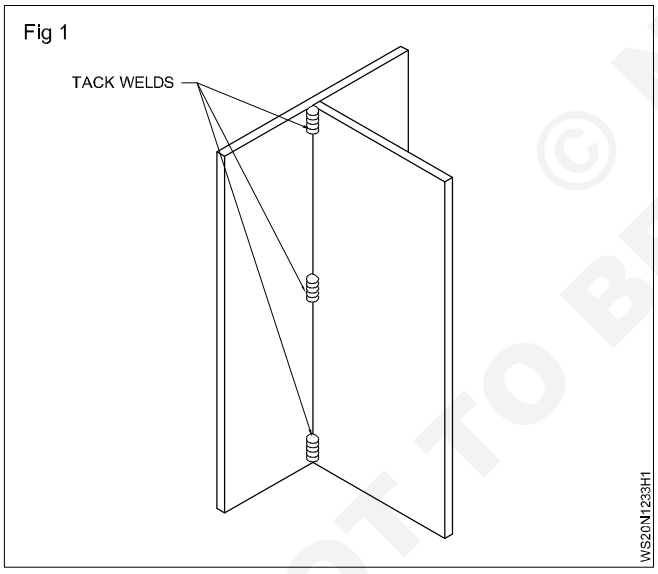
Fillet 'T' weld in MS sheet 2mm in vertical position

Objective: This shall help you 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 center.

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

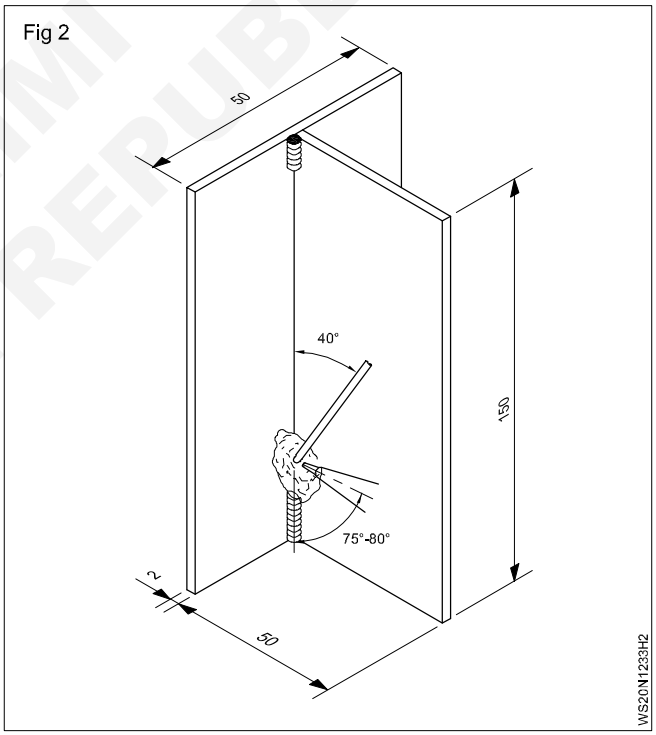
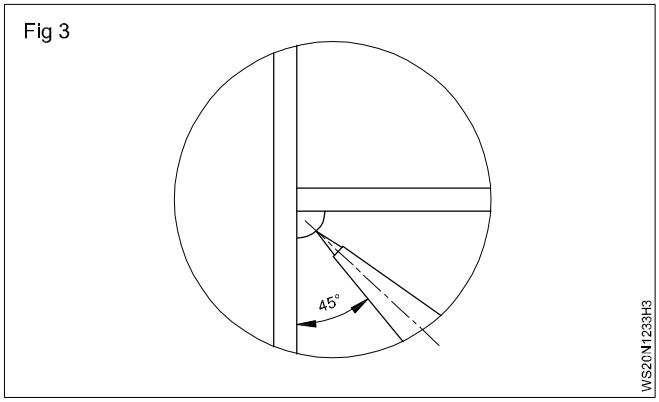


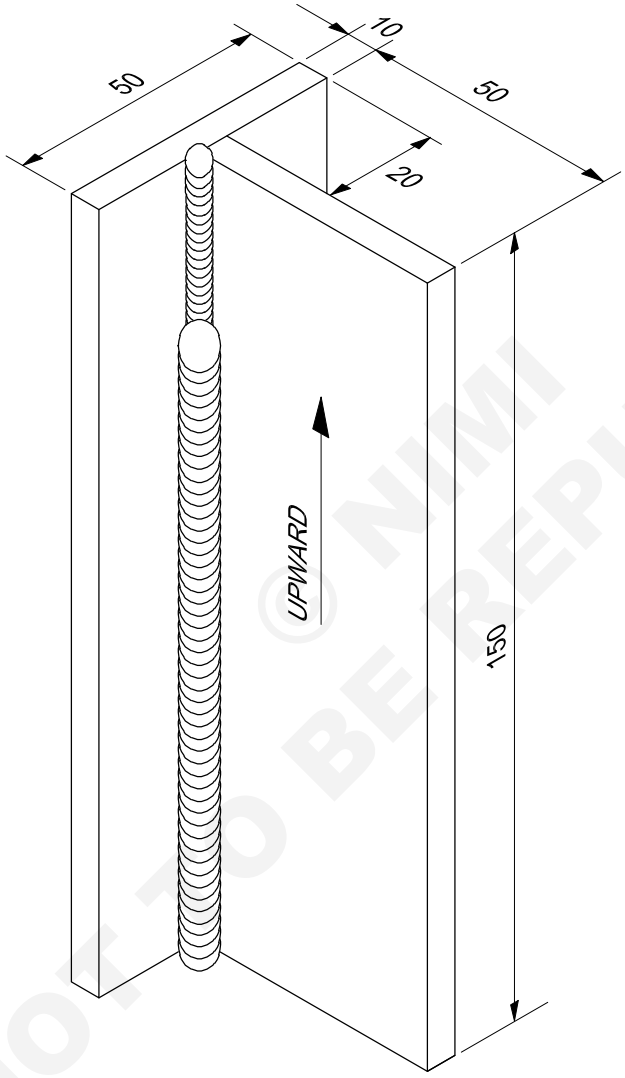
Fig 3

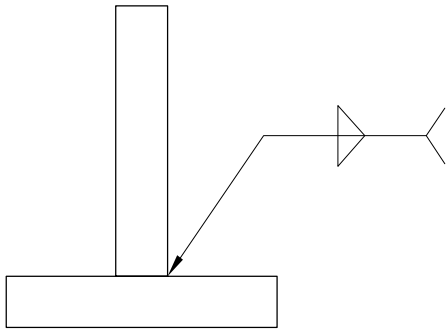


Fillet - "T" joint on MS plate 10mm thick in vertical position

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.**





2	50 ISF 10 - 150	TO EX.NO.28	Fe 310 - W			1.2.34
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	FILLET - "T" JOINT ON M.S PLATE 10mm THICK IN VERTICAL POSITION (3F)-(SMAW-13)				TOLERANCE ±1	TIME
					CODE NO. WS20N1234E1	

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.

- 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.

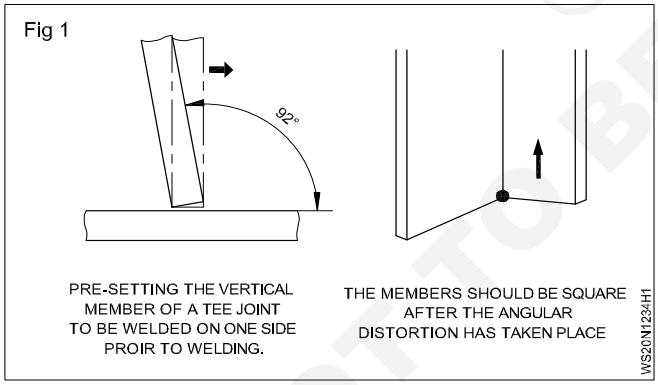
Skill Sequence

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

Objective: This shall help you 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



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 2

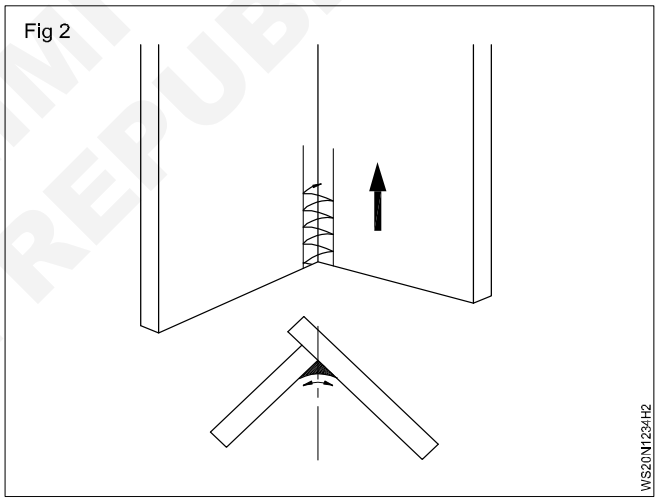


Fig 3

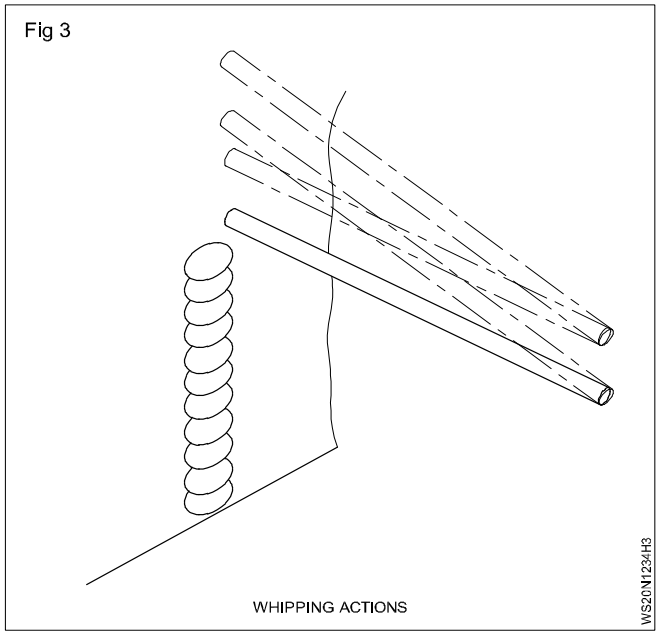
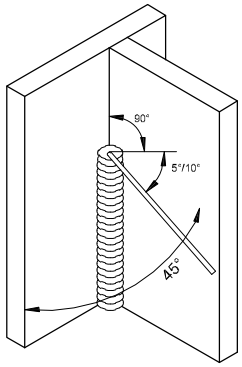


Fig 4



VERTICAL 'T' FILLET ELECTRODE ANGLES

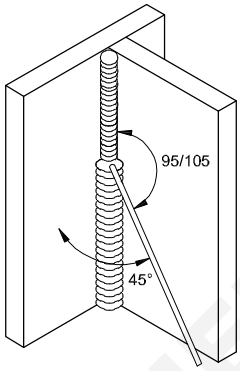
WS20N1234H4

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 .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 5) 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



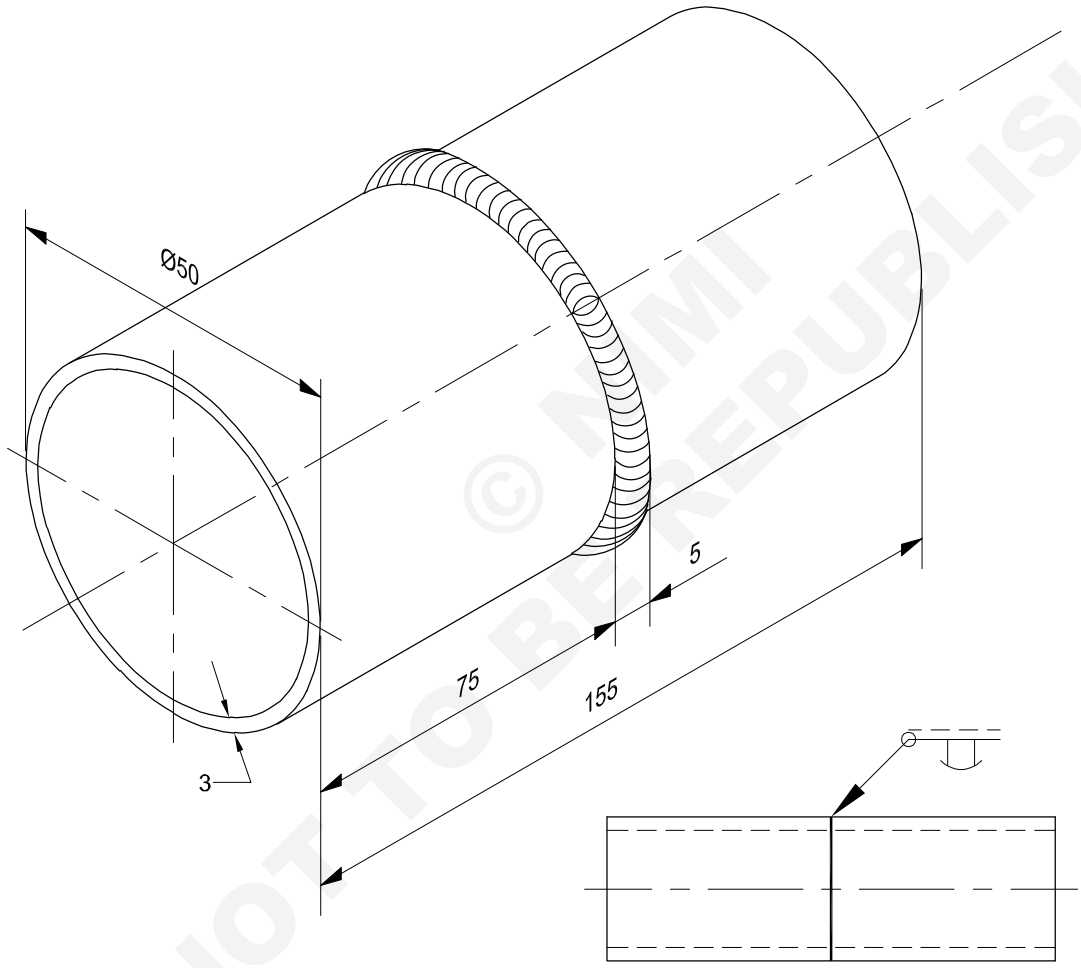
VERTICAL ' T ' FILLET

WS20N1234H5

Structural pipe welding butt joint on MS pipe ø50mm and 3mm wall thick in vertical position

Objectives: At the end of the 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.**



2	Ø50 x 3 - 77	-	Fe 310 - W	-	-	1.3.35
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**STRUCTURAL PIPE WELDING.PIPE BUTT JOINT ON M.S.PIPE Ø50 x 3mm WALL THICKNESS IN 1G (ROLLING)POSITION**	TOLERANCE ±1	TIME
		CODE NO. WS20N1335E1	

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/cm^2 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/cm^2 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.

Skill Sequence

Structural pipe welding butt joint on MS plate ø 50 × 3 mm wall thickness in 1G (Rolling) position

Objective: This shall help you to

- **prepare and weld structural pipe welding butt joint on MS plate ø 50 × 3 mm wall thickness in 1G (Rolling) 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.

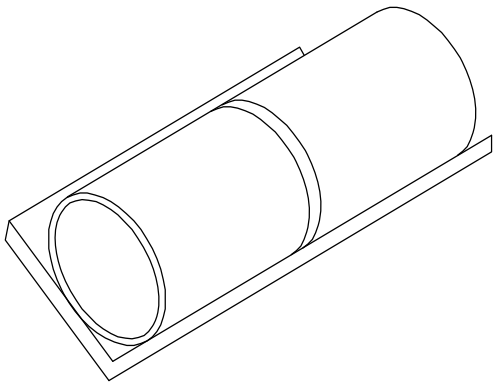
Clean the pipes and remove burrs, if any. Align the pipes in flat position as shown in Fig 1. Tack the weld joint by inserting 1.5 mm wire to maintain a uniform root gap. (Fig 2a and 2b) Ensure the tack welded pipes are coaxial. (i.e., the axis of both the pipes are the same.)

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.

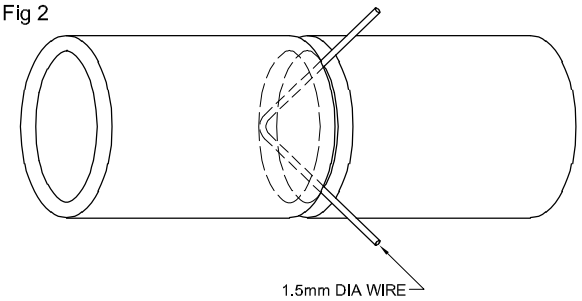
Fig 1



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.

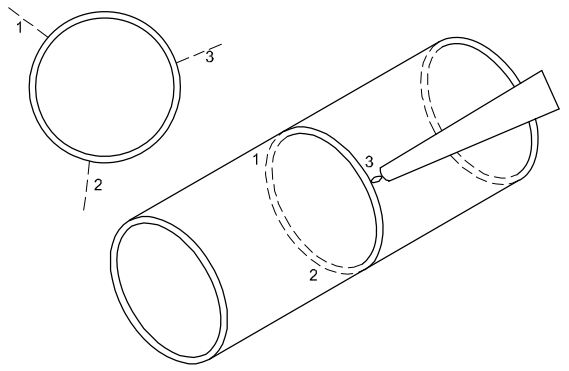
After completion of I segment welded, rotate the pipe joint in clockwise direction until the II segment will come to the position of I segment.

Fig 2



USE OF BENT WIRE OR SUITABLE SPACER TO SET ROOT GAP

(A)

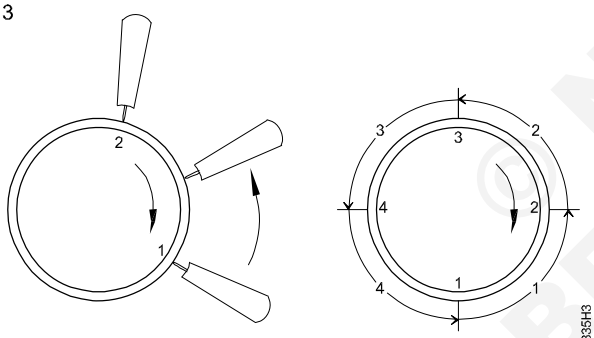


(B)

TACK WELDS AT POINTS 1, 2, AND 3

WS20N1335H2

Fig 3



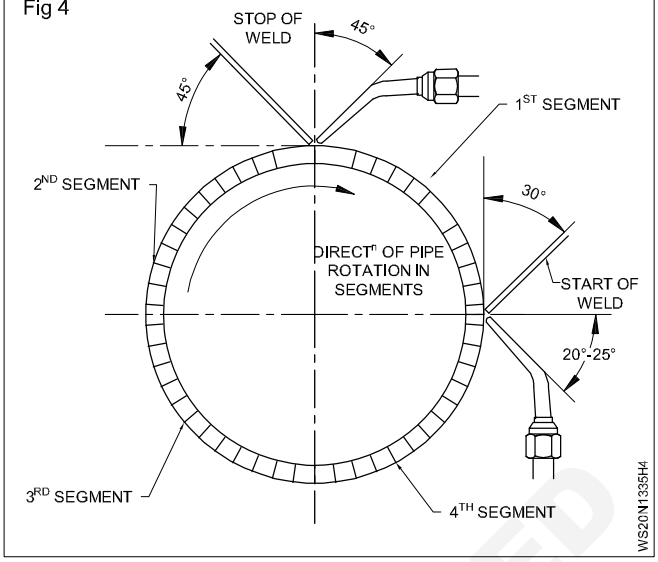
TORCH POSITION AND TURNING THE PIPE

WS20N1335H3

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.

Fig 4



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/cm^2 pressure for the gases and use 3mmø CCMS filler rod.

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

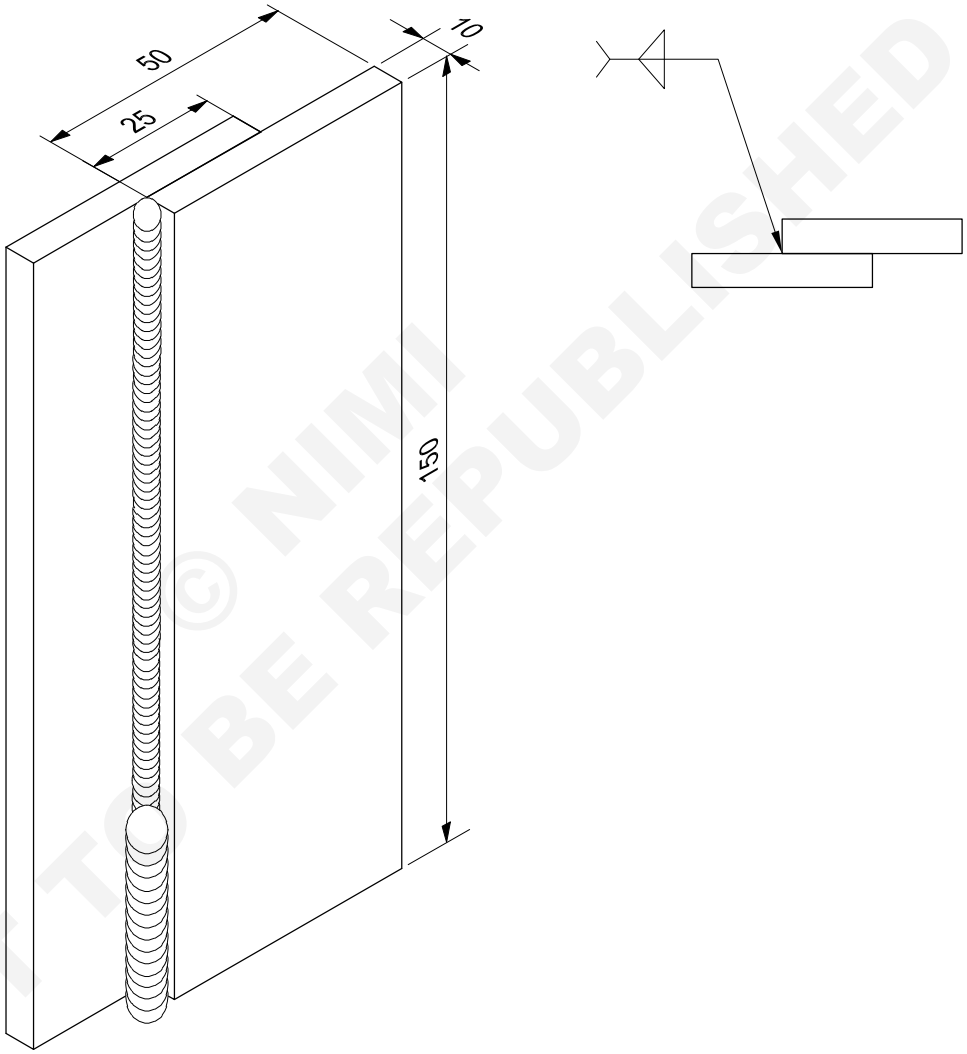
Follow the same welding technique used for the root run except maintaining a keyhole. Ensure proper fusion of the root run and the side walls of the V groove by proper movement of blow pipe and filler rod.

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

Fillet - lap joint on MS plate 10mm in vertical 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.**



2	50 ISF 10 - 150	-	Fe 310 - W	-	-	1.3.36
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FILLET LAP JOINT ON M.S PLATE 10mm IN VERTICAL POSITION (UPWARD)	TOLERANCE ±0.5	TIME
		CODE NO. WS20N1336E1	

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.

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.

Follow the necessary safety precautions during welding.

Skill Sequence

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

Objective: This shall help you 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 edge 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.

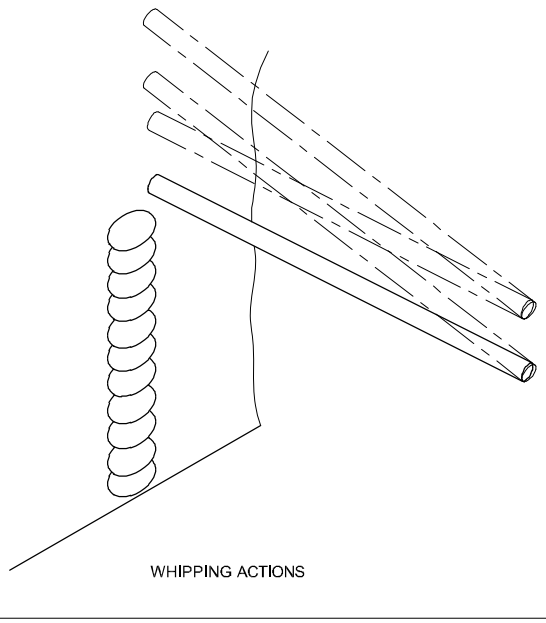
Use a short arc for depositing root run with whipping motion so as to prevent sagging of the weld metal. (Fig 1 and 2) Deposit the 2nd run with weaving motion and this will avoid sagging of the molten metal. The angle of the electrode should be 75° - 80°. (Fig 3)

Any one of the weaving motion shown in Fig 2 can be used.

Do not break the arc while moving in the upward direction.

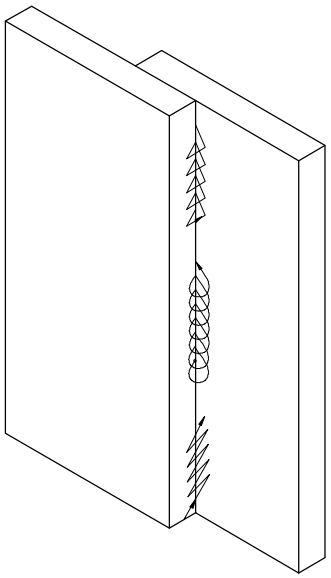
The motion of the electrode should be a weaving motion.

Fig 1



WHIPPING ACTIONS

Fig 2

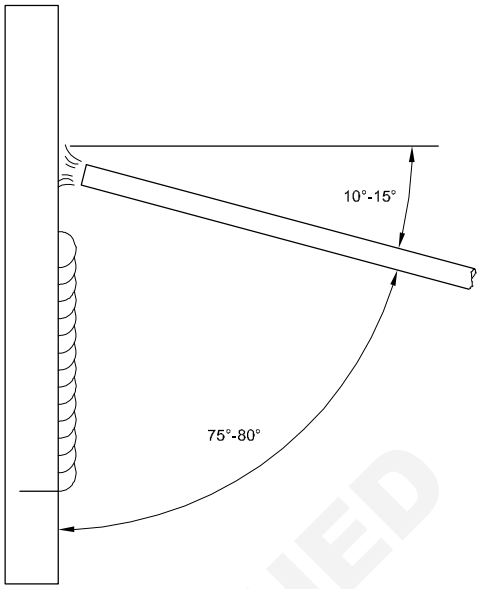


WS20N1336H2

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.

Fig 3



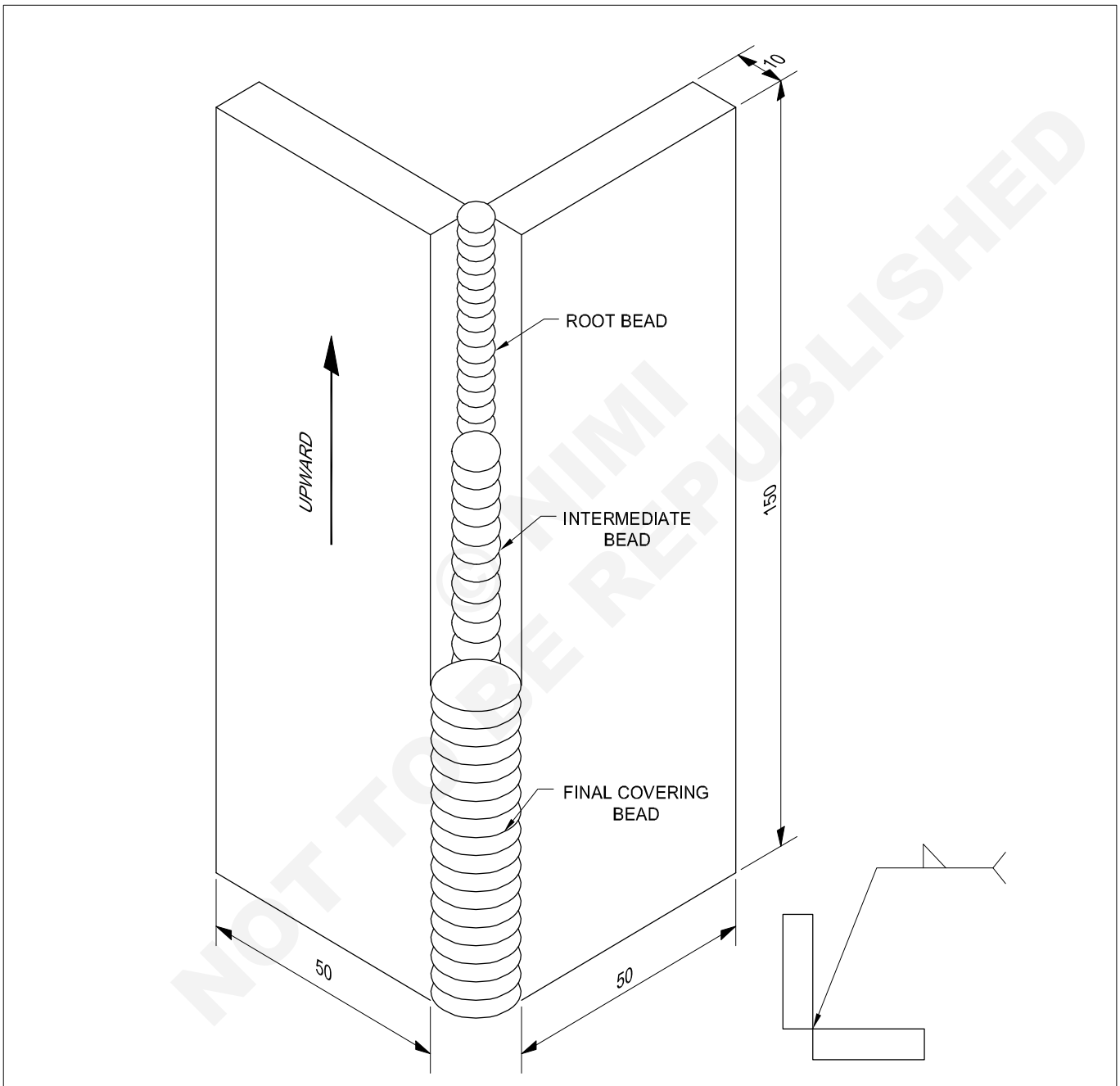
WS20N1336H3

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

Open corner joint on MS plate 10mm thick in vertical position (3F)-(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.**



2	50 ISF 10 - 150	-	Fe 310 - W	-	-	1.3.37
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	OPEN CORNER JOINT ON MS PLATE 10mm THICK IN VERTICAL POSITION (3F)-(SMAW-15)	TOLERANCE ±1	TIME
		CODE NO. WS20N1337E1	

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 a 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.

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

Objective: This shall help you 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.

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

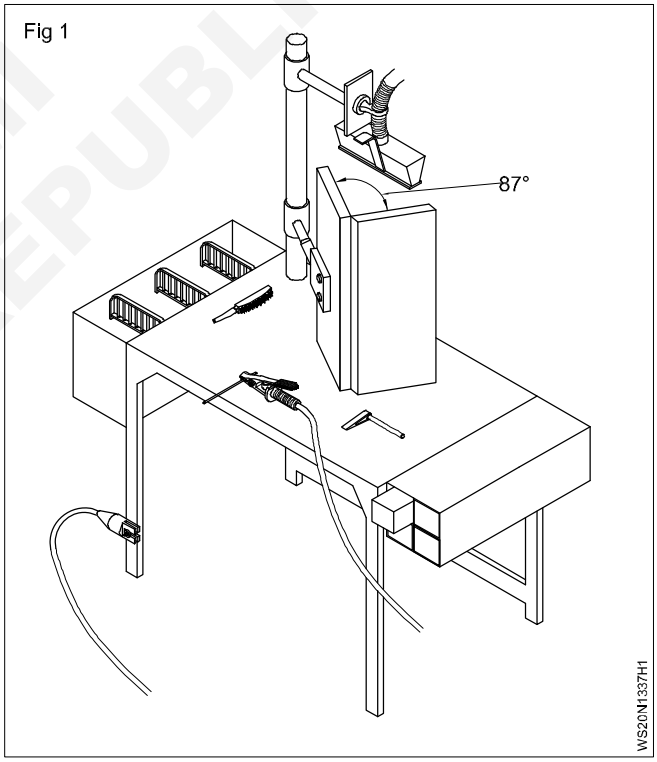
Deposit root run with a 3.15 mm dia. electrode and 110 amps welding current. (Fig 2)

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.

Fig 1



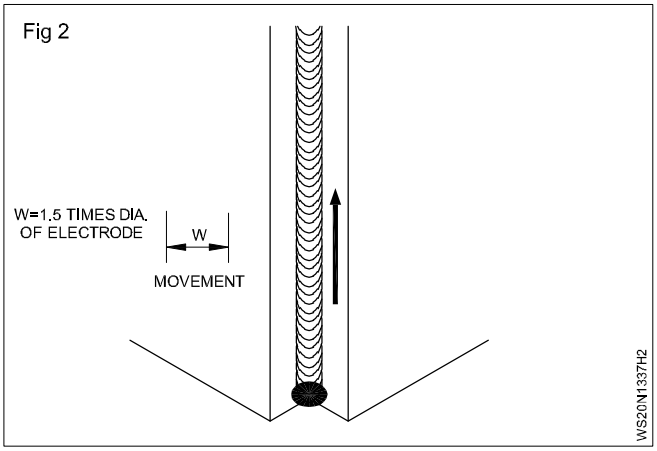
Deslag and clean the root bead at the toes thoroughly; also Deslag and clean the weld bead.

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 done in exercise No.

Fig 2



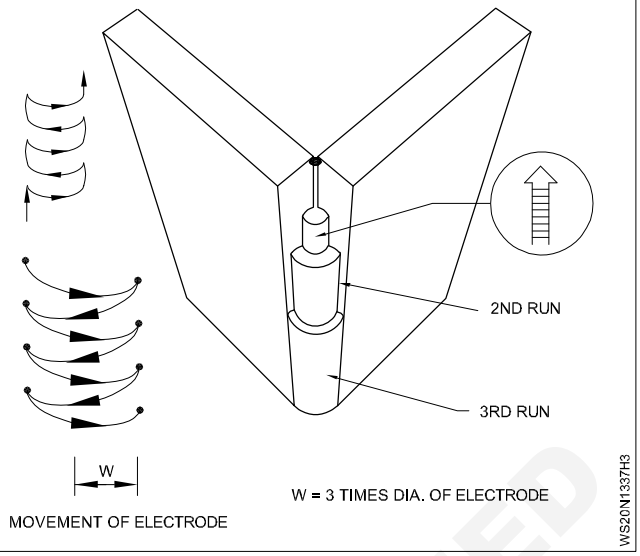
Deslag and clean the weld bead.

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.

Avoid over-reinforcement height and edge burning.

Fig 3



Inspect the open corner fillet weld for:

– external weld defects

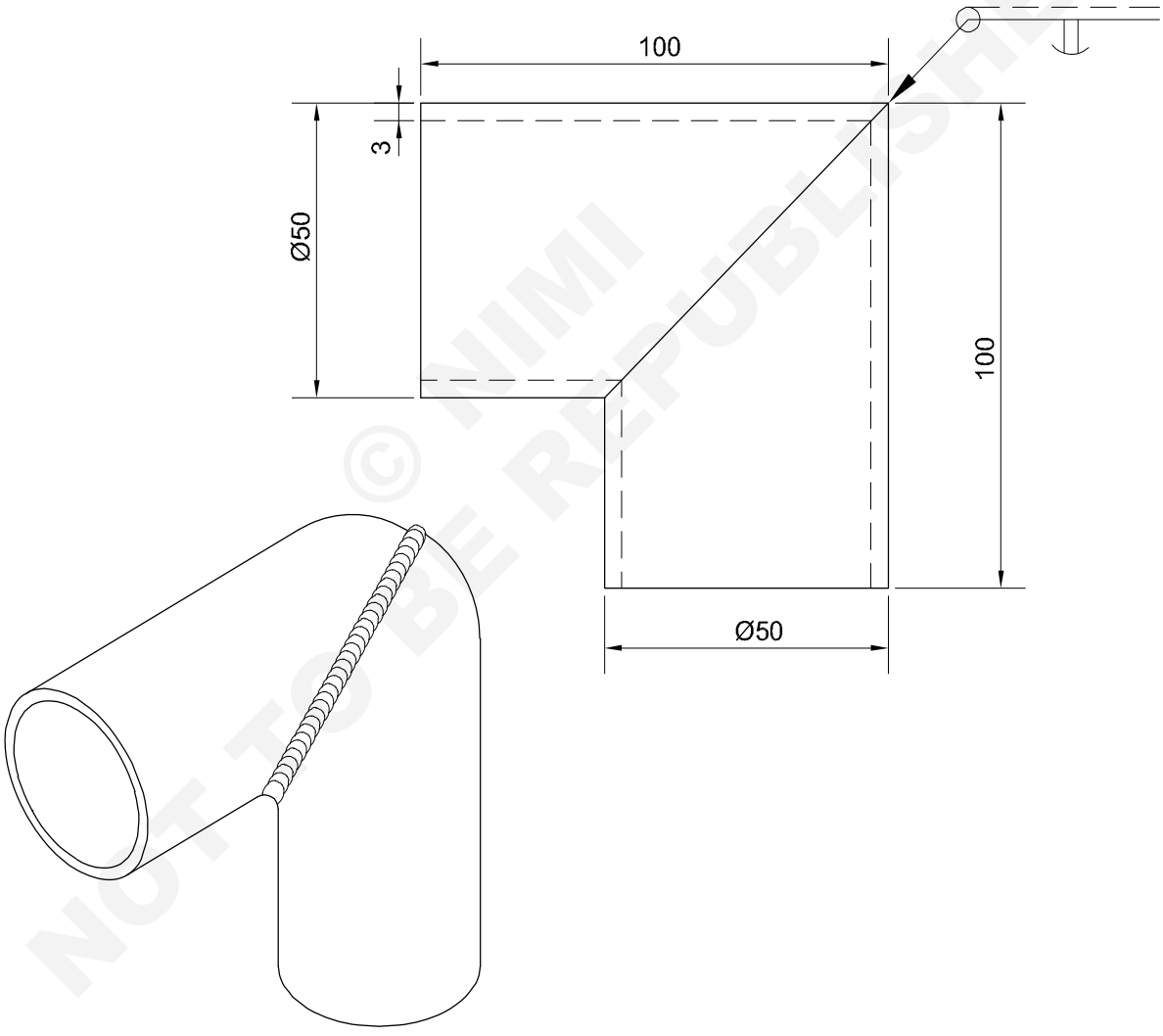
– edge burning and reinforcement height

– depth of root penetration.

Pipe welding - Elbow joint on MS pipe ø50mm and 3mm wall thickness in flat position (1G)

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.**



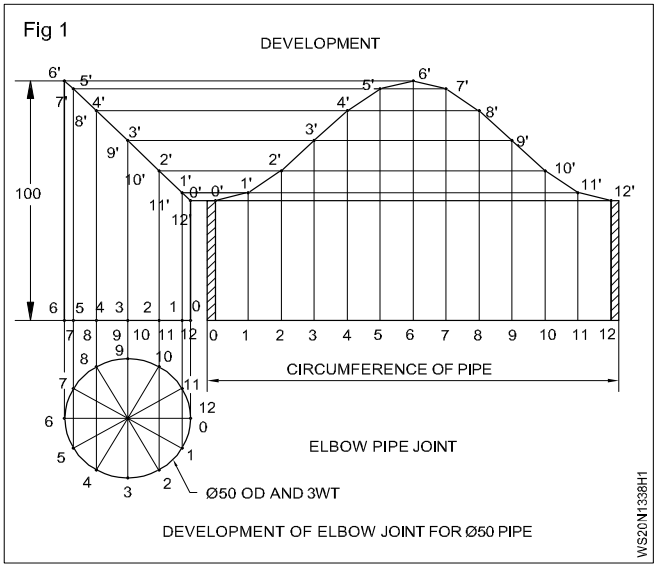
2	Ø50 x 3 - 100	-	Fe 310 - W	-	-	1.3.38
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PIPE WELDING - ELBOW JOINT ON MS PIPE Ø50mm AND 3mm WALL THICKNESS IN FLAT POSITION (1G)-(OAW-14)	TOLERANCE	TIME
		CODE NO. WS20N1338E1	

Job Sequence

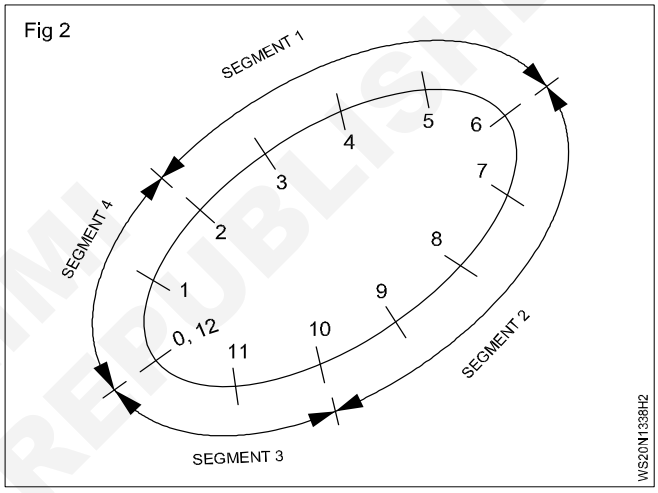
- Ensure the correct size of the pipes are used.
- Draw development for an "elbow" joint. (Fig 1) on a drawing sheet scale full size.

Fig 1



- 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/cm^2 pressure for both gases.
- Set neutral flame.
- Follow necessary safety precautions.
- Tack weld 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.

Fig 2



- 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

Objective: This shall help you to

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

Fix no. 7 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.

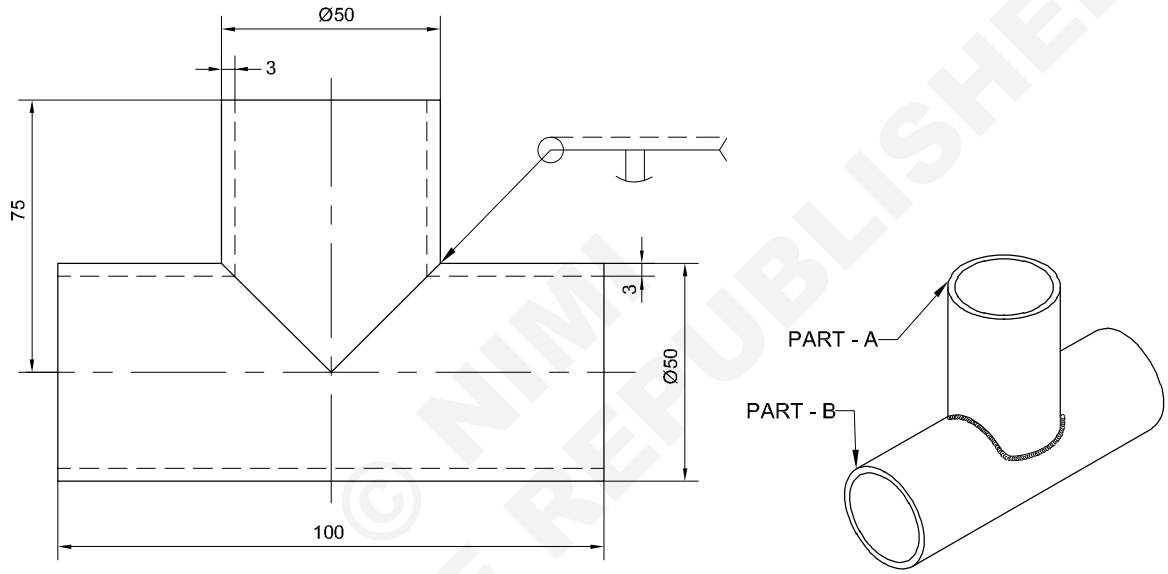
During welding fuse the tacks fully and also ensure proper fusion of edges and root of the joint of each segment.

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 (1G) - (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.**



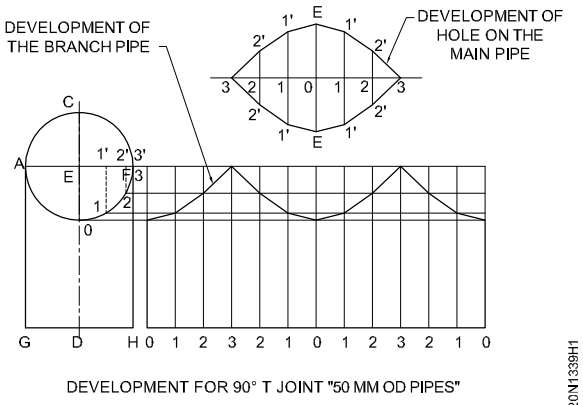
1	Ø50 x 3 - 100	-	Fe 310 - W	-	B	1.3.39
1	Ø50 x 3 - 75	-	Fe 310 - W	-	A	1.3.39
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**PIPE WELDING - 'T' JOINT ON MS PIPE Ø50mm AND 3mm WALL THICKNESS IN FLAT POSITION (1G)**	TOLERANCE ±1	TIME
		CODE NO. WS20N1339E1	

Job Sequence

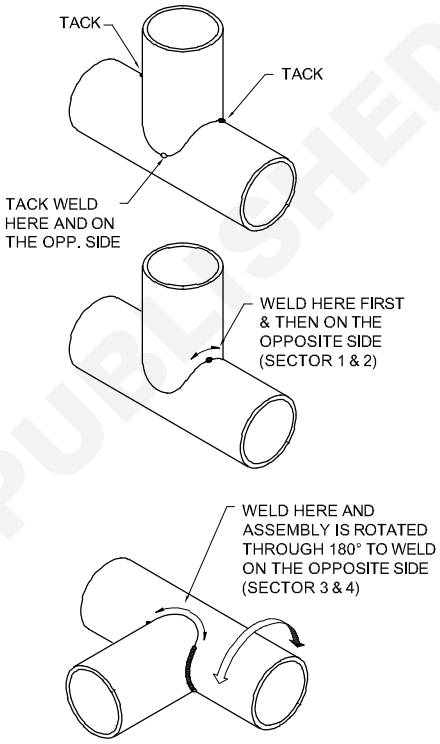
- Ensure the correct size of pipes are used.
- Prepare development for 90° branch. (Fig 1) on a drawing sheet.

Fig 1



- Cut and paste it on the pipes.
- Punch mark 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/cm^2 pressure for both gases.
- Follow necessary safety precautions.
- Tack-weld the joint at 4 place 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)

Fig 2



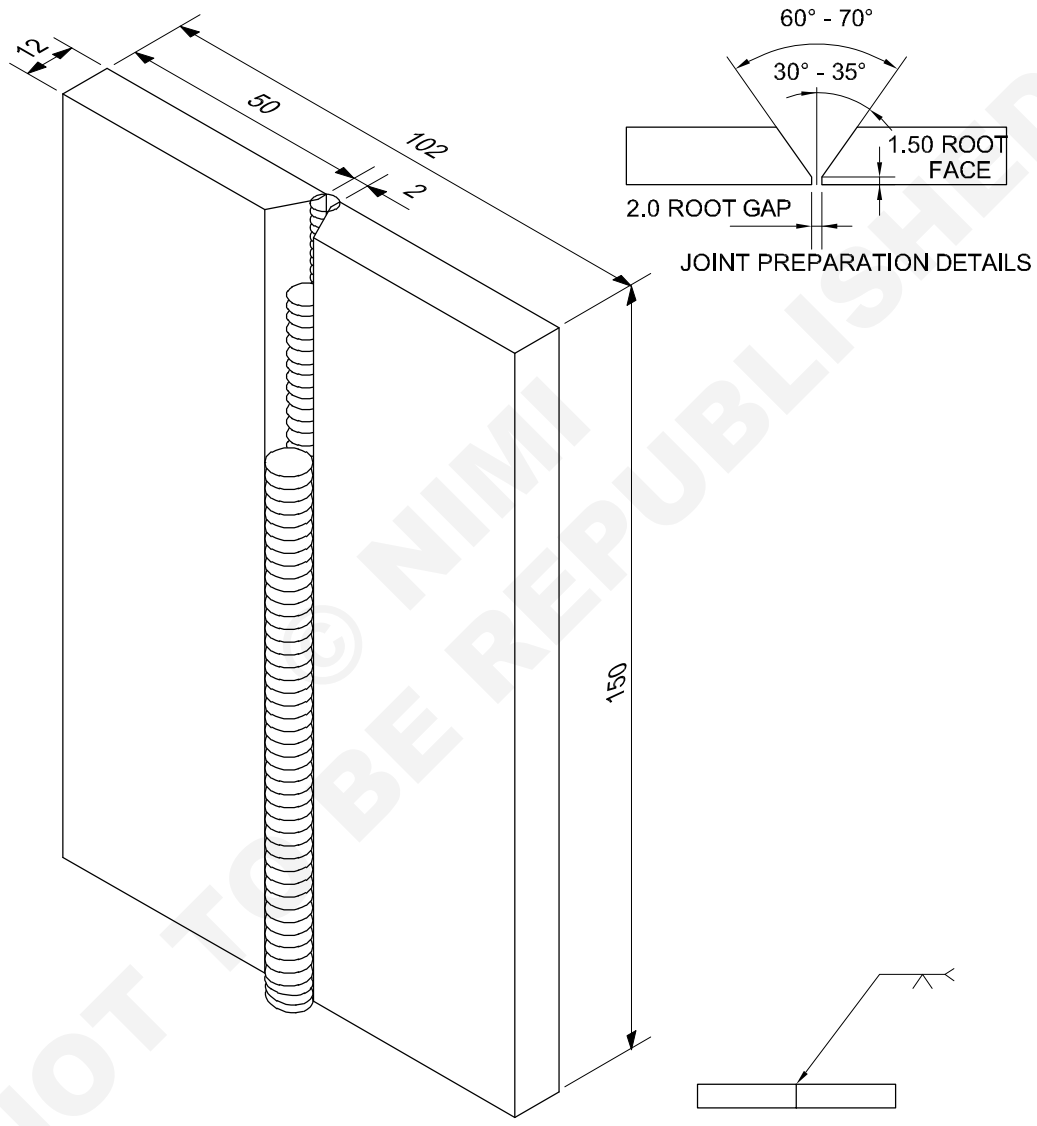
Avoid excess penetration.

- Clean the weld and inspect the weldment for defects.

Single "V" butt joint on MS plate 12mm thick in vertical position

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.**



2	50 ISF 12 x 150	-	Fe 310 - W	-	-	1.3.40
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SINGLE "V" BUTT JOINT ON MS PLATE 12mm THICK IN VERTICAL POSITION (3G)-(SMAW-16)	TOLERANCE ±1	TIME
		CODE NO. WS20N1340E1	

Job Sequence

- Cut the MS plate 12mm 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

Objective: This shall help you 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.

Use goggles while cutting and grinding.

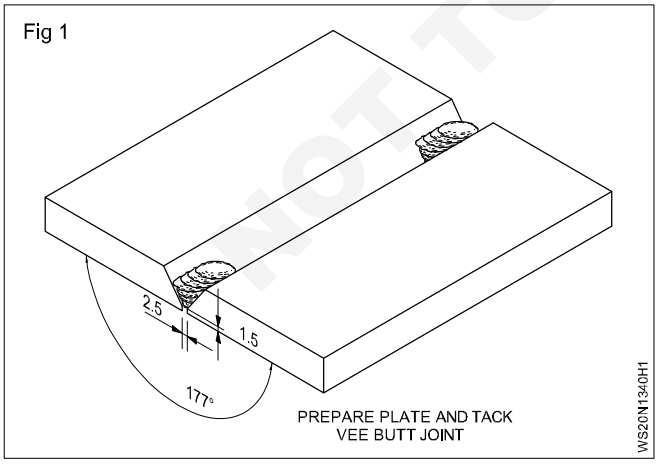
Prepare a 1.5mm root face throughout the length by filing.

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°.

Fig 1

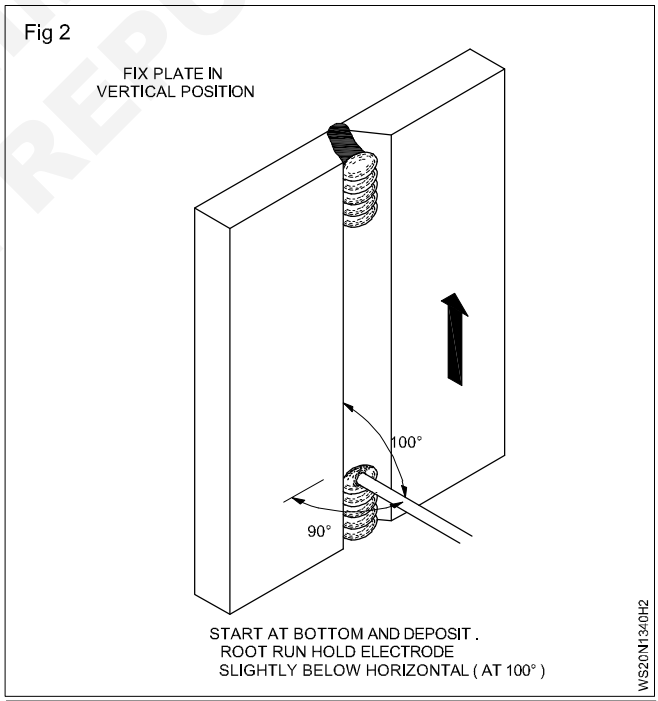


Position the joint in vertical using the weld positioner.

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)

Fig 2



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.

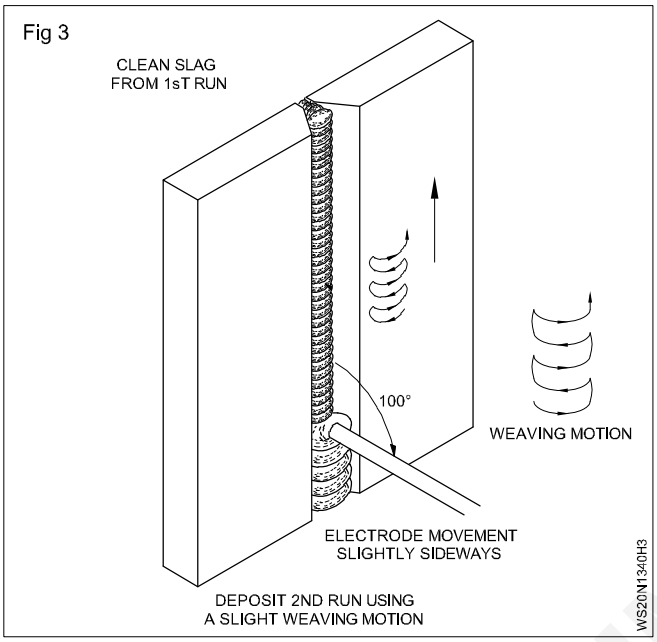
The arc length should be short.

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)

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 pausing regularly at the toes of the weld.

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

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

Avoid undercut and excessive convexity, concavity.

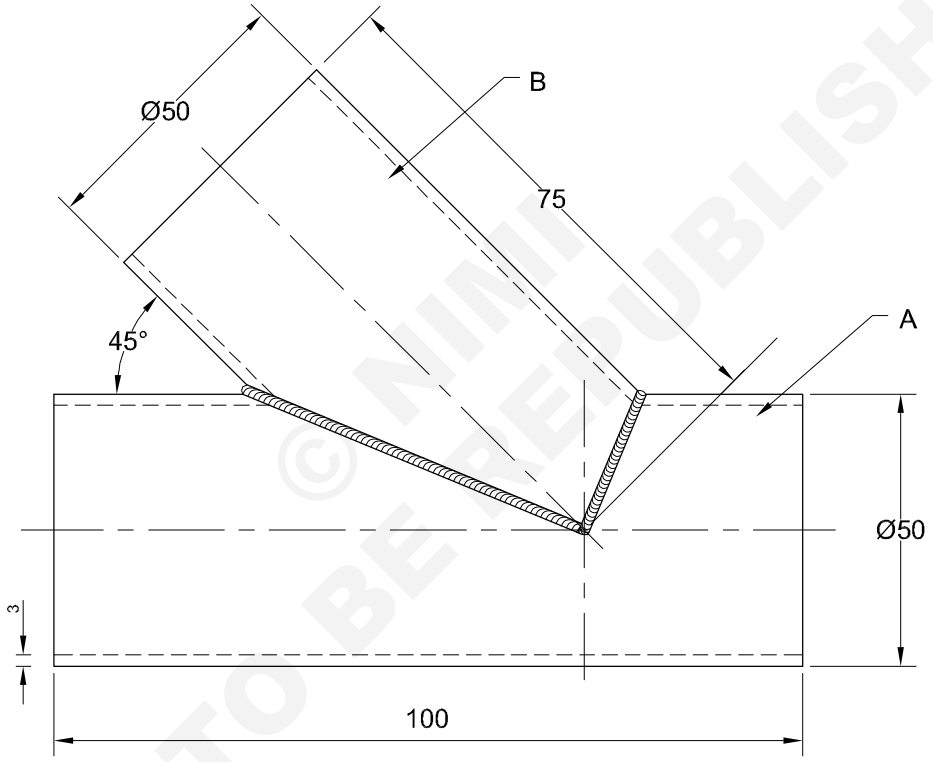
Remove slags with a chipping hammer and clean the weld bead thoroughly with a wire brush.

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

Pipe welding 45° angle joint on M.S. pipe ø50mm and 3mm wall thickness (1G) - (OAW-16)

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.**

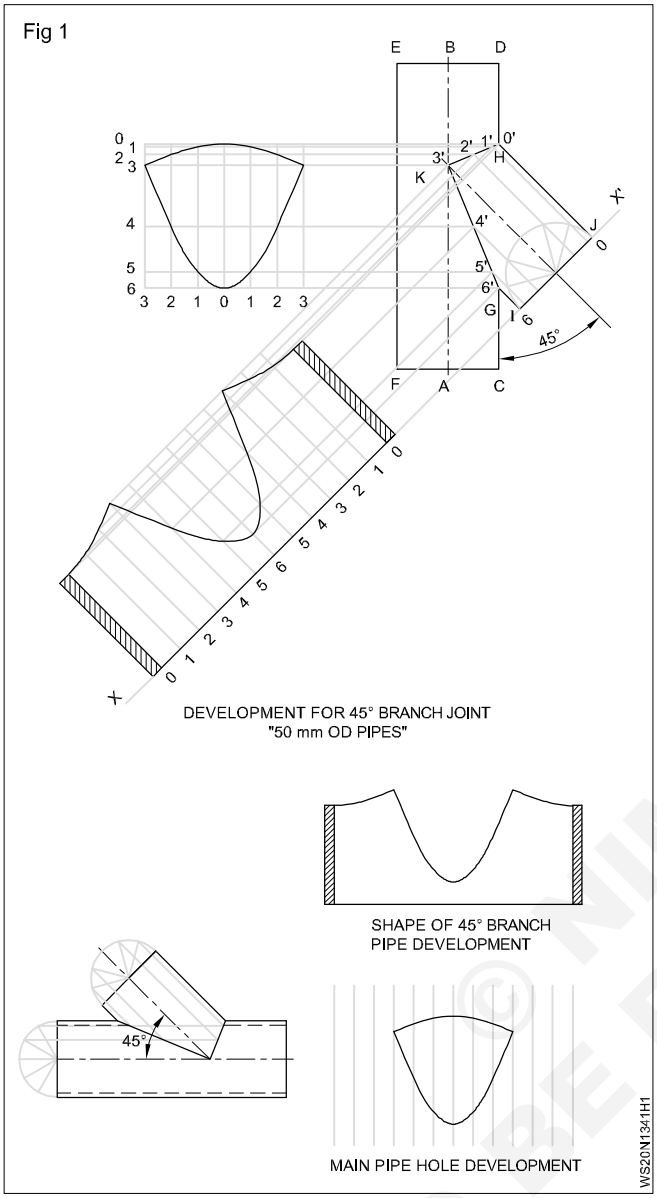


2	-	-	Fe310 - W	-	A	1.3.41
1	Ø 50 x 3 - 75	-	Fe310 - W	-	B	1.3.41
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PIPE WELDING 45° ANGLE JOINT ON M.S. PIPE Ø50mm AND 3mm WALL THICKNESS (1G)	TOLERANCE ±1	TIME
		CODE NO. WS20N1341E1	

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

Fig 1



Mark the points C, D, E and F taking the radius and the length of the given pipe with the center 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 center line for the branch pipe. This line will cut the main pipe's center 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 G as 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 vertical 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 mark 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 angle of 45°. (Fig 2)
- Select no. 7 nozzle, ø3mm CCMS rod and use neutral flame with 0.15 kg/cm^2 pressure for both gases.
- Follow necessary safety precautions.
- Tack-weld the joint at 4 place 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.

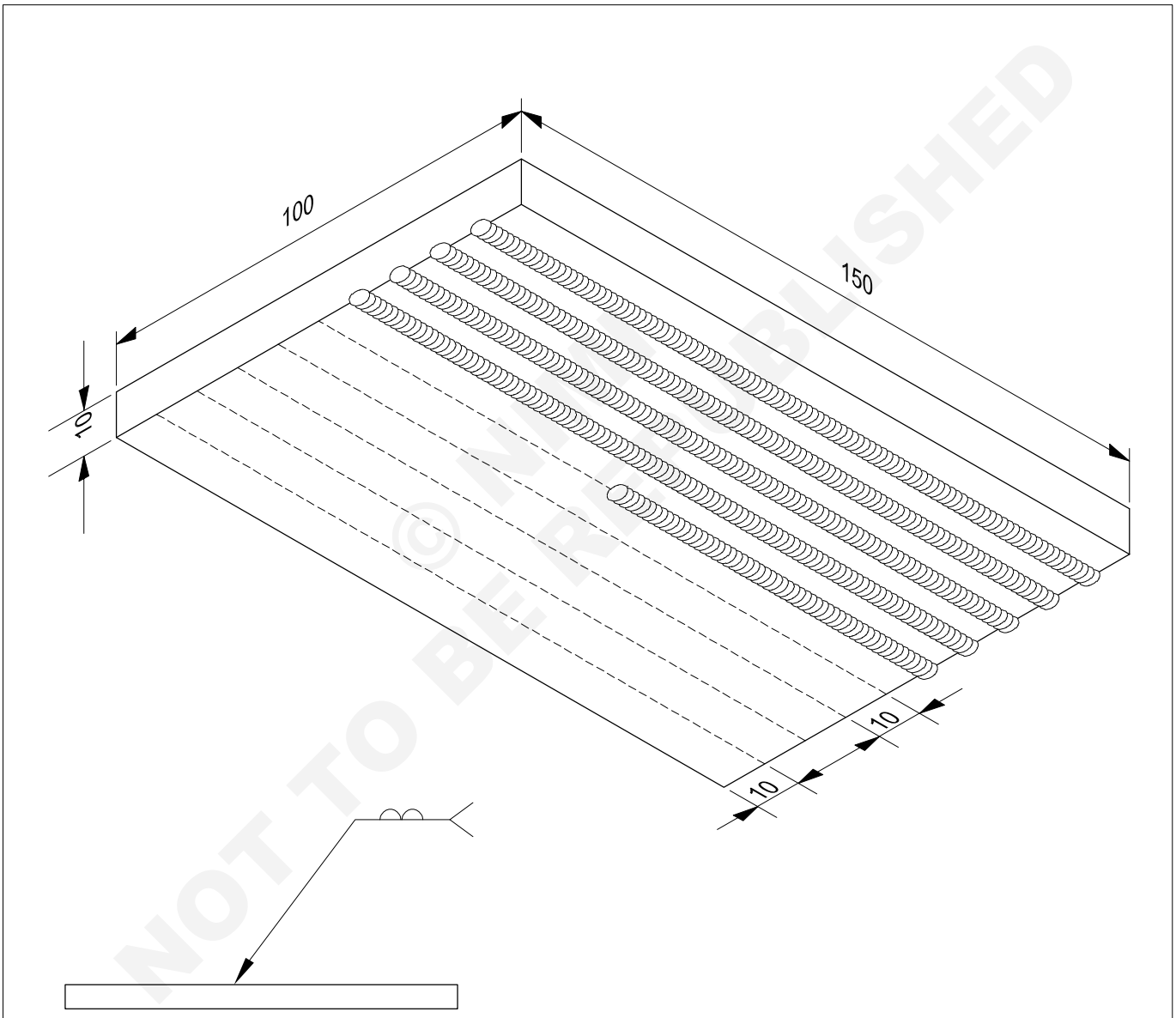
Avoid excess penetration.

- Clean the weld and inspect the weldment for defects.

Straight line beads on MS plate 10mm thick in over head position

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

- **set the M.S. plate in overhead position to lay straight line beads**
- **select the electrode, current polarity and arc length for overhead welding**
- **deposit uniform beads in straight line in overhead position and control the sagging of the molten metal and slag from the beads**
- **clean and inspect the straight line beads for surface defects.**



1	150 ISF 10 - 100	-	Fe 310 - W	-	-	1.3.42
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	STRAIGHT LINE BEADS ON MS PLATE 10mm THICK IN OVER HEAD POSITION				TOLERANCE ±1	TIME
					CODE NO. WS20N1342E1	

Job Sequence

- Prepare and clean the plate.
- Lay out parallel lines as per drawing.
- Mark and punch lines with a center punch.
- Fix the plate in overhead position in the positioner. Adjust the job to suit your height.
- Select and fix a 3.15 mm dia. M.S. electrode and set 100-110 amperes current.

Use a helmet specially when welding in overhead position.

Run and support the electrode-holder cable over your shoulder.

Use hand sleeves and leg guards in addition to other protective clothing.

- Deposit the first bead along the punched line with short arc at normal speed.

Control the molten pool and slag using proper technique.

- Deslag, clean the bead and inspect for defects.
- Deposit the other beads along the punched line as done in the case of the first bead.
- Inspect the weld beads for defects.

Practice until you are able to deposit uniform straight beads without defects.

Skill Sequence

Straight line bead on MS plate 10mm thick in over head position

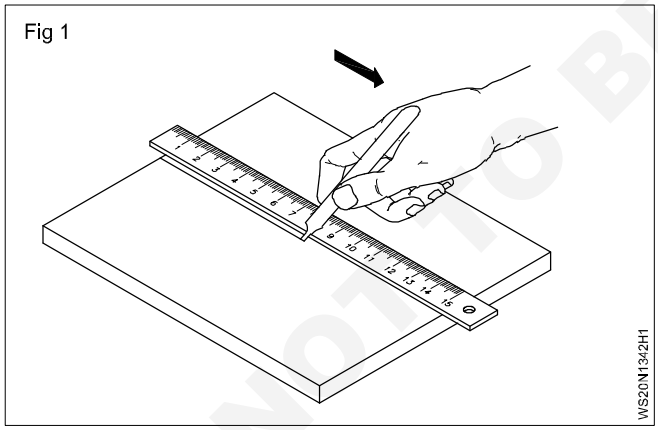
Objective: This shall help you to
- **prepare and practice straight line bead on MS plate 10mm thick in over head position.**

Introduction

Though overhead welding is the most difficult one, it can be made easy by following proper welding techniques. Welding in overhead position is done in piping work, ship building and in structural fabrication.

Mark parallel lines with a scriber (Fig 1) and punch the line with a center punch.

Fig 1

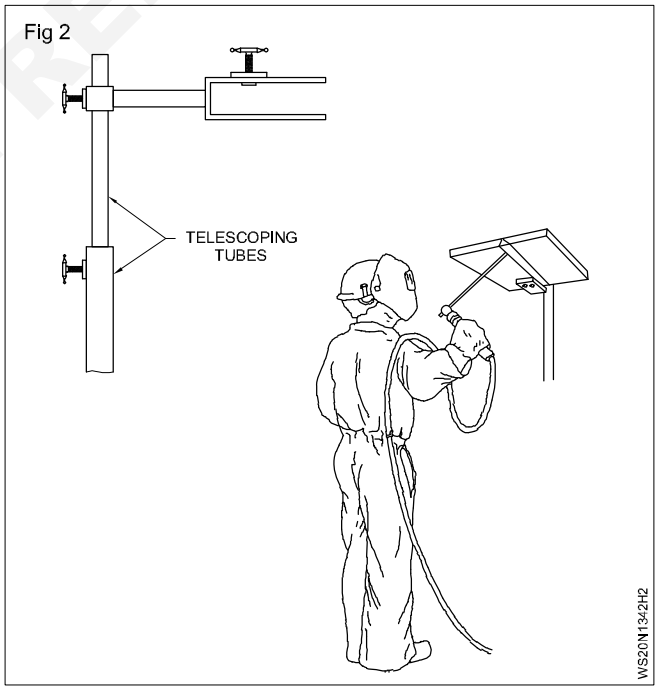


When setting the job in overhead position, the job with the punched line should be facing the ground. (Fig 2)

The height of the job is to be adjusted depending on your height using the telescoping tubes of the jig or positioner. (Fig 2) Small particles of molten metal and spatters will fall down from the joint during welding in overhead position and to protect yourself from these hot particles it is very important to use a helmet, hand sleeves, leg guards, gloves, apron and shoes.

In this position, the hand will be pulled down due to the weight of the cable. Due to this it is difficult to maintain a short arc constantly. This can be reduced by placing the cable over the shoulder as shown in (Fig 2).

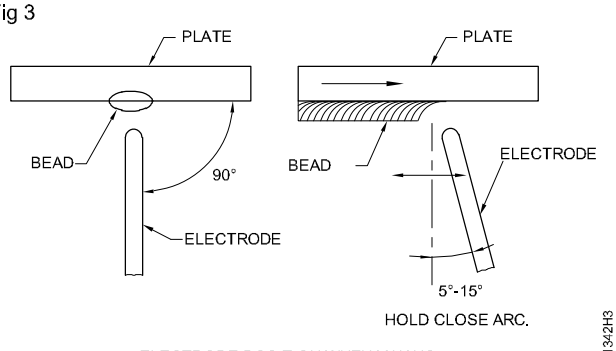
Fig 2



Use 3.15 mm ø MS electrode and set 100 - 110 amperes current. The current is set around 10amp less than that used for flat position, because maintaining a small molten pool is very important to reduce the pulling effect of gravity.

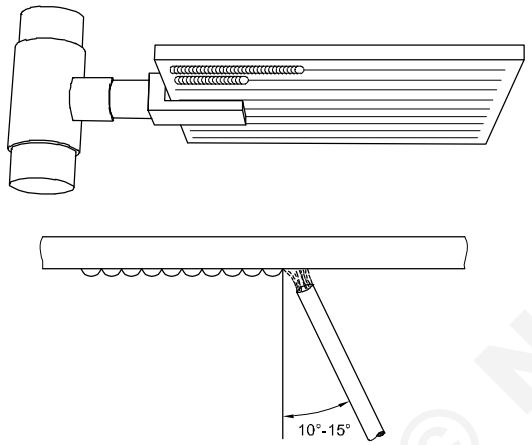
The electrode should be held at 90° to the base metal surface and at 5° to 15° to the direction of the weld. (Figs 3 & 4)

Fig 3



ELECTRODE POSITION WHEN MAKING BEADS IN OVERHEAD POSITION

Fig 4



POSITION OF THE ELECTRODE FOR OVERHEAD WELDING

You can successfully overcome the force of gravity by using a short arc.

Deposit the first bead along the punched line. Care should be taken to maintain a very small molten pool to reduce the gravitational effect.

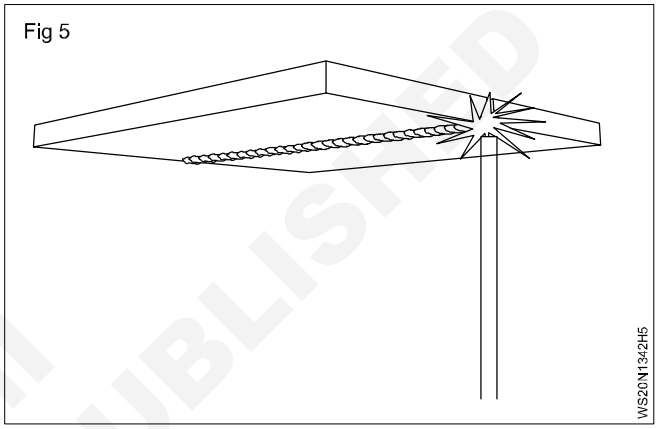
This will also help to control the molten slag from entering the molten metal.

Deposit the run up to the end of the work piece. (Fig 5)

Repeat the same procedure to weld the second and subsequent beads. (Fig 6)

Inspect the weld for surface defects like uniformity of beads, undercuts, slag inclusions, blow holes etc.

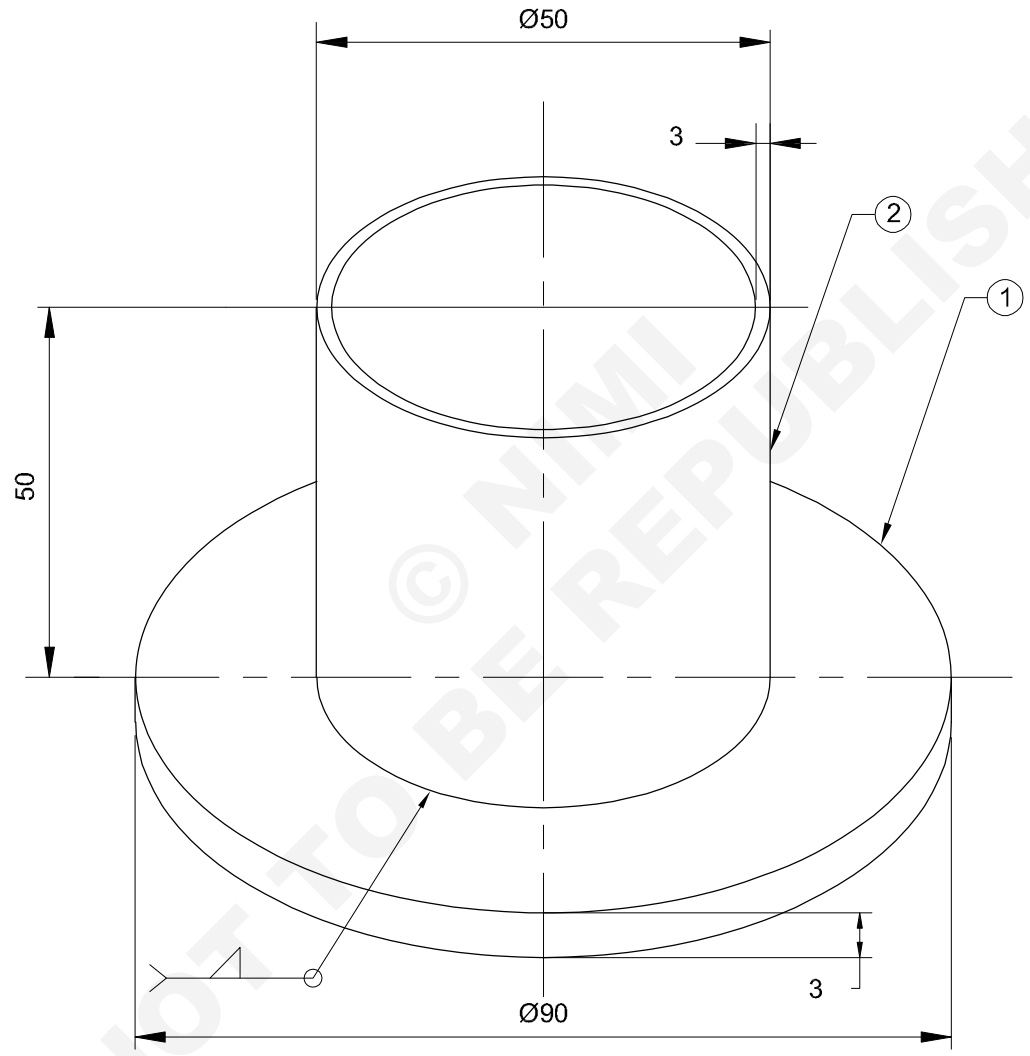
Fig 5



Pipe flange joint on MS plate with MS pipe ø50mm × 3mm wall thickness (1F)

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

- **mark an internal and external circle on a square plate**
- **cut the internal and the external circles by oxy-acetylene gas cutting**
- **insert an MS pipe into the internal circle cut by gas and tack weld to form a pipe flange joint**
- **weld the pipe with the flange by arc in 1G position (rolling) in one run**
- **clean the joint and inspect for any external weld defect, proper bead profile and perpendicularly.**



1	Ø50 x 3 - 50	-	Fe 310 - W	-	2	1.3.43
1	100 ISF 3 - 100	-	Fe 310 - W	-	1	1.3.43
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PIPE FLANGE JOINT ON MS PLATE WITH MS PIPE Ø50mm x 3mm WALL THICKNESS (iF)-(SMAW-18)	TOLERANCE ±1	TIME
		CODE NO. WS20N1343E1	

Job Sequence

- Find the center of the given 3mm thick square plate by joining the 2 diagonals of the square plate using a scriber and mark a dot on the meeting joint of the diagonals using a dot punch.
- Using a spring divider scribe/draw a circle of radius 25mm at the center of the square plate and another larger circle with a radius of 45mm and punch mark both the circumference of the circles.
- Select 0.8mm size cutting nozzle and fit it with the cutting torch.
- Set a pressure of 0.15 kg/cm^2 for acetylene gas and 1.5 kg/cm^2 for oxygen gas for cutting 6mm MS plate.
- Set neutral flame and preheat at the center point of one of the edges of the square plate until it reaches bright red hot condition/kindling temperature.
- Press the oxygen cutting lever and move the torch by hand from the edge of the plate until the punch marked circumference of the larger circle is reached.
- Now using a roller guide and circle cutting attachment start cutting the larger external circle of 90mm diameter.

Ensure necessary safety precautions to be used for gas cutting is followed.

- To cut the internal circle, first pierce a small hole at about 10mm inside the circumference of the 50mm dia. circle.
- Move the torch towards the circumference from the pierced hole and complete the 50mmø hole cutting using a small circle cutting attachment.
- Clean the cut edges and trim the inside face of the cut edges using a half round file.
- Insert the given pipe of 50mm outside diameter in the cut hole of the plate such that the end of the pipe is flush with the flat surface on the other side of the 6mm plate to form a pipe flange joint.
- Select a 3.15mm medium coated MS electrode and set 110 amperes current and DCEN if a DC welding is used.
- Tack weld at four places at 90° intervals on the other side of the joint.

Ensure that the pipe is at 90° to the plate surface while tacking.

- Change the electrode to 4mm dia. medium coated MS electrode and set 160 ampere current.
- Position the joint on a suitable weld fixture so that welding can be done by 1G rolling method.
- Complete the welding of the joint in one run using segment welding method.
- Deslag and clean the joint with a wire brush.
- Inspect visually for any external weld defects.

Ensure proper crater filling at the end of each segment welding.

Use appropriate safety precaution during arc welding and deslagging.

Skill Sequence

Pipe flange joint on MS pipe in flat position

Objective: This shall help you to

- **weld pipe flange joint on MS plate with MS pipe ø50 mm × 3mm wall thickness.**

For external circle cutting to get a 90mm dia. circular plate from the given 100mm square plate, the cut can be started from the free edge of the plate Fig 1. After the cut reaches the punch marked circumference line, fix the circle cutting attachment (Fig 4) at a distance of 45mm from the center of the cutting nozzle and keeping the conical point of the circle cutting attachment at the center of the plate and cut the external circle of radius 45mm.

To cut an internal circle, a small hole called pilot hole is to be drilled or pierced by gas cutting inside the circumference of the circle/profile before starting to cut the required circle/profile. The procedure to pierce a pilot hole is as follows. Refer (Fig 2).

Fig 1

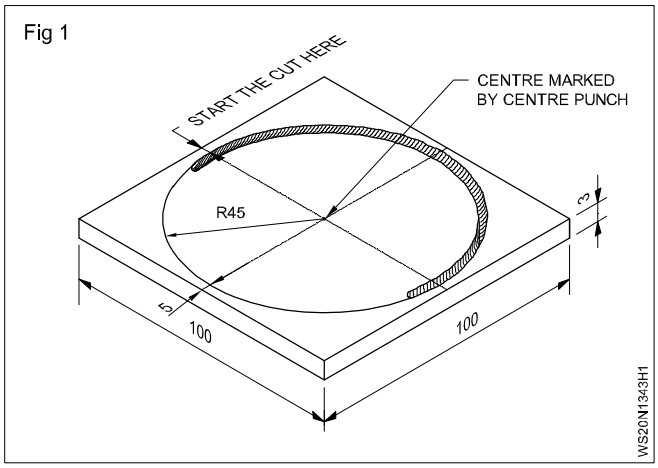
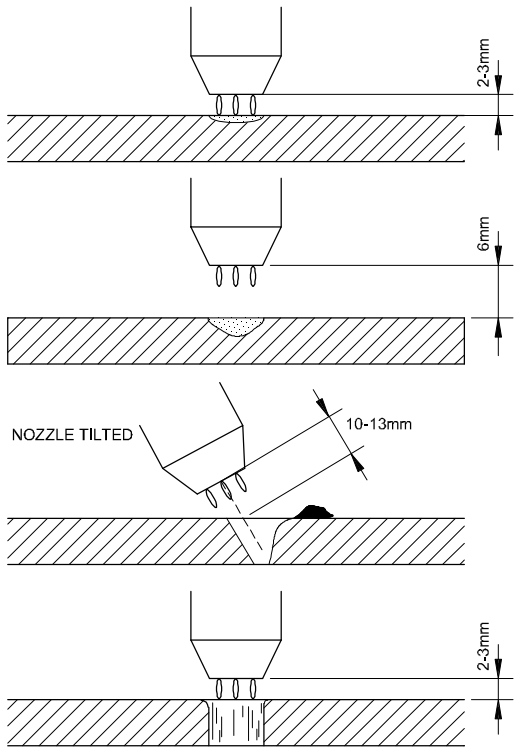


Fig 2



PIERCING A PILOT HOLE

Set the flame in the usual manner then:

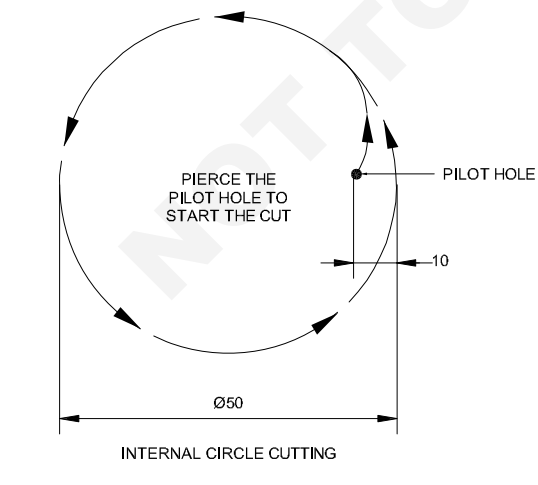
– Preheat the spot with the torch about 6mm from the plate, so that inner cones almost touch the plate.

– When the spot is bright red, lift the torch to about 13mm above the plate until the metal nearly melts and tilt the torch to the side a little.

– Press the cutting oxygen lever slowly and move the torch around slightly until the cut is through the plate.

After piercing the pilot hole move the torch as shown in (Fig 3) until it reaches the circumference of the 50mmø circle.

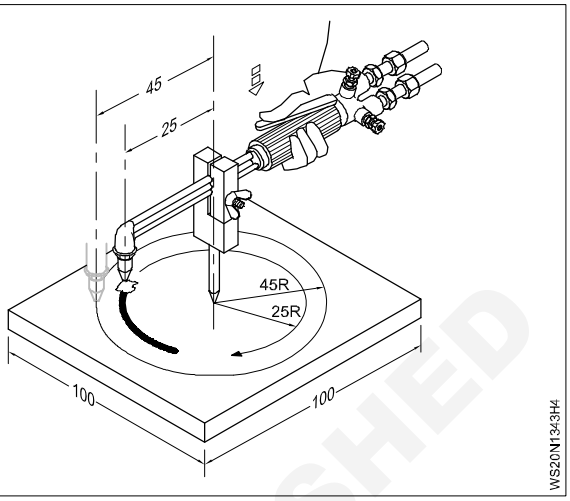
Fig 3



INTERNAL CIRCLE CUTTING

To cut a circle, it can be done by free hand movement along the circumference or a circle cutting attachment as shown in Fig 4 can be used which will give an accurate cut surface very close to 50mm diameter. To get a fine and uniform cut surface the torch has to be moved steadily with a uniform speed along the circumference.

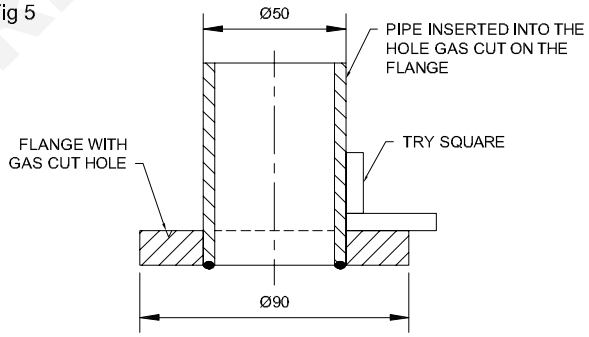
Fig 4



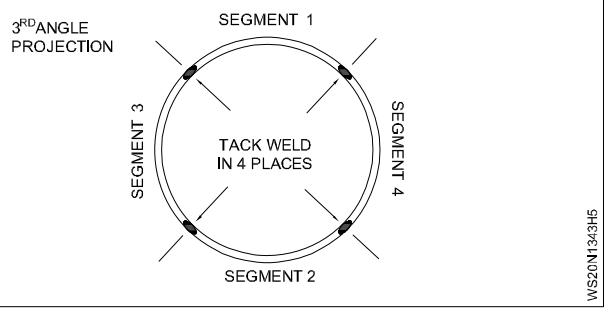
While tacking the pipe with the gas cut flange ensure that perpendicularly is maintained. Refer Fig 5 Tacking is done at 4 places on the other side of the flange joint. Fig 5. Use 4mm dia. electrode so that the required fillet size of 3 to 3.5mm can be maintained.

To weld the joint in 1G (rolling) position, use a weld fixture as shown in Fig 6 to make it convenient to weld in 1G position and complete the weld in 4 segments. 1, 2, 3 and 4 (Fig 5)

Fig 5



CHECK PERPENDICULARITY OF
THE PIPE INSERTED INN TO THE FLANGE



Maintain as short an arc as possible and an electrode angle of 45° between the plate and pipe surfaces.

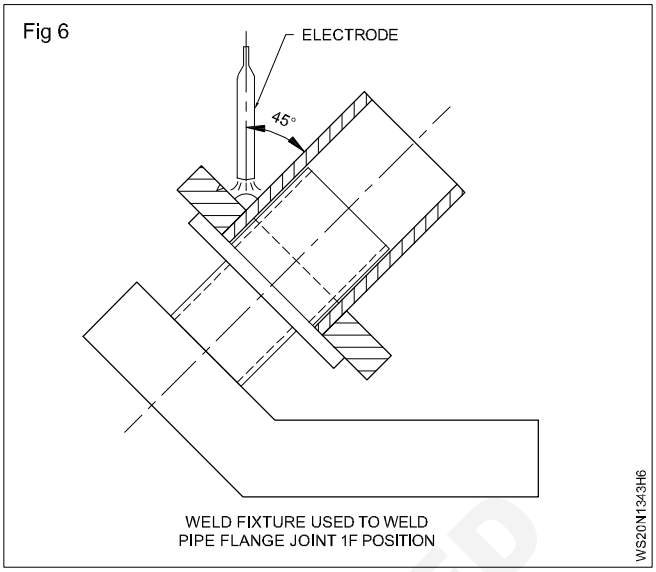
Follow the weld sequence as shown in the Fig 5 which will help to control distortion i.e. First weld segment (1) in down hand position. Then rotate the joint by 180° and weld segment (2) in down hand position. Similarly, weld segment (3) and segment (4) by rotating the joint on the fixture to bring the segments for welding in down hand position. (Fig 5).

While welding segments 3 and 4 the weld deposit should cover about 10mm distance over the previous deposit to ensure crater filling and continuity in the root penetration.

Deslag after welding each segment and avoid undercut by proper current setting and speed of welding.

Clean the weld using wire brush. Check the fillet size with a weld gauge.

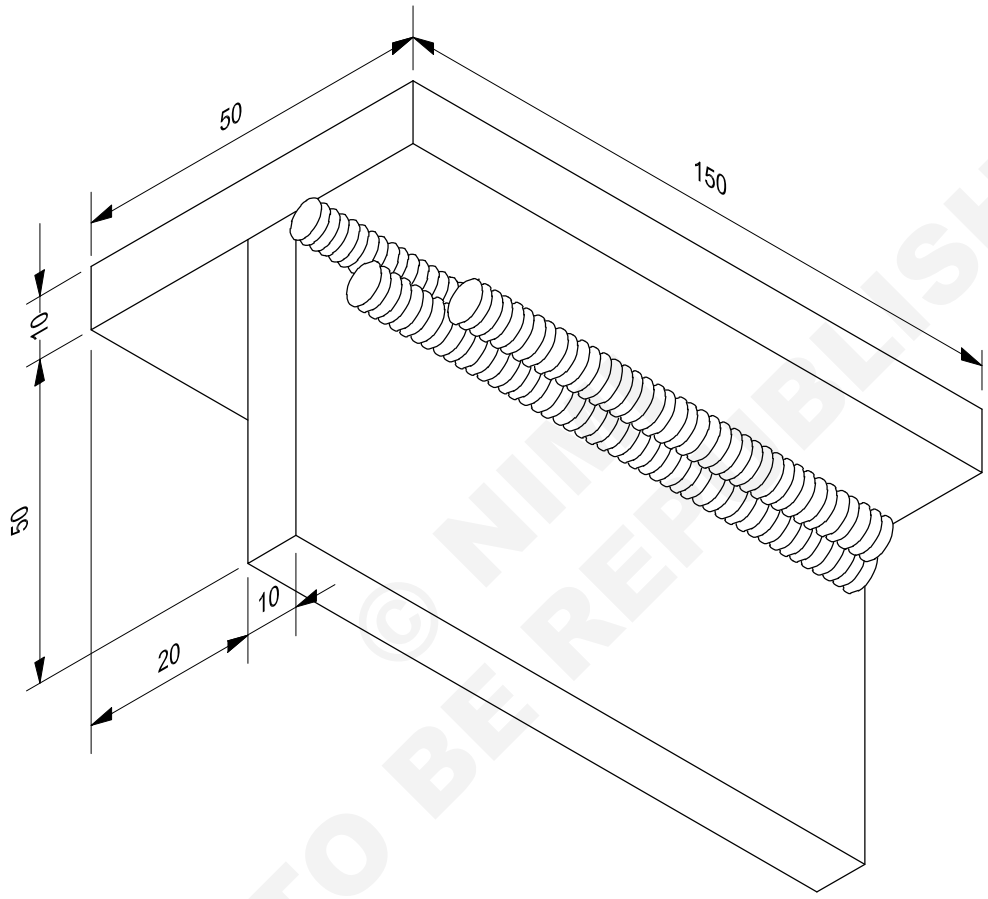
Fig 6

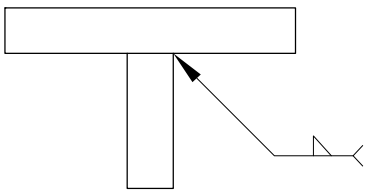


Fillet - "T" 10mm thick in over head position

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.**





2	150 ISF 10 - 50	-	Fe 310 - W	-	-	1.3.44
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FILLET - "T" JOINT ON MS PLATE 10mm THICK IN OVER HEAD POSITION (4F)	TOLERANCE ±1	TIME
		CODE NO. WS20N1344E1	

Job Sequence

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

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

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

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

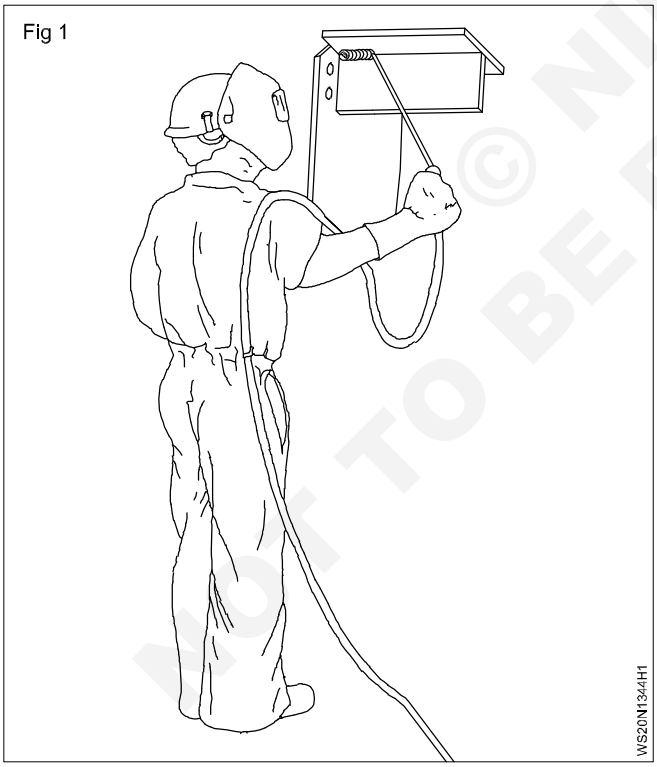
Fillet 'T' joint on MS plate 10mm thick in over head position

Objective: This shall help you to
- **prepare and weld fillet 'T' joint on MS plate 10mm thick in over head position.**

Job setting

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

Fig 1



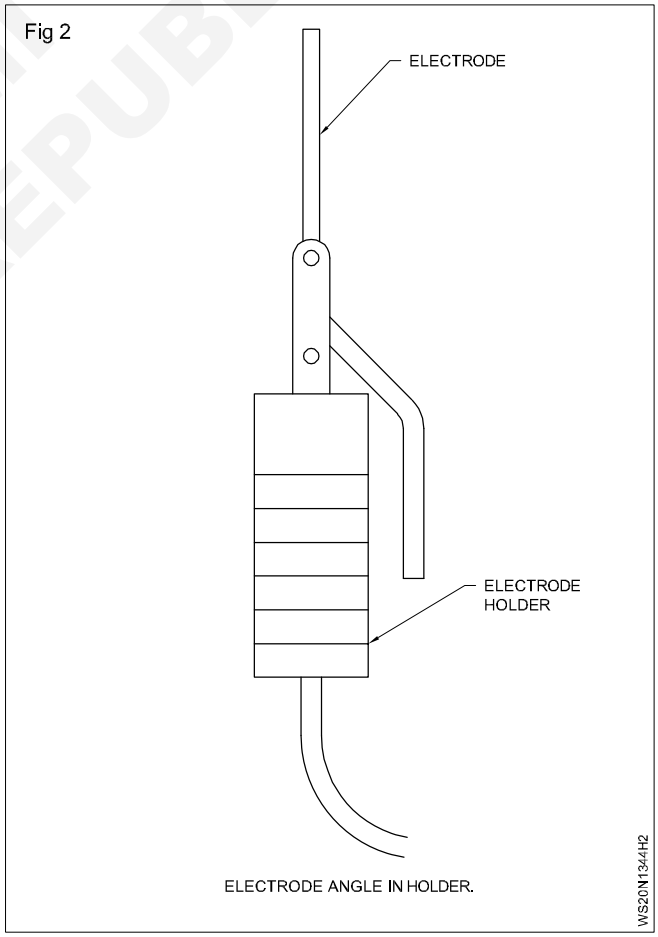
Fix the electrode as shown in (Fig 2).

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

Use a 30° work angle off the vertical plate as shown in (Fig3).

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

Fig 2

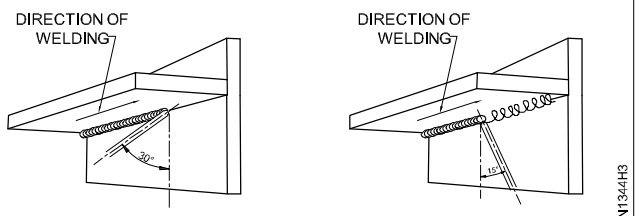


Use a drag angle of approximately 10-15° to the direction of the weld.

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

Maintain a short arc all the time.

Fig 3



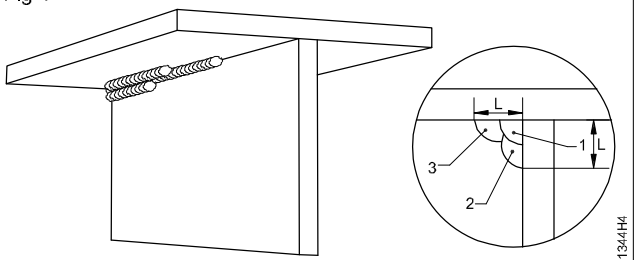
FILLET WELD IN THE OVERHEAD POSITION

WS20N1344H3

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 4



T-JOINT IN AN OVERHEAD POSITION

WS20N1344H4

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.

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.

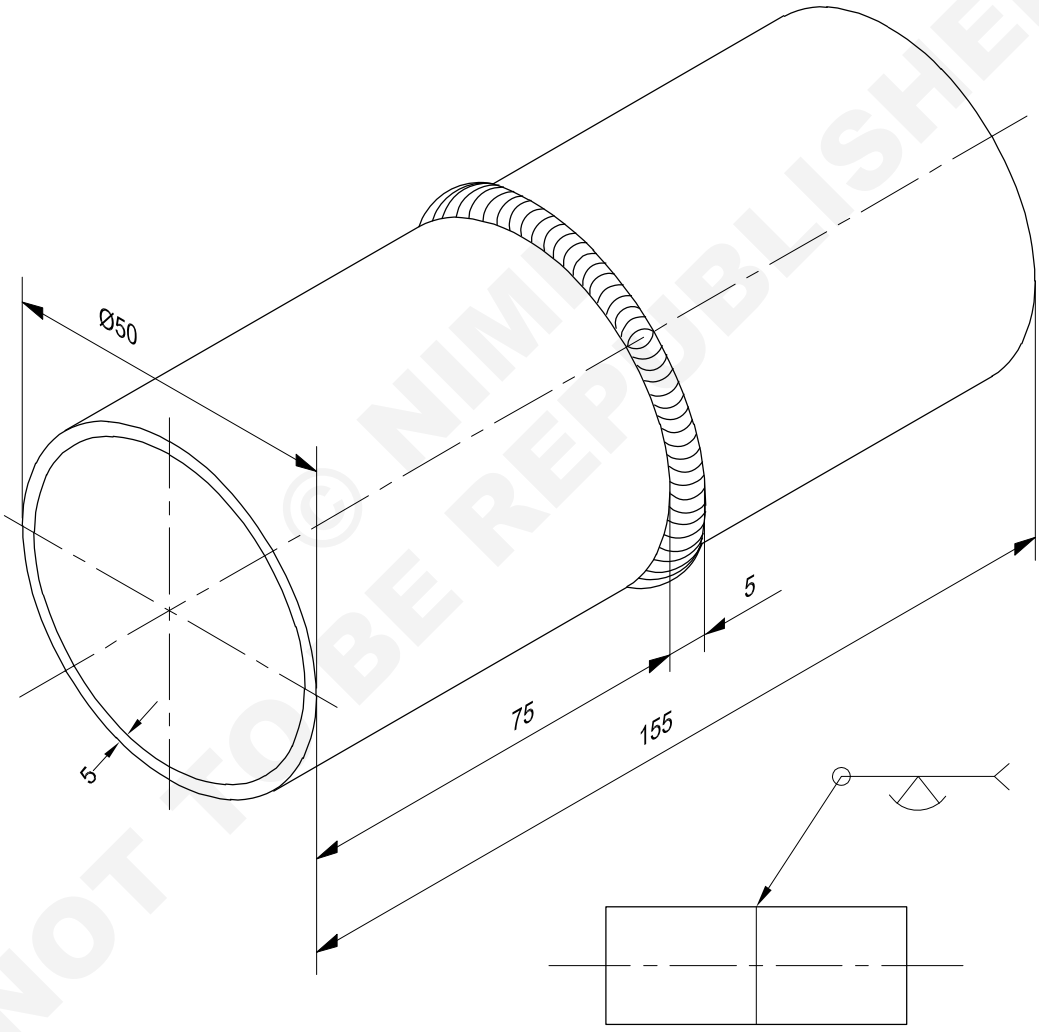
The discomfort of the cable can be minimized by dropping it over the shoulder if you are welding in a standing position as shown in Fig 1 or over the knees if in a sitting position.

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

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

- **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.**



2	Ø50 x 5 - 75	-	Fe 310 - W	-	-	1.3.45
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PIPE WELDING. BUTT JOINT ON M.S. PIPE Ø 50mm x 5mm WALL THICKNESS IN 1G POSITION	TOLERANCE ±1	TIME
		CODE NO. WS20N1345E1	

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.

Wear protective clothing.

- 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 intervals 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 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 ø electrodes i.e. the same as for the root run.
- Clean and inspect the joint.

Skill Sequence

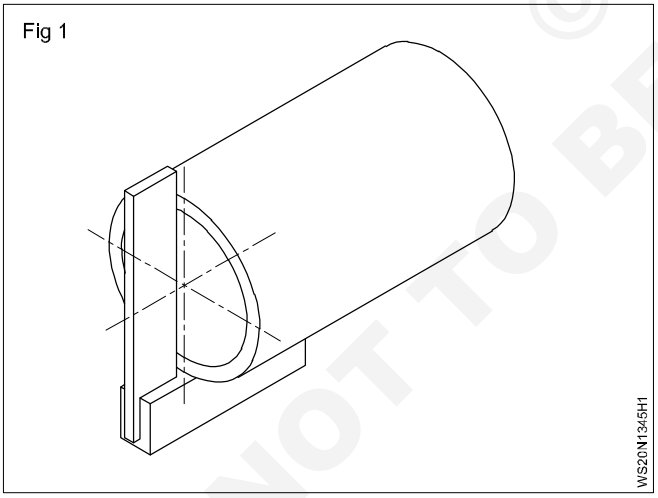
Pipe welding butt joint on MS pipe joint ∅ 50 mm

Objective : This shall help you to
- **tack weld at equal angle set the pipe joint**
- **weld by rotation.**

Cut the pipes to the given size by a hacksaw.

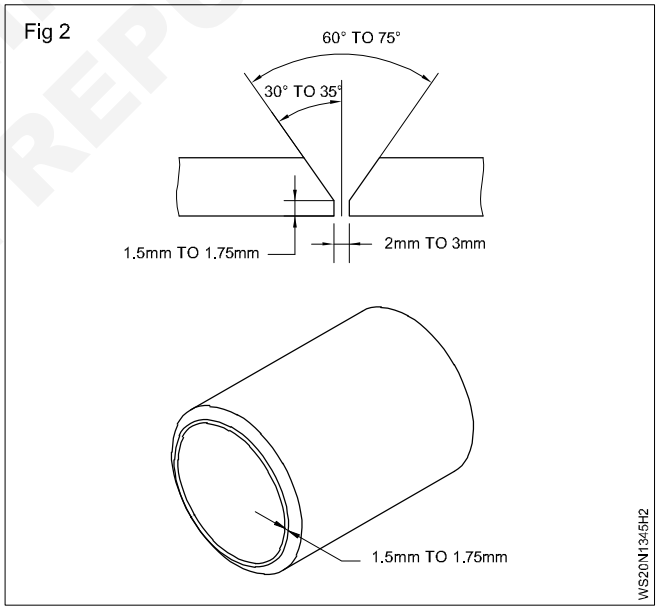
Check the squares of the pipe end by using a try square. (Fig 1) and file the pipe end so that it is square with the pipe axis.

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)

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.

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.

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 3

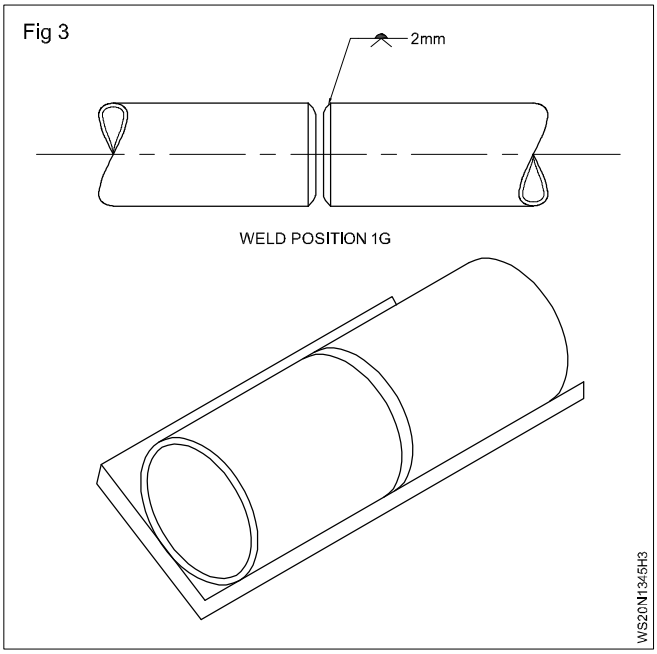


Fig 4

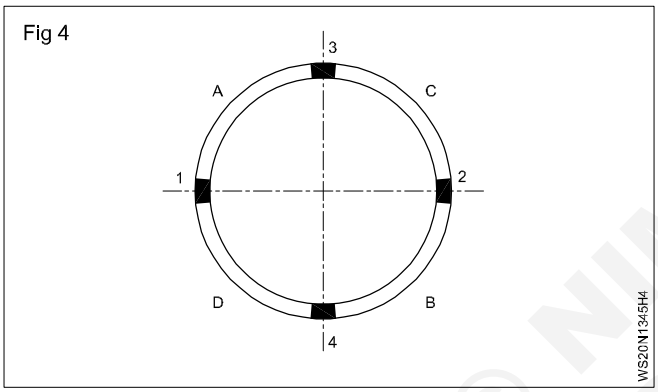


Fig 5

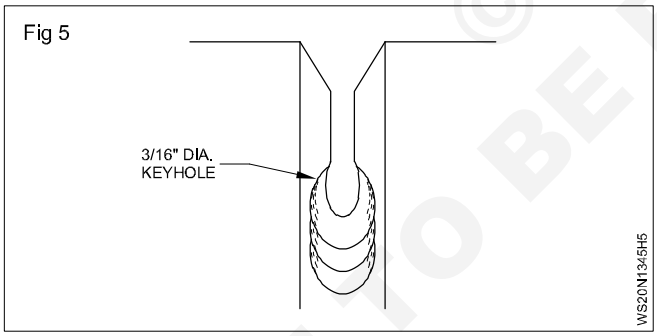
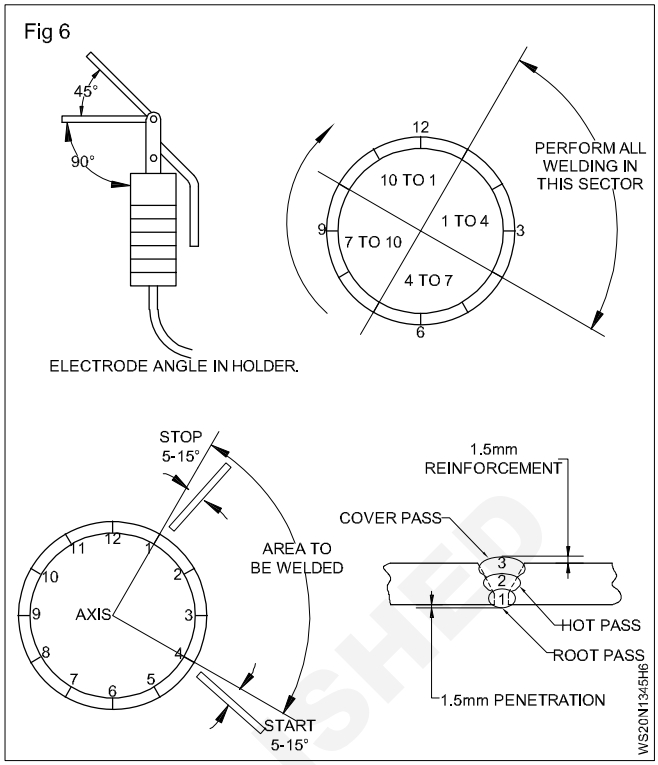


Fig 6



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.

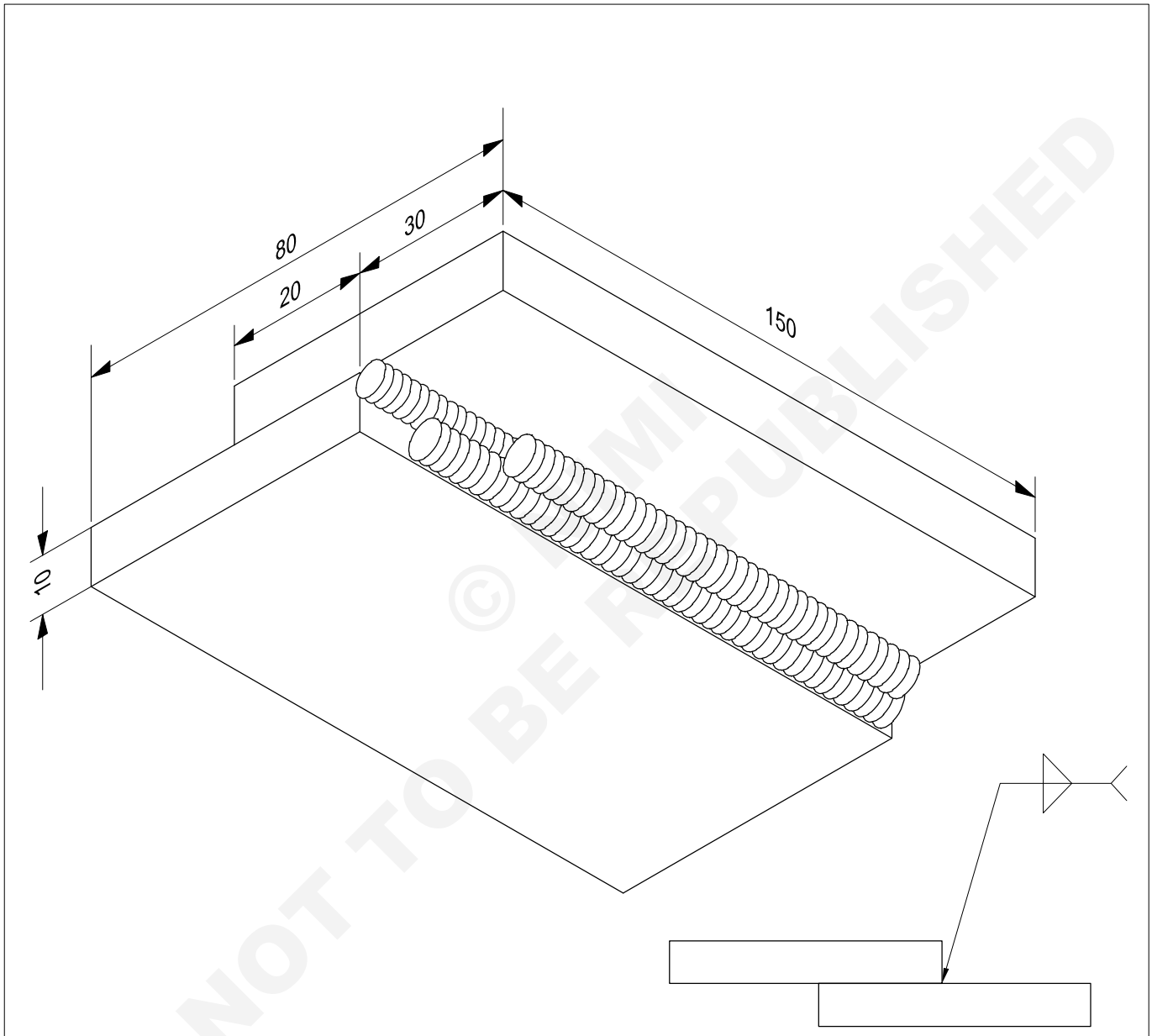
The sequence of beads is shown in Fig 6. Adhere to the maximum root and face reinforcement shown.

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.

Fillet - lap joint on MS plate 10mm thick in over head position (4G)-(SMAW -21)

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.**



2	50 ISF 10 - 150	-	Fe 310 - W	-	-	1.3.46
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**FILLET LAP JOINT ON M.S. PLATE 10mm THICK IN OVERHEAD POSITION (4G)**	TOLERANCE ±1	TIME
		CODE NO. WS20N1346E1	

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 surface 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 over head position

Objective: This shall help you to
- **prepare and weld fillet lap joint on MS plate 10mm thickness in over head 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.

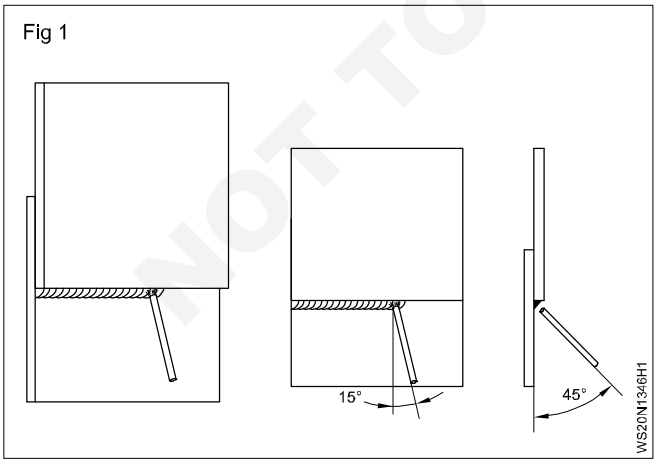
Wear leather gloves, hand sleeves, apron, leg guard, helmet etc.

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)

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.

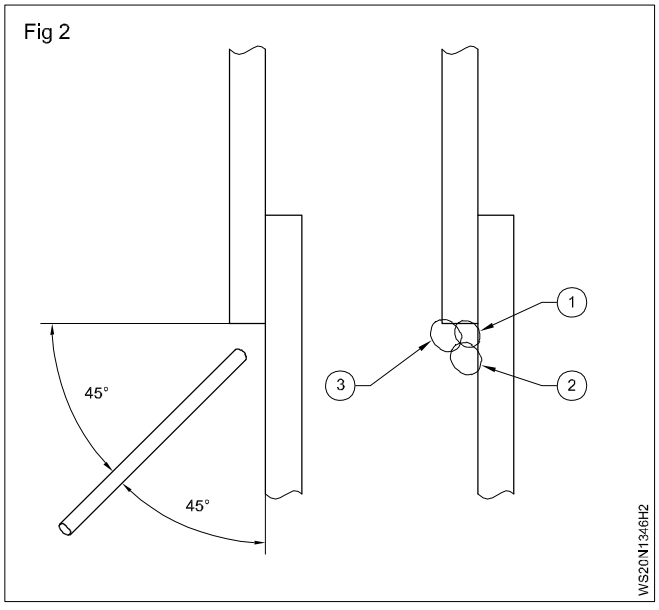
Deslag the second bead thoroughly.

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 avoid 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.

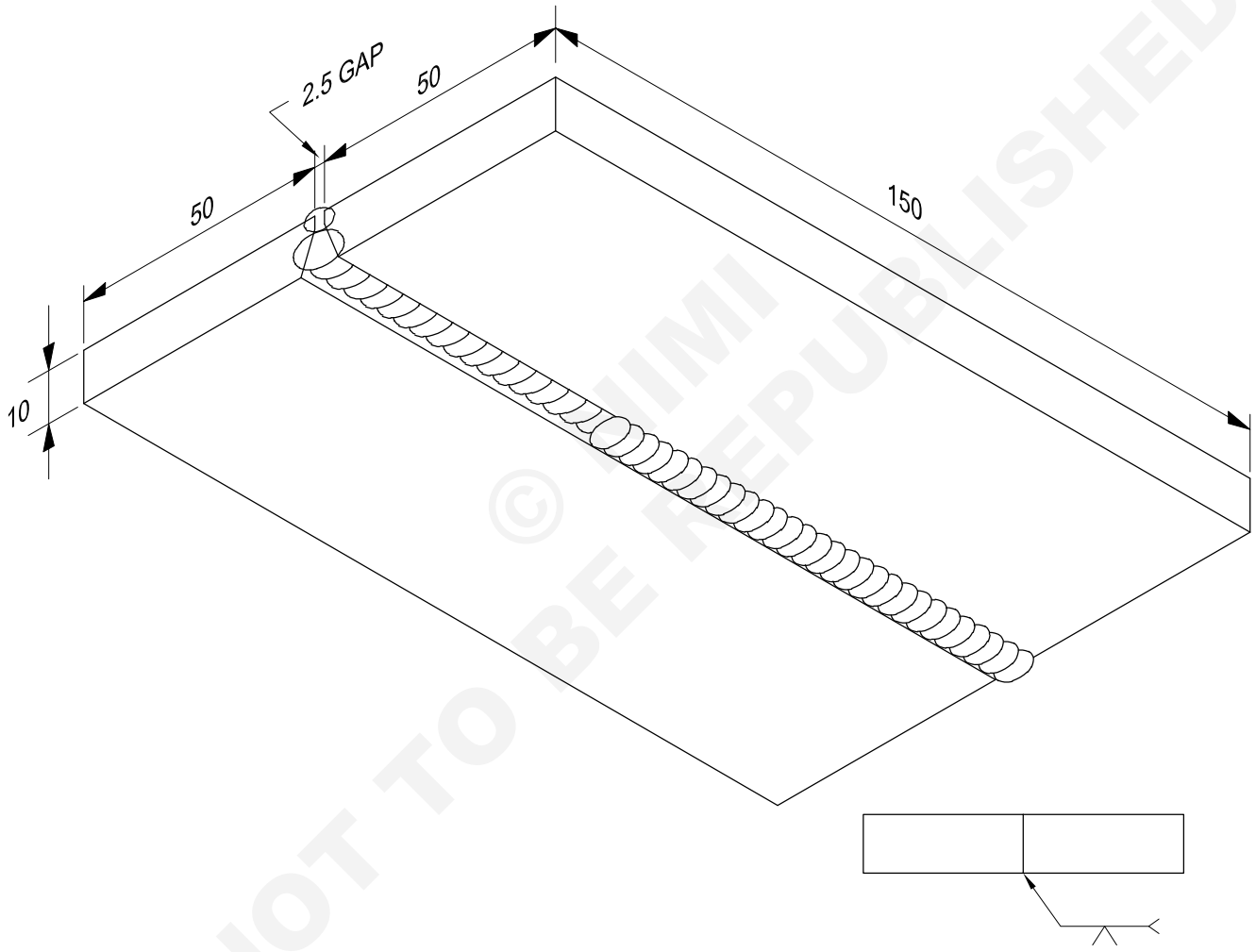
Fig 2



Single "V" butt joint on MS plate 10mm thick in over head position (4G)

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.**



2	50 ISF x 10 - 150	-	Fe 310 - W	-	-	1.3.47
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SINGLE 'V' BUTT JOINT ON M.S. PLATE 10mm THICK IN OVERHEAD POSITION. (4G)-(SMAW-22)	TOLERANCE ±1	TIME
		CODE NO. WS20N1347E1	

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.

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.

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. (Refer to Skill Sequence.)

Skill Sequence

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

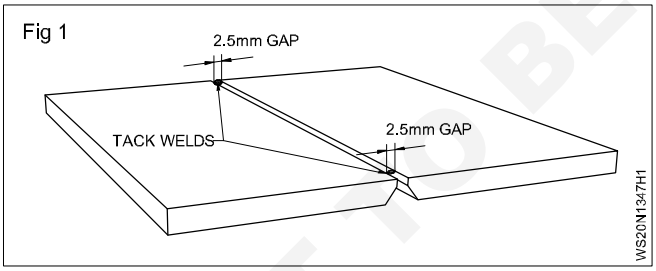
Objective: This shall help you to
- **prepare and weld single 'V' butt joint on MS plate 10mm thick in over head position.**

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.

Fig 1



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)

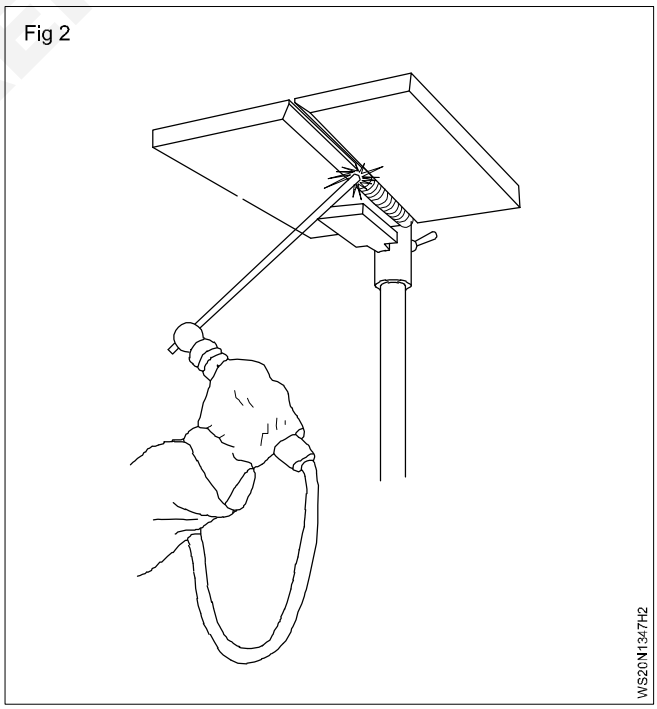
Adjust it to a suitable height.

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 2



Keep a short arc length. (Fig 4)

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

Fig 3

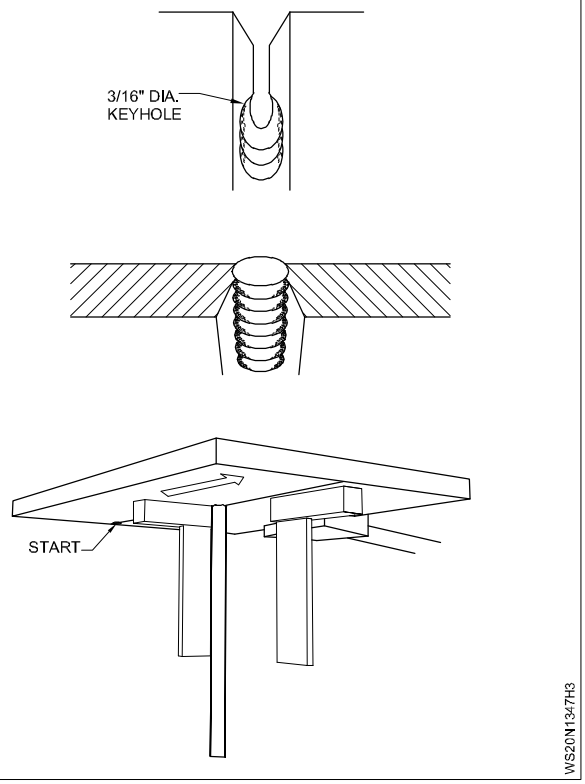
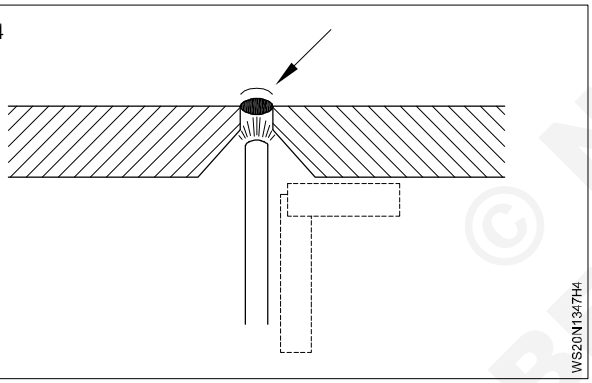


Fig 4

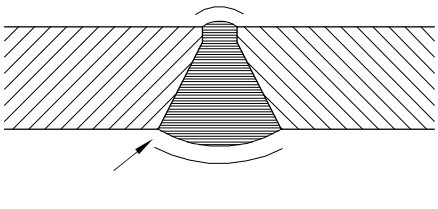


Weld up to the end of the work piece, chip off the slag after cooling and inspect the weld.

Weld second and third passes

Select a 3.15 electrode and set 100 amps current. Use

Fig 5



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

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

The side-to-side movement should be kept within the required weld size.

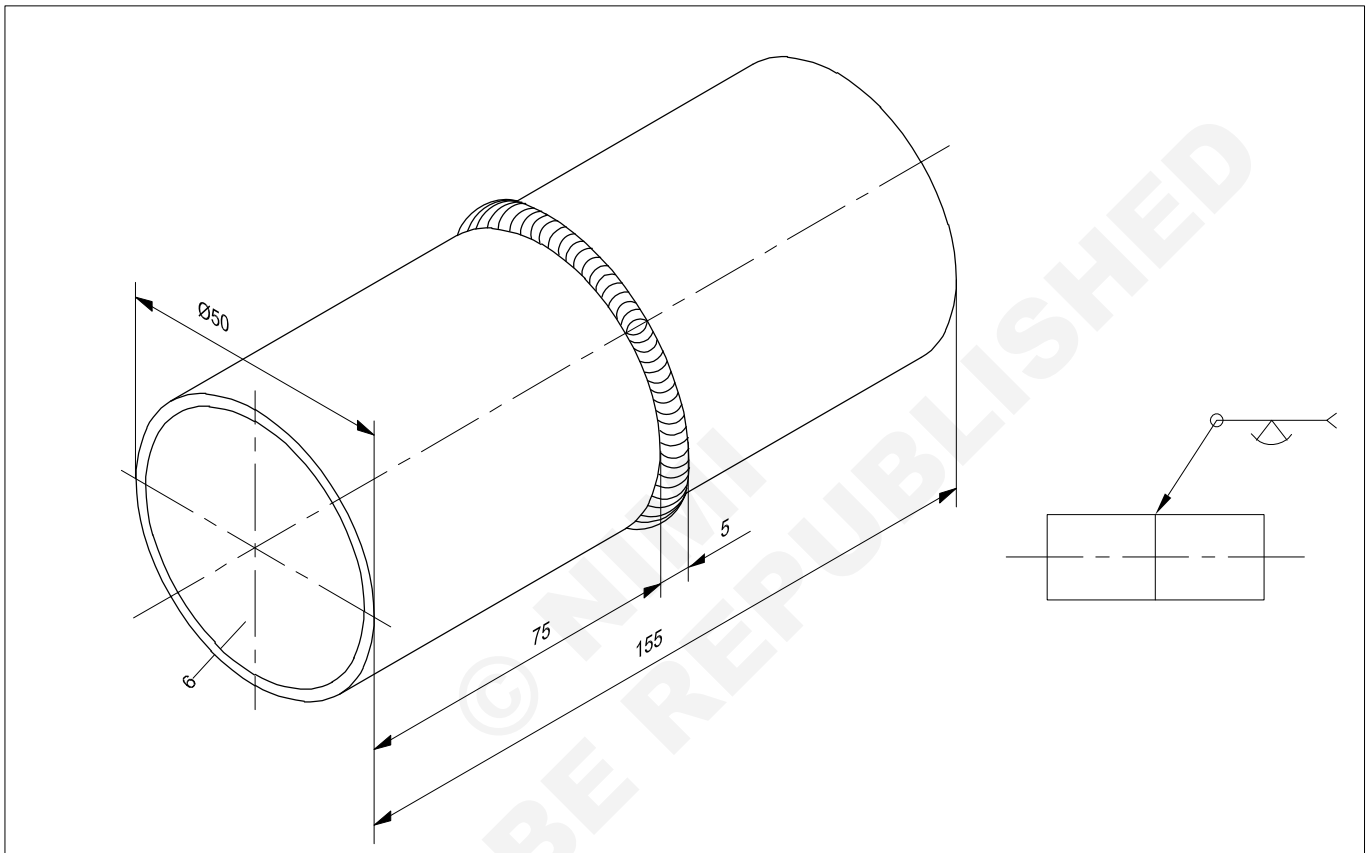
Stop a while at the sides of the weld to prevent undercut.

Chip off the slag and inspect the weld.

Pipe butt joint on MS pipe ø50mm wall thickness 6mm (1G Rolled) position

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.**



2	Ø50 x 6 - 75	-	Fe 310 - W	-	-	1.3.48
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PIPE BUTT JOINT ON M.S. PIPE Ø 50mm x 6mm WALL THICKNESS IN 1G (ROLLED) POSITION (SMAW-23)	TOLERANCE ±1	TIME
		CODE NO. WS20N1348E1	

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.

Wear protective clothing.

- 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

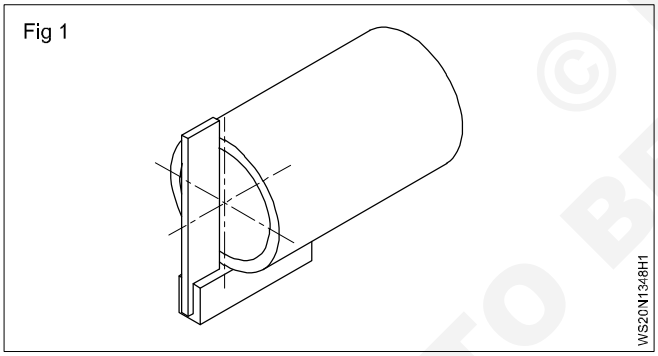
Pipe joint on MS pipe ø50mm×6mm wall thick in over head rolled position

Objective: This shall help you to
• prepare and weld pipe joint on MS pipe ø50mm×6mm wall thick in over head 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)

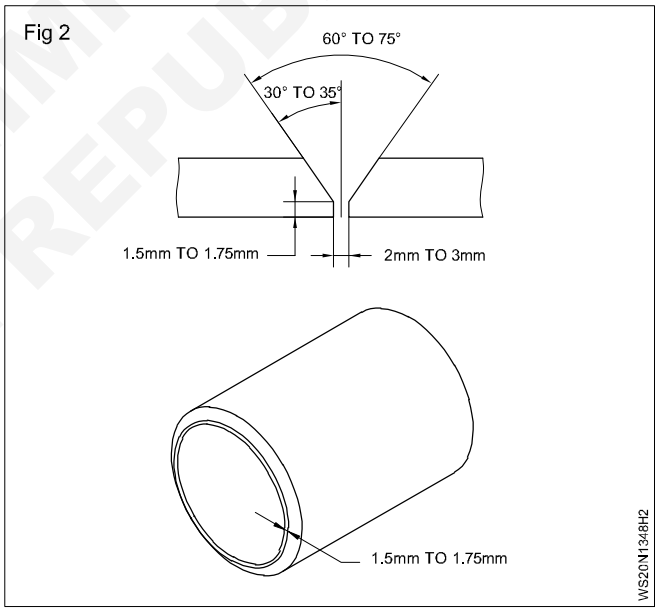
Switch 'on' the machine and adjust 110 amp current for 3.15 mm ø medium coated M.S. electrode (B.I.S code ER4211). Use DCEN polarity.

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 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.

Fig 2



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 .Then reverse your electrode direction.

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. 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,. 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.

Fig 3

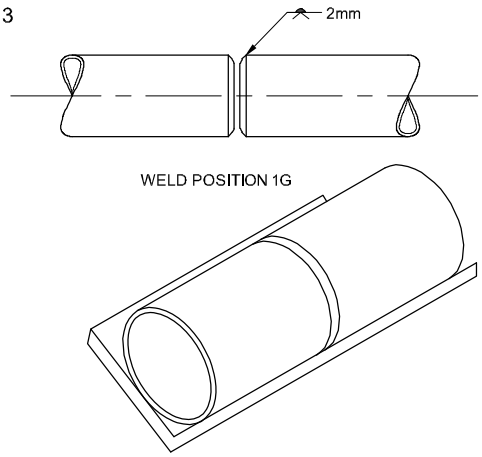
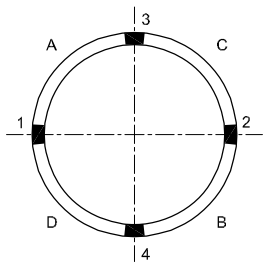


Fig 4

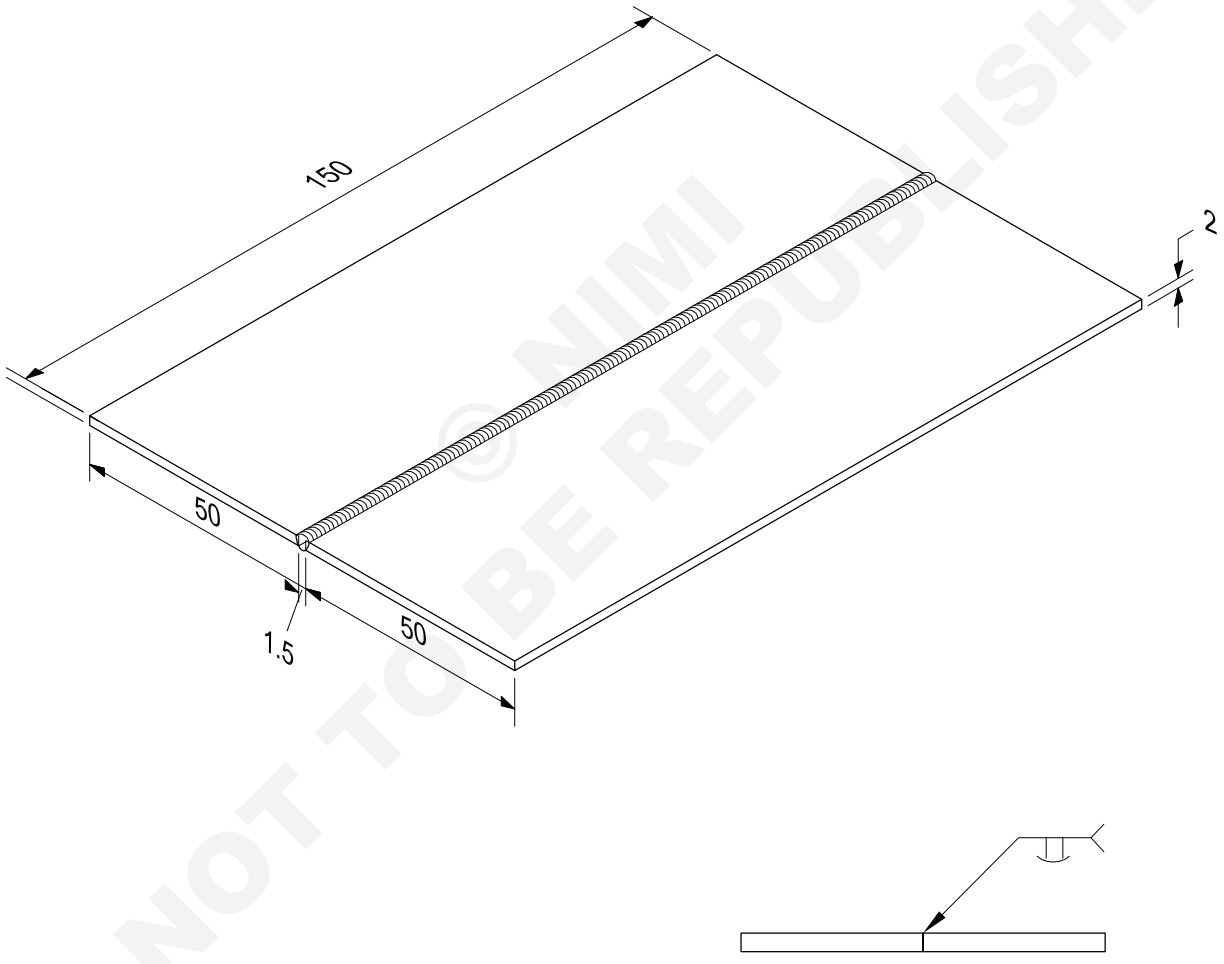


The second pass (hot pass) and third pass (cover pass) can be welded using 3.15mm electrode with either the triangle motion or the alternate weave, as in vertical plate welding. Take care to pause at the sides of the joint. Burn out any entrapped slag and fill in any undesirable undercut.

Square butt joint on stainless steel sheet 2mm thick in flat position (1G) (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.**



2	150 x 50 x 2	-	X 04 Cr19 Ni9	-	-	1.3.49
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	SQUARE BUTTJOINT ON STAINLESS STEEL SHEET 2mm THICK IN FLAT POSITION (1G)				TOLERANCE ±1	TIME
					CODE NO. WS20N1349E1	

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

Objective: This shall help you 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.

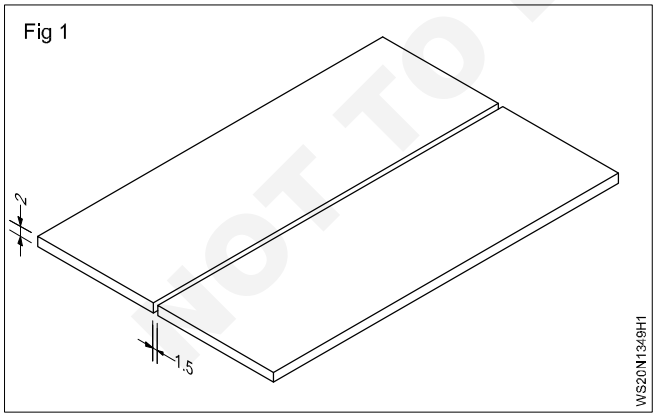
Select nozzle No. 5 and fix on the blowpipe.

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).

Fig 1

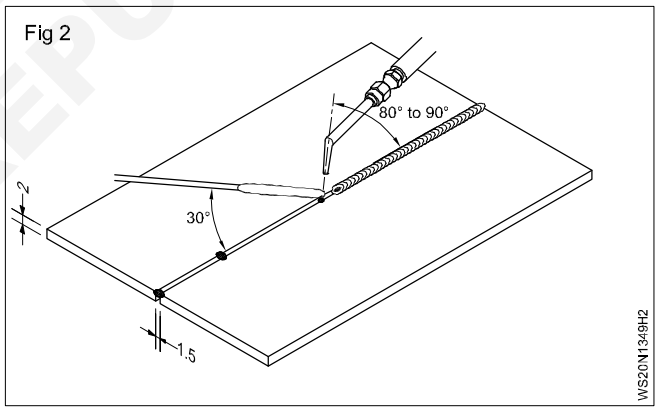


Set a strict neutral flame or slightly carburizing flame so as to prevent the formation of oxidizing flame which is harmful.

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 blow-pipe at an angle of 80° to 90° and the filler rod at 20° to 30°. (Fig 2)

Fig 2



Ensure uniform penetration at the root of the joint.

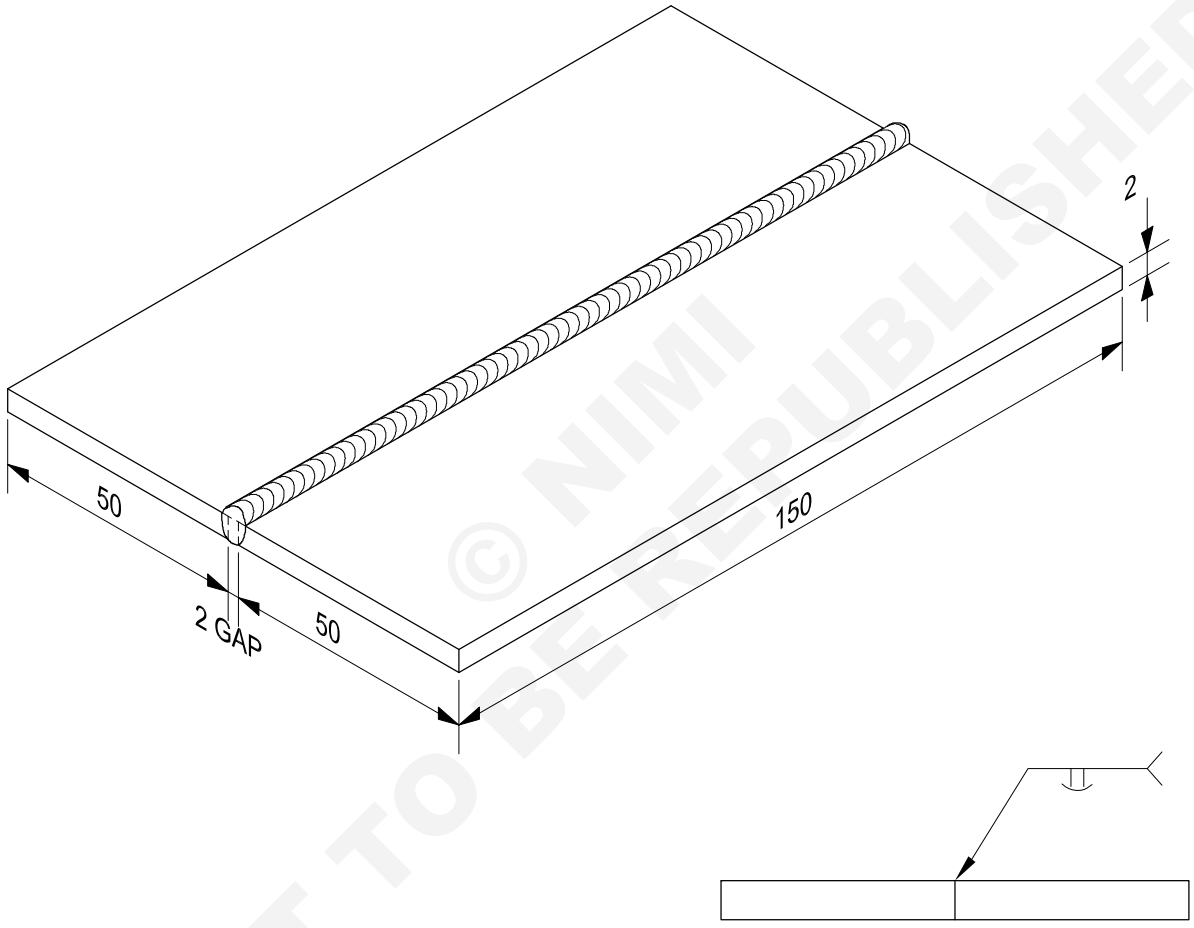
Finish the weld by filling up the crater at the end of the bead.

Clean the weld bead and inspect.

Ensure the complete removal of the flux residues.

Square but joint on stainless steel sheet 2mm thick in flat position (SMAW-24)

Objectives: At the end of this exercise you shall be able to
- **set and tack the stainless steel sheets**
- **select the electrode, polarity and set the current**
- **finish the weld in a single pass**
- **clean and inspect the weld.**



2	ISST 50 x 2 - 150	-	X 04 Cr 19 Ni 9	-	-	1.3.50
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SQUARE BUTT JOINT ON STAINLESS STEEL SHEET 2 mm THICK IN FLAT POSITION.	TOLERANCE ±1	TIME
		CODED NO. WS20N1350E1	

Job Sequence

- Prepare square edges.
- Clean the prepared edges.
- Select a 3.15 mm ø stabilized electrode and set 100 amps current.
- Follow necessary safety precautions.
- Set and tack the pieces.
- Place copper chill plates on the job by the side of the joint.
- Keep the current low to reduce over heating of the electrode and job.
- Complete the weld in a single pass without weaving.
- Clean the weld and inspect the bead for surface defects.
- Use stainless steel wire brush and separate hand gloves for stainless steel welding. This helps to avoid ferrous contamination and corrosion.

Skill Sequence

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

Objective: This shall help you to
- **prepare and weld square butt joint on stainless steel sheet 2mm thick in flat position.**

Prepare square edges by filing.

Remove burrs from the edges, and clean the edges with a stainless steel wire brush and remove the surface impurities.

Take a 3.15 mm ø stainless steel electrode and connect it to the positive side of the DC machine.

Columbium based electrodes (called stabilized stainless steel electrode) are used to avoid the welded joint getting corroded/rusted after welding.

Set the cleaned stainless steel plates on the work table with a uniform root gap of 2 mm as shown in Fig 1 and tack them at every 50 mm.

Clean the joint thoroughly to remove slag from the tacks.

Clamp chill plates adjacent to the joint to minimize distortion and buckling. (Fig 2)

To prevent damaging the metal surface, the polished side of a sheet should be placed down.

Fig 1

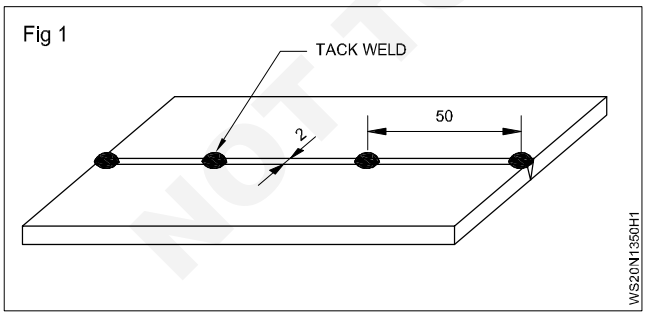
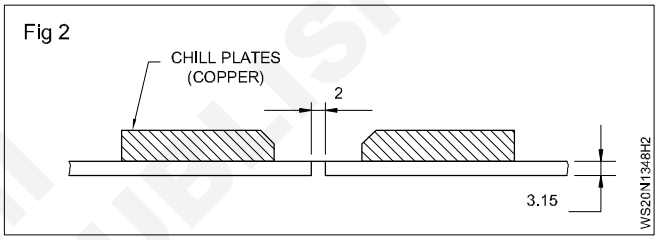


Fig 2



Keep the current as low as possible to reduce overheating of the job.

Start welding at the left hand side of the joint and maintain a short arc.

Do not weave the electrode.

The electrode angle must be 70° to 80° in the direction of the weld.

Maintain a high welding speed to avoid over-heating of the plate edges.

Finish the welding at the right end of the plate.

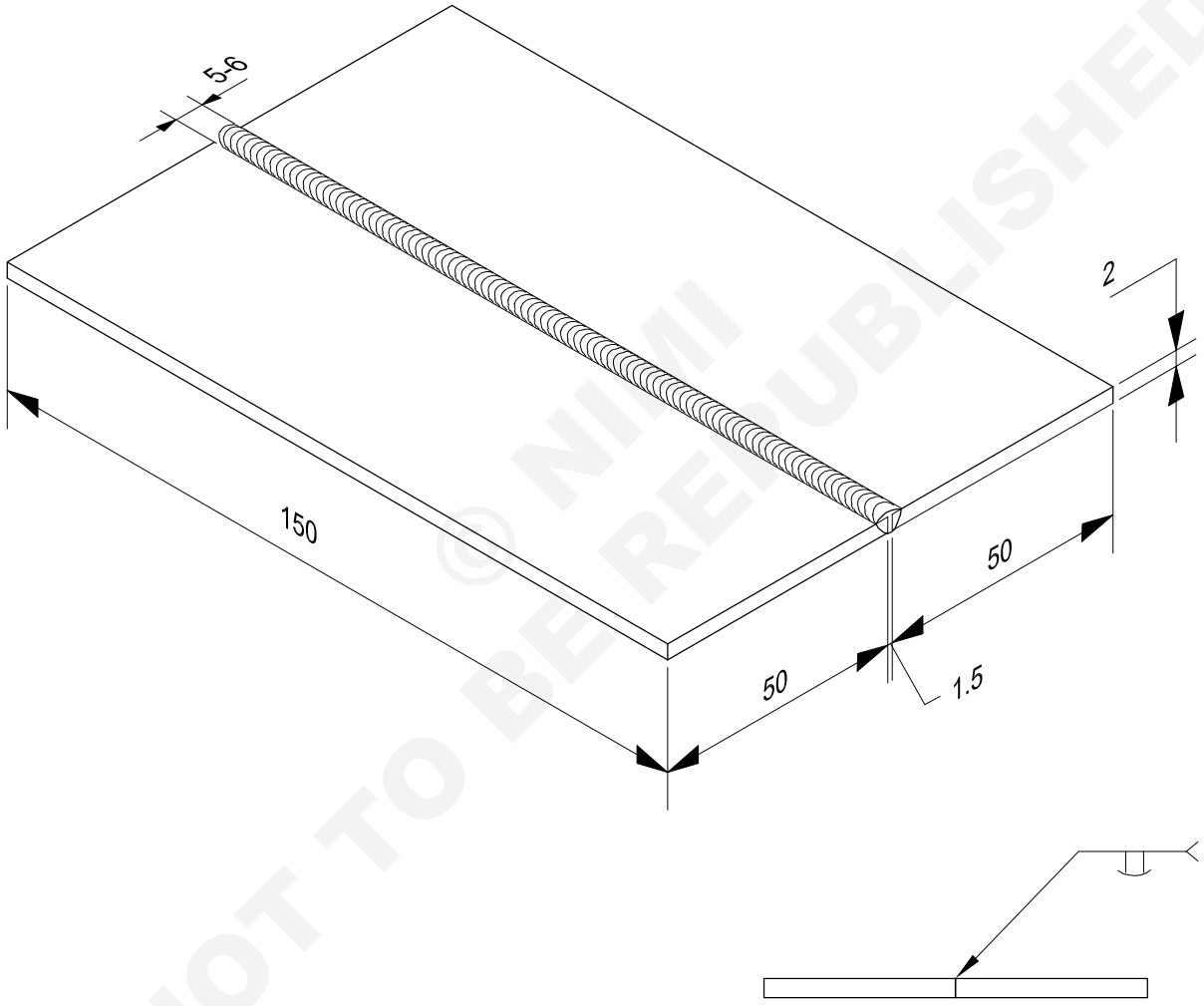
Deslag and clean thoroughly with a stainless steel wire brush.

Inspect for surface defects.

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.**



2	150 x 50 x 2	-	CuZn30-O IS:2378	-	-	1.3.51
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SQUARE BUTT JOINT ON BRASS SHEET 2 mm THICK IN FLAT POSITION (OAW-18)	TOLERANCE ±1	TIME
		CODE NO. WS20N1351E1	

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/cm^2 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.
- 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.

Skill Sequence

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

Objective: This shall help you 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 disappear. This is the required oxidizing flame for the particular brass sheet to be welded.

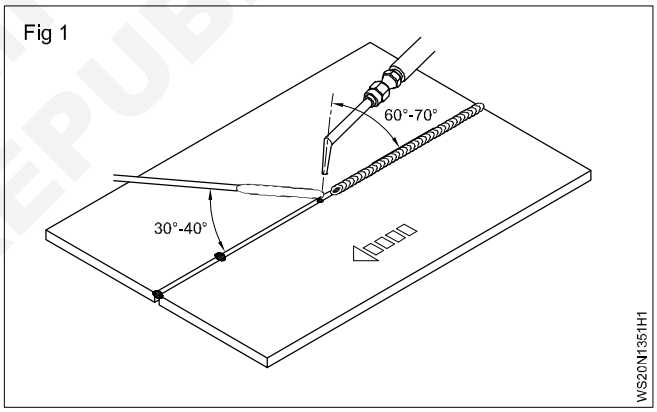
Commence welding at right side end and continue until the joint is completed. The filler rod is fed into the pool as the surface sinks, indicating that penetration is being achieved.

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°.

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.

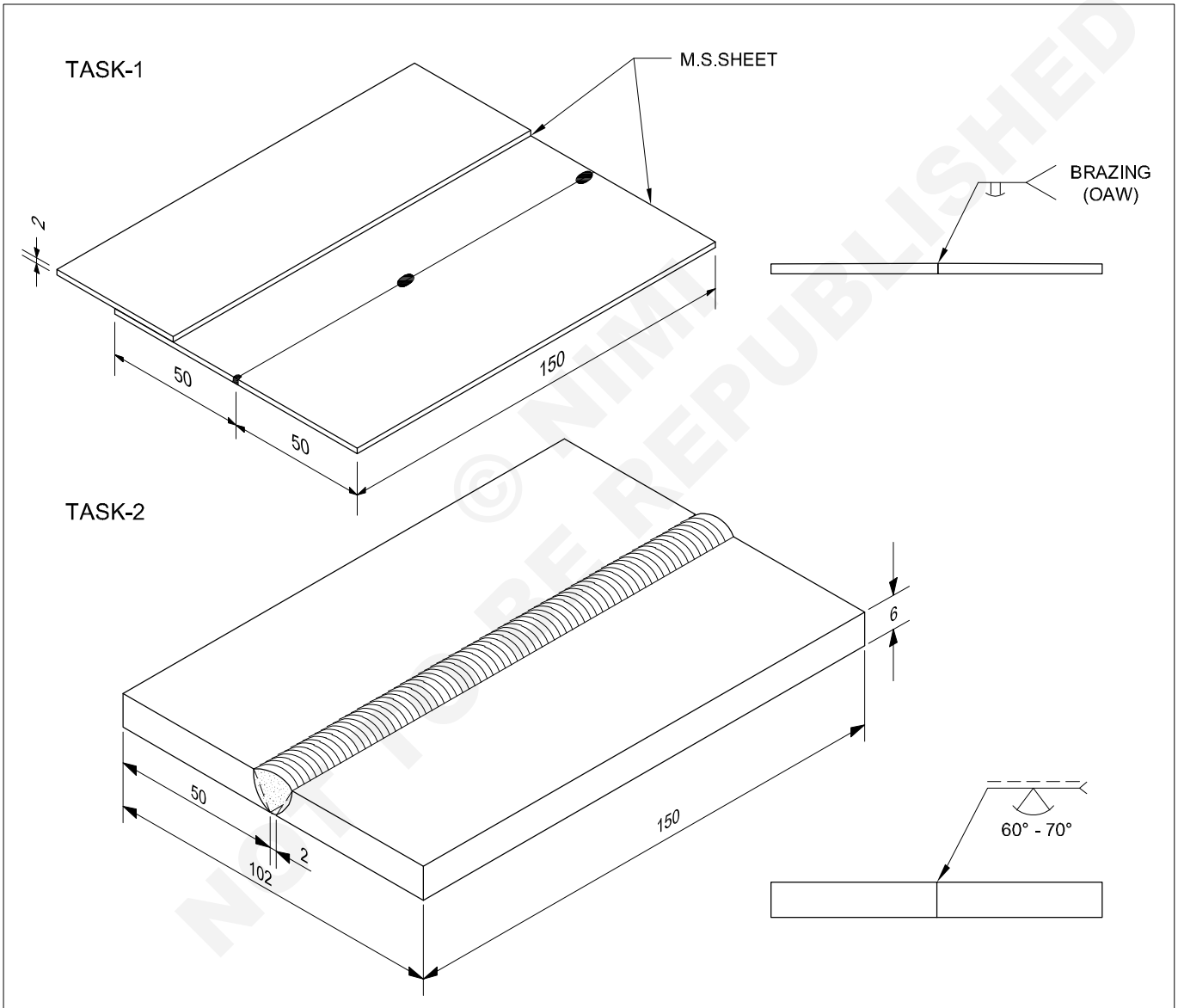
Fig 1



Square butt and lap joint on M.S. sheet 2mm thick by brazing & Single 'v' butt joint ci plate 6 mm thick in F/P

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**
- **prepare the edges, set the cast iron plates and tack weld**
- **select the electrode and set the current**
- **deposit root run, second and third runs withoout crack**



2	150 x 50 x 6	-	FG 15	-	-	1.3.52
3	ISST 50 x 2 - 150	-	Fe310 - W	-	-	1.3.52
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**SQUARE BUTT AND LAP JOINT ON M.S SHEET 2MM THICK BY BRAZING IN FLAT POSITION**	TOLERANCE ±1	TIME
		CODE NO. WS20N1352E1	

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

Objective: This shall help you 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).

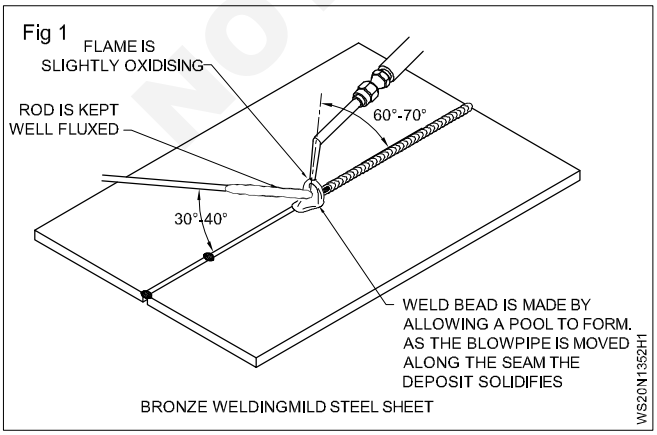
A No. 3 size nozzle with 0.15 kg/cm^2 pressure for both gases is used as the base metal is not melted, but heated to around 800°C.

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 center 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)

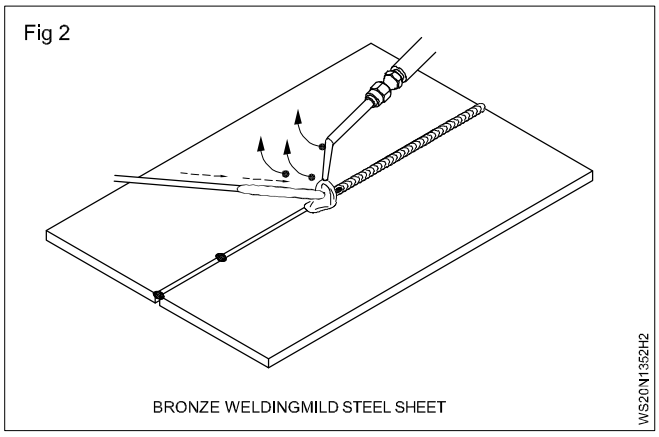
Fig 1



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.

Fig 2

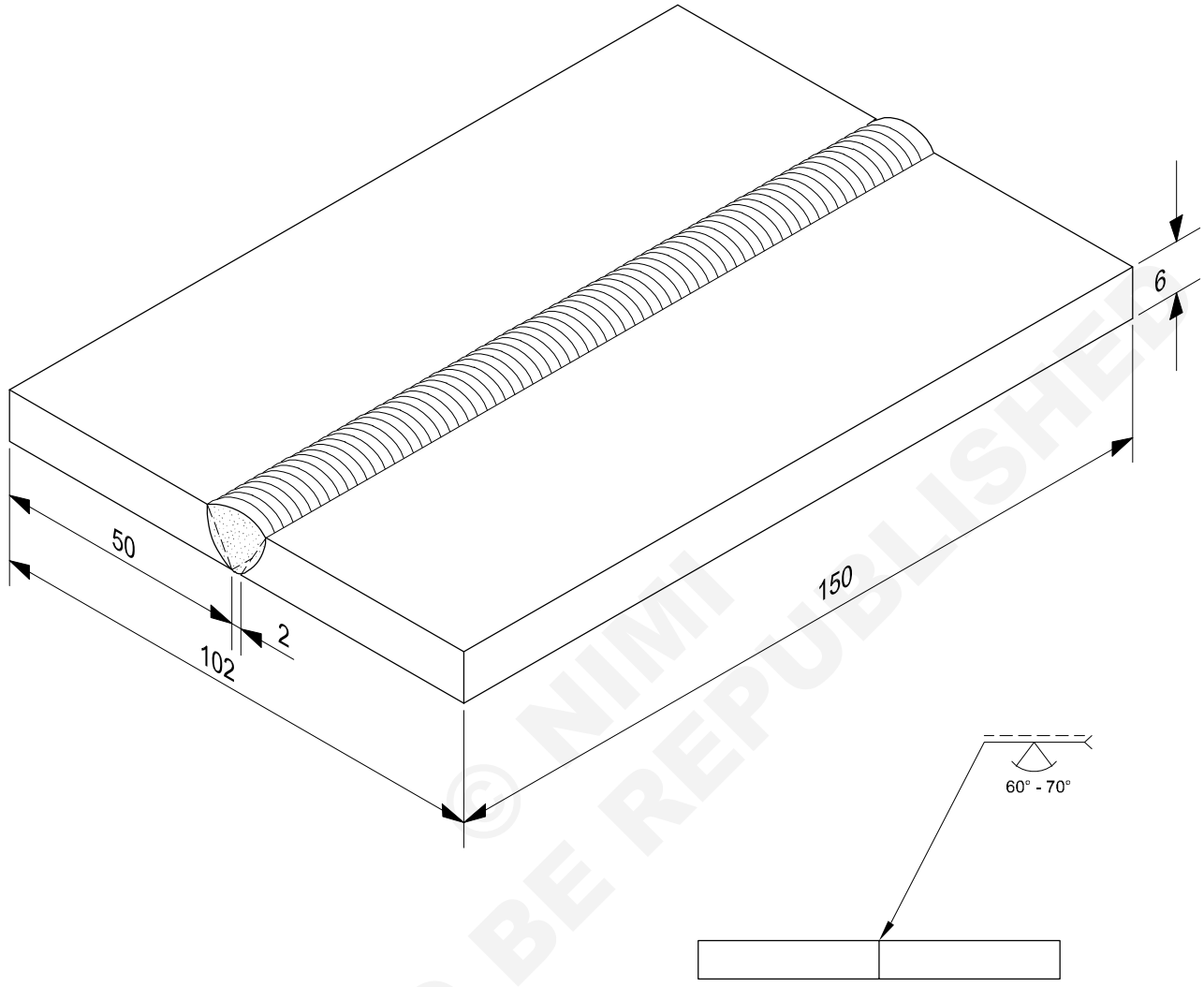


To avoid crater at the end of the weld the filler rod is continued to be added into the molten pool at the finishing point and the flame is withdrawn.

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.

TASK 2



2	150 x 50 x 6	-	FG 15	-	-	1.3.52
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**SINGLE "V" BUTT JOINT ON CAST IRON PLATE 6mm THICK IN FLAT POSITION (1G)**	TOLERANCE ±1	TIME 4 Hrs
		CODE NO. WS20N1352E2	

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

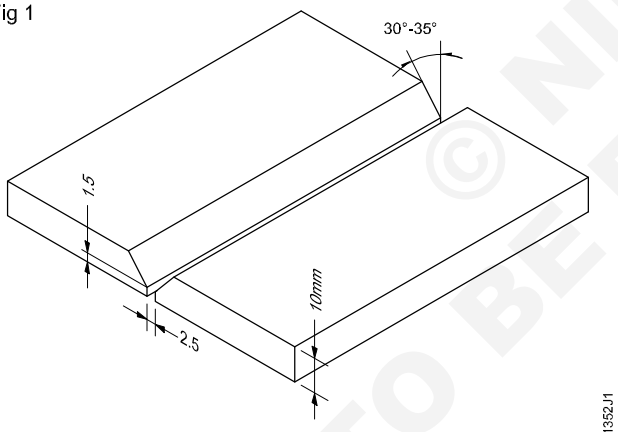
Single 'V' butt joint on cast iron plate

Objective: This shall help you 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

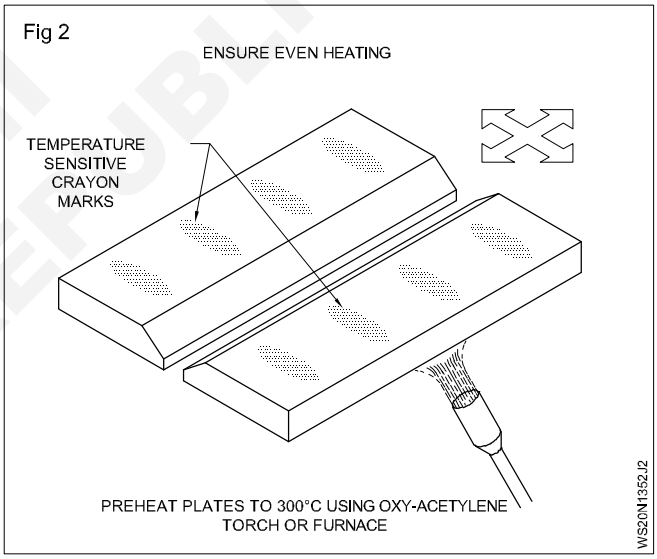


Set and tack weld: Keep the job parallel in flat position and maintain the root gap 2.5 mm.

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.

Fig 2

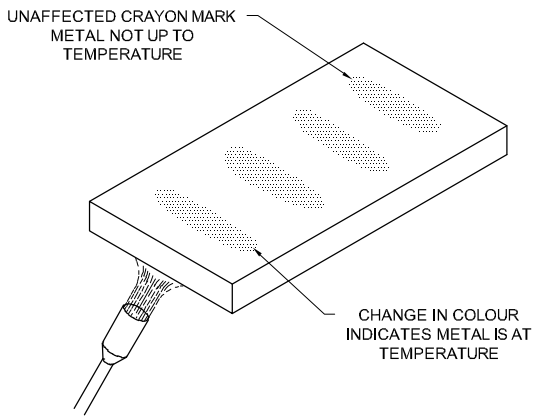


Clean the root run by a wire brush. Deposit the second the by using a 3.15 mm dia. electrode with slightly weaving motion and keep the electrode angle 80° to the line of weld. Move the electrode with a digging action. Since fluidity of cast iron is less, to make the molten metal to flow into the joint easily the electrode has to be given a digging action.

Clean the second run by a wire brush.

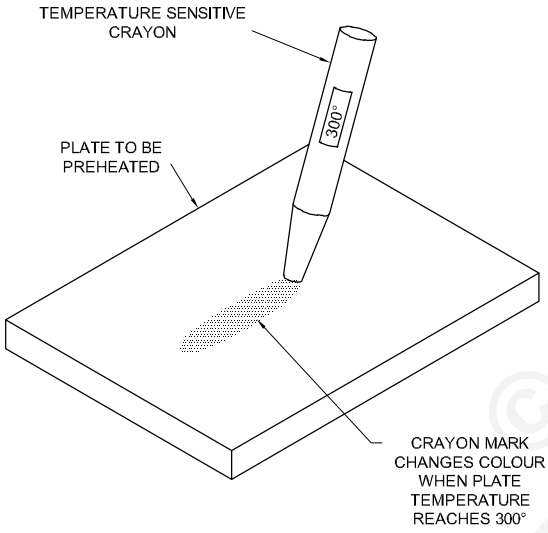
Deposit the third run by using a 3.15 mm dia. electrode with a slight weaving motion. Keep the electrode angle at 80° to the line of weld. Peen the welded bead by a ball pein hammer to remove internal stresses. Post heat the job to preheating temperature. Keep the job under dry sand or ash and allow to COOL SLOWLY. Clean the weldment by using a wire brush.

Fig 3



USE OF TEMPERATURE SENSITIVE CRAYON
FOR TEMPERATURE MEASUREMENT

(3a)

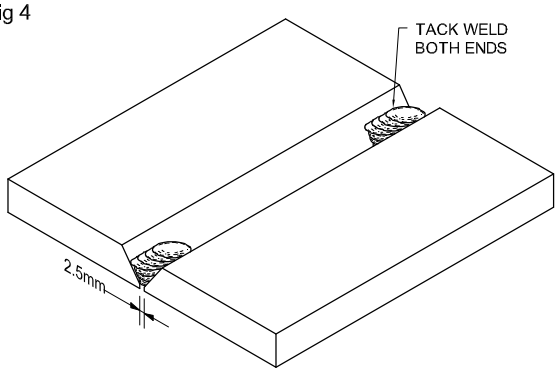


TEMPERATURE SENSITIVE CRAYON

(3b)

WS20N1352J3

Fig 4



PREPARED PLATES SET UP FOR A SINGLE-V BUTT JOINT

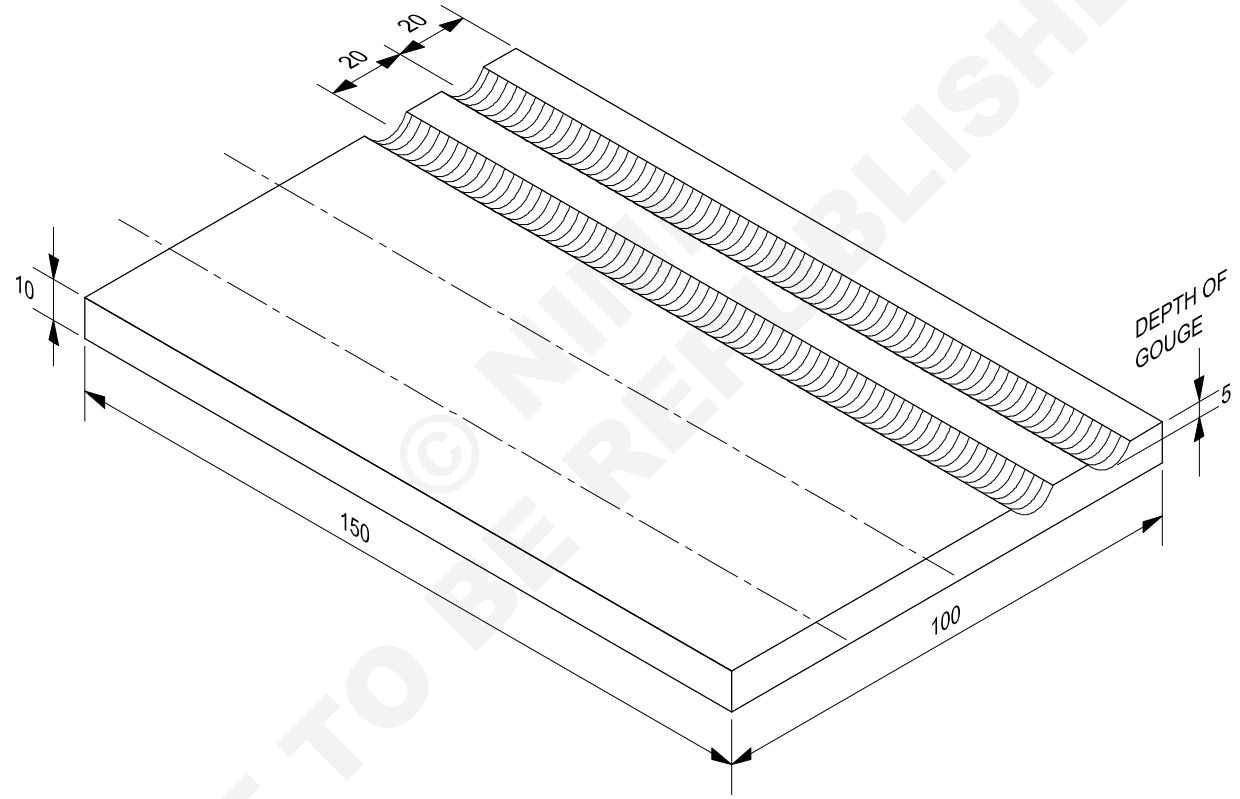
WS20N1352J4

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.

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.**



1	100 ISF 10 - 150	-	Fe310 - W	-	-	1.3.53
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	ARC GOUGING ON M.S.PLATE 10mm THICK IN FLAT POSITION	TOLERANCE ±1	TIME
		CODE NO. WS20N1353E1	

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

Objective: This shall help you 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.

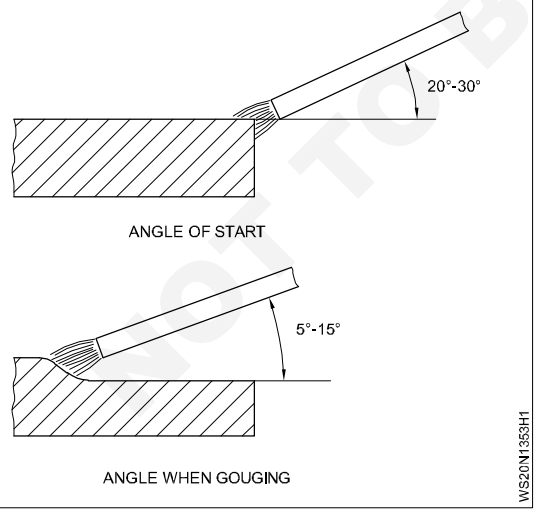
Select the electrode and set the current.

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.

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.

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

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.

Inspect the gouging.

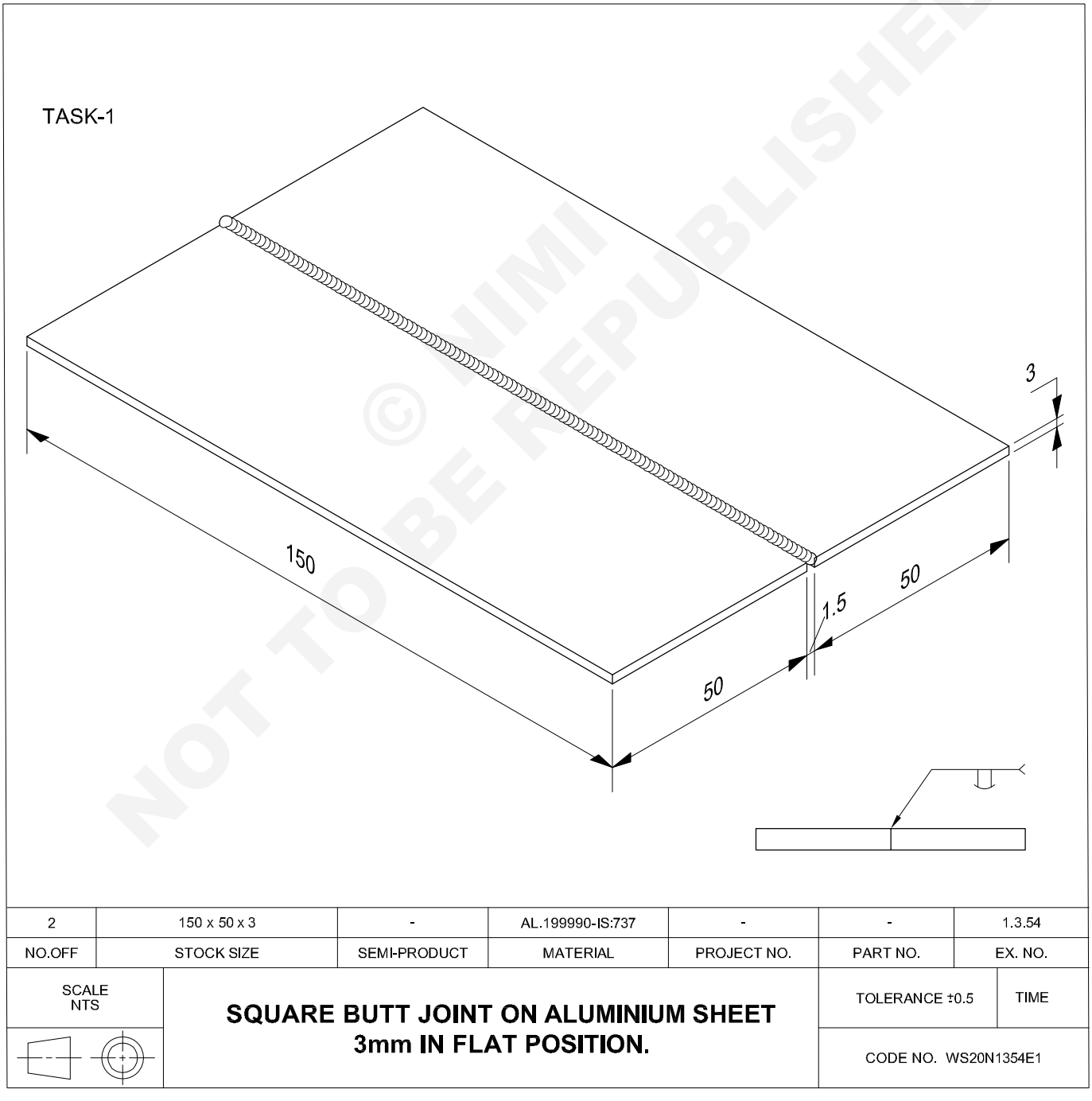
Check the smoothness, depth and uniformity of gouging.

Square butt joint on aluminium sheet 3mm thick in flat position (OAW),Bronze welding of cast iron (single V' butt joint) 6mm thick plate

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

- **set the sheets with sufficient root gap after cleaning the edges**
- **weld aluminium butt joint**
- **ensure fusion of edges without making holes at the joint**
- **remove flux residues from the weldment by chemical cleaning**
- **select the correct nozzle size and filter rod (composition and size)**
- **set a slightly oxidized flame**
- **select and identify the correct type of flux and method of application of flux**

TASK 1



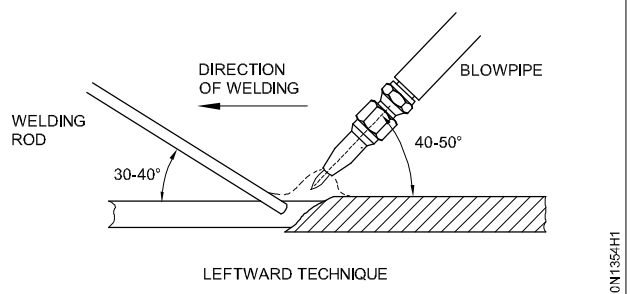
2	150 x 50 x 3	-	AL.199990-IS:737	-	-	1.3.54
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SQUARE BUTT JOINT ON ALUMINIUM SHEET 3mm IN FLAT POSITION.	TOLERANCE ±0.5	TIME
		CODE NO. WS20N1354E1	

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. 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.cm^2 for both gases.

Fig 1



- Adjust a strict neutral flame.
- 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 center.
- 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)
- 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

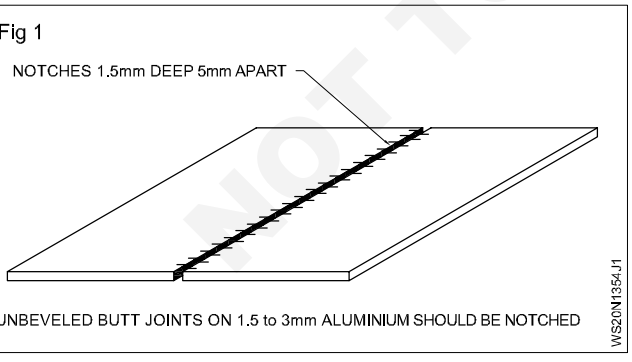
Square butt joint on aluminium sheet of 3mm thick

Objective: This shall help you 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

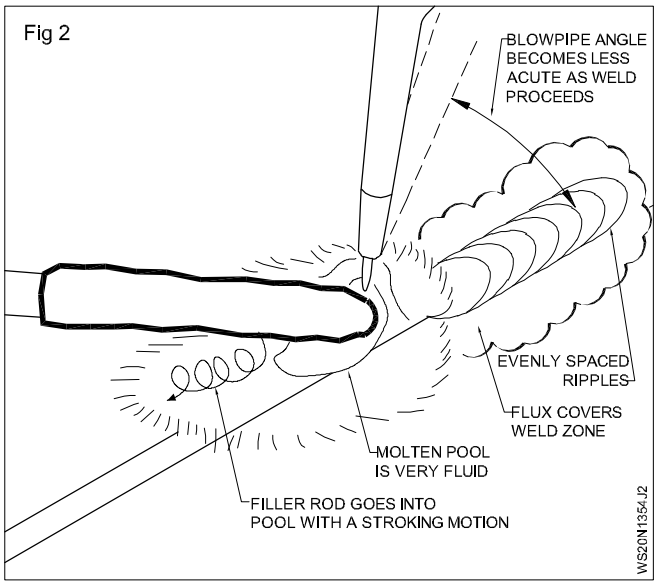


Since setting a strict neutral flame is difficult a very slight carburizing flame is set for welding aluminium.

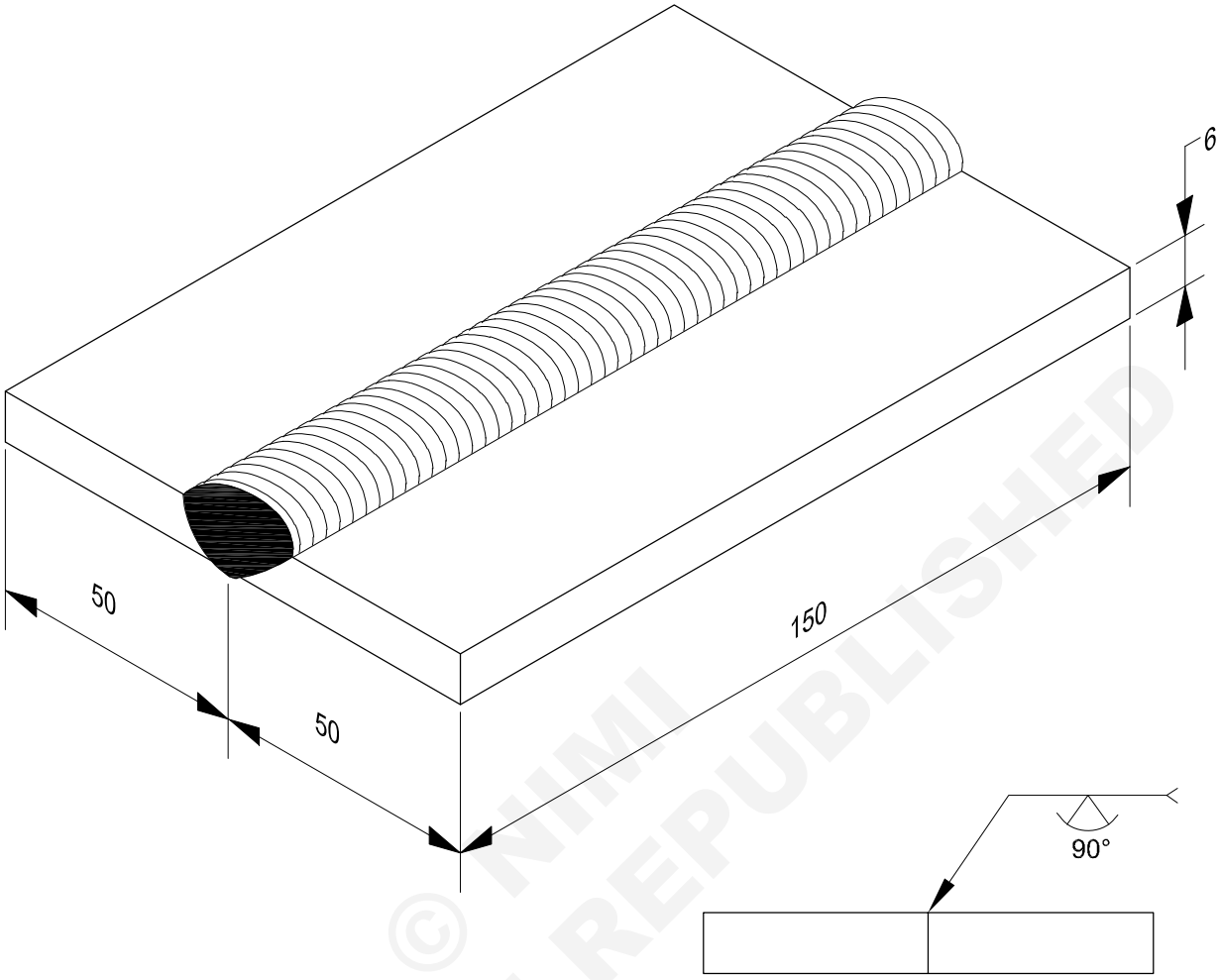
While using leftward technique, the blow pipe angle will be reduced gradually as the welding progresses.(Fig 2).

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



TASK 2



2	150 x 50 x 6	-	FG 15	-	-	1.3.54
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	BRONZE WELDING OF SINGLE 'V' BUTT JOINTON 6 mm THICK CAST IRON PLATE IN FLAT POSITION.	TOLERANCE ±1	TIME
		CODE NO. WS20N1354E2	

Job Sequence

- 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/cm^2 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

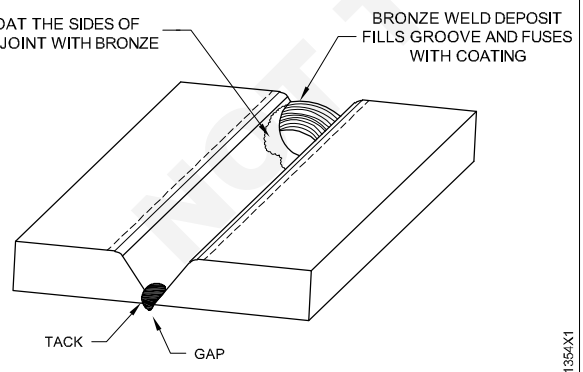
Objective: This shall help you to
- **prepare and bronze welding of single 'V' butt joint on cast iron plate of 6mm thick.**

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.

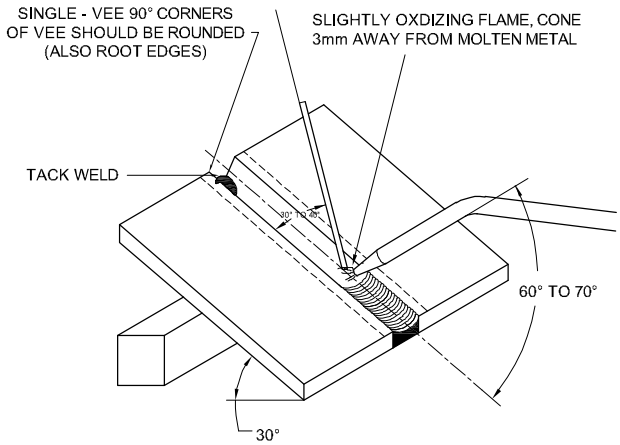
Fig 1



BRONZE WELDING CAST IRON MAKING THE COATING AND DEPOSIT

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).

Fig 2



ANGLES OF ROD AND BLOWPIPE FOR BRONZE WELDING

BRONZE WELDING CAST IRON (ROOT RUN)

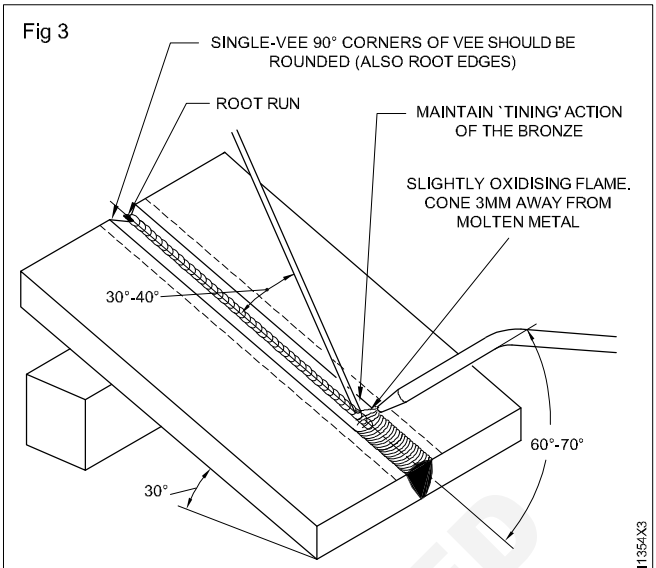
Then return to the starting point and add sufficient filler metal to produce a satisfactory weld. This method is repeated continuously until the root run is completed. Fig 2 Ensure root penetration by the filler metal and fusion between consecutive bronze filler metal deposits.

Weld similarly the 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).

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.

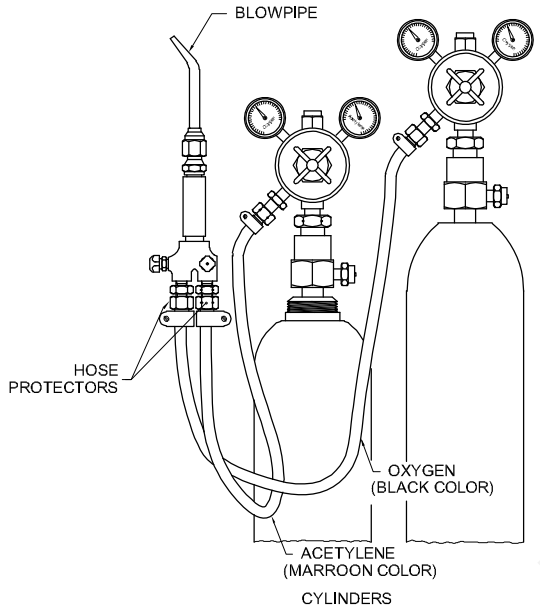
Fig 3

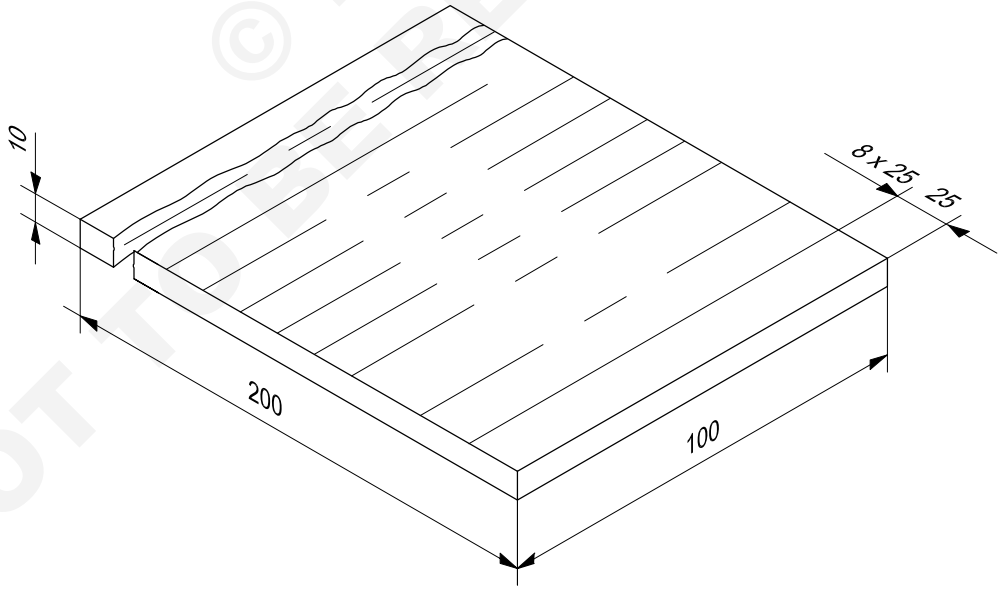


BRONZE WELDING CAST IRON DEPOSITING SECOND RUN

Setting up gas cutting equipment and cutting MS Plate required size

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**





1	100 ISF 10x100x200mm	-	Fe310-W	-	-	1.4.55
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	SETTING UP GAS CUTTING EQUIPMENT AND CUTTING MS FLATS	DEVIATIONS	TIME:
		CODE NO. WS20N1455E1	

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 90^0 to the cut line and plate surface.
- Hold at one end of the plate on the punch line up to cherry red hot.

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.

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

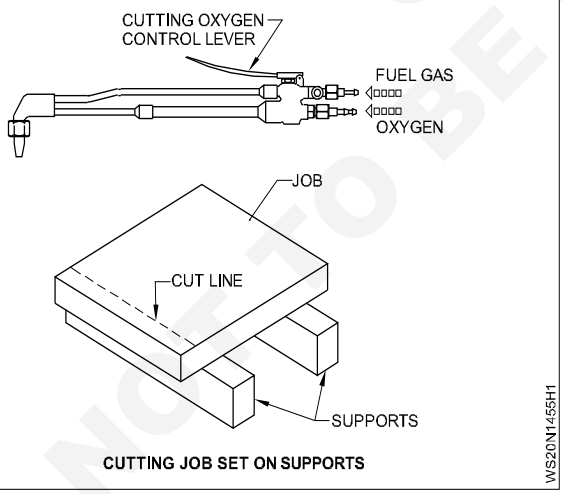
Straight cutting along by hand

Objectives: This shall help you 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)

Fig 1



CUTTING JOB SET ON SUPPORTS

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 thickness. (Table 1)

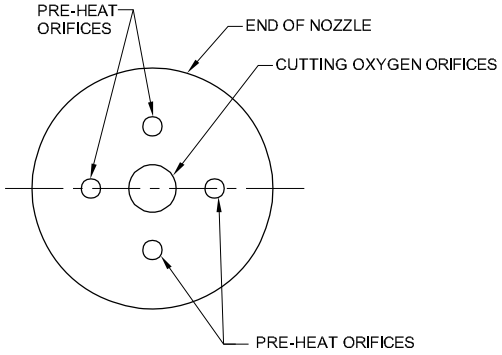
Set the cutting nozzle in the blowpipe correctly. (Fig 2)

TABLE 1

Data for cutting

Diameter of cutting oxygen orifice nozzle	Thickness of steel plate	Cutting oxygen pressure
(1) mm	(2) mm	(3) kg/cm^2
0.8	3-6	1.0-1.4
1.2	6-19	1.4-2.1
1.61	9-100	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

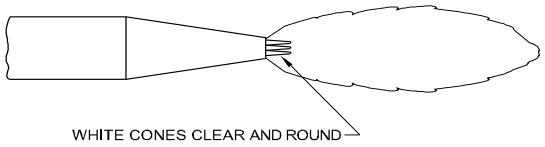
Fig 2



HOLES ON THE CUTTING BLOWPIPE NOZZLE

Adjust the neutral flame for preheating. (Fig 3)

Fig 3



CORRECT FLAME ADJUSTMENT FOR CUTTING

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

Straight cutting

Hold the cutting blowpipe at 90^0 with the plate surface, and cut along the line (Fig 4)

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

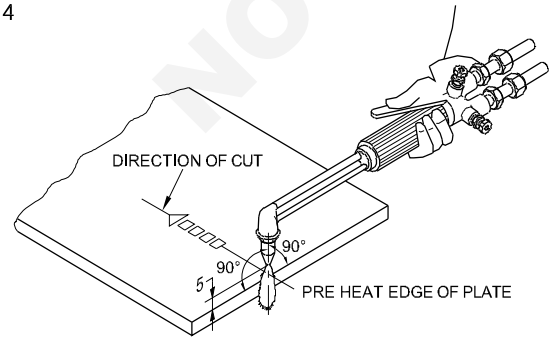
Keep the distance between the work piece and the nozzle about 5mm to avoid backfire. (Fig4)

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

While gas cutting ensure

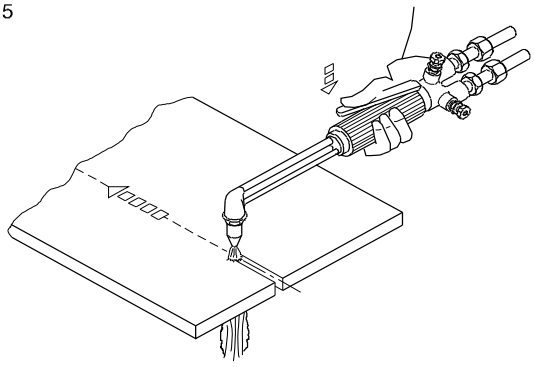
Straight travel of the cutting blowpipe without side-to-side movement and correct nozzle position with the plate surface till the cutting oxygen valve is fully open.

Fig 4



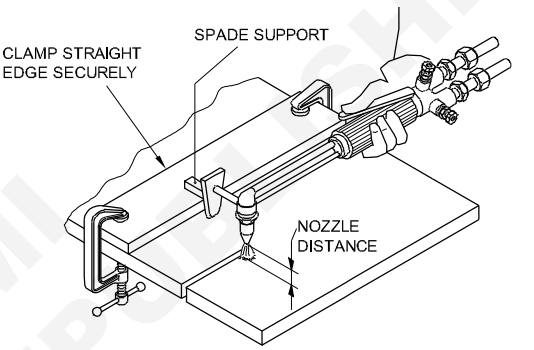
STARTING OF CUT

Fig 5



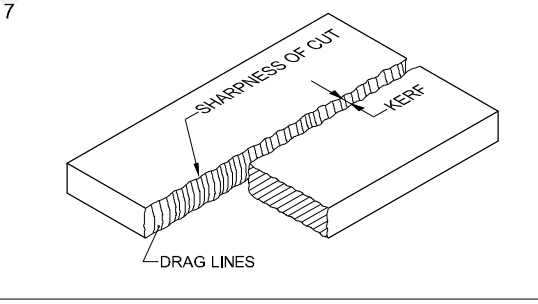
If possible, fix the straight edge to the plate, and also the spade support to ensure a straight cut (Fig 6) and to maintain correct nozzle distance.

Fig 6



Inspection of gas cut (Fig 7)

Fig 7



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

Inspect for uniform

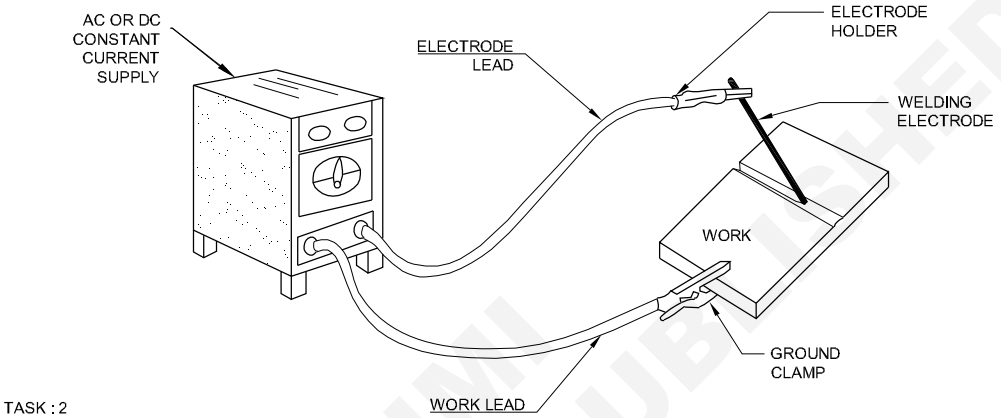
- Smooth cut or drag lines
- Straightness of cut
- Sharpness of cut
- Width of cut.

Setting up SMAW welding equipment and making straight and weaving based on MS in all position.practice on plasma cutting. practice on gouging techniques

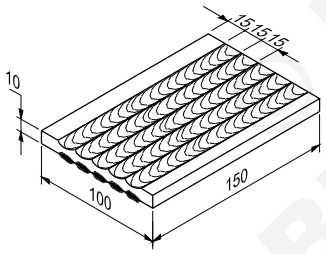
Objectives: At the end of this exercise you shall be able to

- **set an SMAW welding equipment**
- **making straight and weaving bead on M.S in flat position, horizontal, vertical & overhead position.**

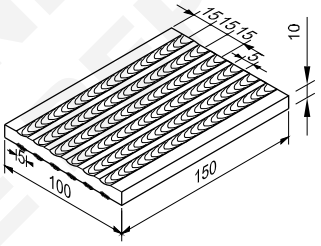
TASK : 1



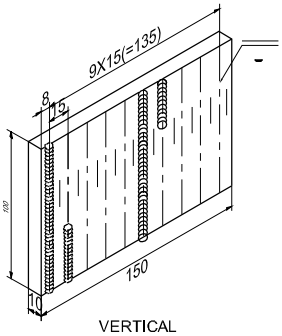
TASK : 2



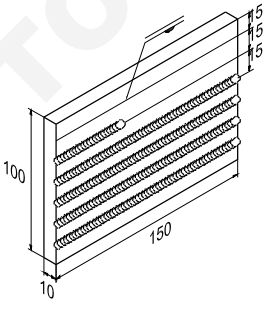
STRAIGHT LINE BEADS FLAT



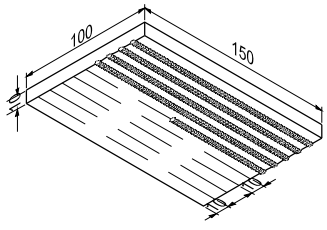
WEAVING BEADS FLAT



VERTICAL



HORIZONTAL



OVERHEAD

4	50 ISF x 10-150	-	Fe310	-	-	1.4.56
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**SETTING UP SMAW WELDING EQUIPMENT AND MAKING STRAIGHT AND WEAVING BEAD ON MS IN ALL POSITIONS.PRACTICE ON PLASMA CUTTING.PRACTICE ON GOUGING TECHNIQUES**	DEVIATIONS ±0.5	TIME:
		CODE NO. WS20N1456E1	

Job Sequence

- Prepare the plates to size (as per drawing) gas cutting /hack saw cutting and grinding.
- Clean the plate surface (job) with a wire brush and remove the burrs by filling.
- Lay out parallel lines on both sides of the job surface as per sketch and mark with a center punch.
- Set the plate on the welding table in a required position
- Ensure the plate is contacting well with the welding table and the earth clamp is not loosely connected with the work table.
- Wear protective clothing (safety apparels)

Refer the table:1 Repeat the exercise for all positions

Table :1

Weld position	Electrode size	Current setting	Electrode angle	Polarity	Arc length	Arc travel speed
Down hand position Fig – 2&3	4mm Ø M.S. electrode	150 to 160 amps	Straight line - 70° to 80°	Reverse polarity	Medium arc length	Approximately 150 mm per minute
Horizontal position Fig - 4	3.15 mm Ø M.S. electrode	110 amps	70° to 80°	Reverse polarity	Short arc length	–
Vertical position Fig - 5&6	3.15 mm Ø M.S. electrode	100-110 amps	80°	Reverse polarity	Short arc length	–
Overhead position Fig - 7	3.15 mm Ø M.S. electrode	100-110 amps	90°	Reverse polarity	Short arc length	–

Skill Sequence

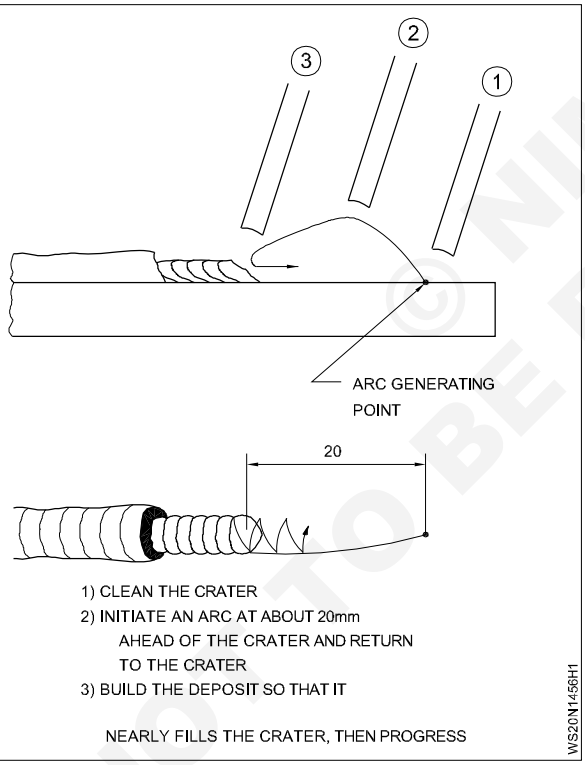
Making straight and weaving bead on MS in all position (SMAW)

Objectives: This shall help you to

- **set on SMAW equipment**
- **straight & weaved bead on MS plate in all position.**
- **prepare a M.S. plate piece 100x150x10 using a hacksaw and file.**

- Ensure the burning of the electrode is normal and the arc is smooth
- Read just the welding current if necessary(Ref table1)
- Use a correct arc length (Ref table 1)
- Deposit straight line beads on the work piece along the punched line from the end to end
- Restart the bead whenever the arc is broken and ensure fill the crater Ref (fig 1)
- Fill the crater at the end of the beed without fail
- Remove slag from the weld bead using a chipping hamme and clean with steel wire brush.

Fig 1



- Inspect deposited beads for :
  - uniform width and height - unfilled crater
  - straightness - porosity
  - uniform ripples - undercut
  - slag inclusion

straight line beeds and weaving beads in flat position

Fig 2

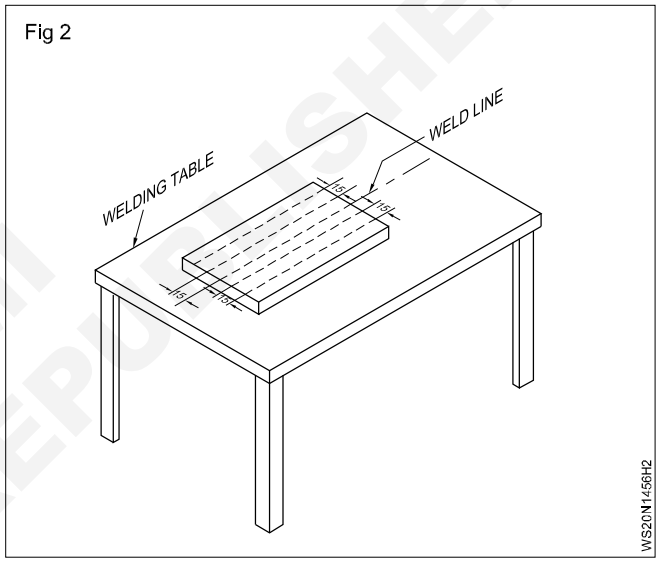


Fig 3

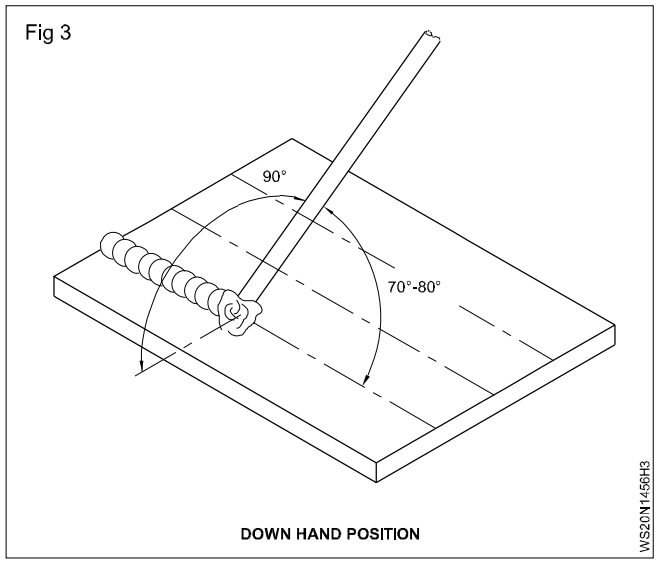
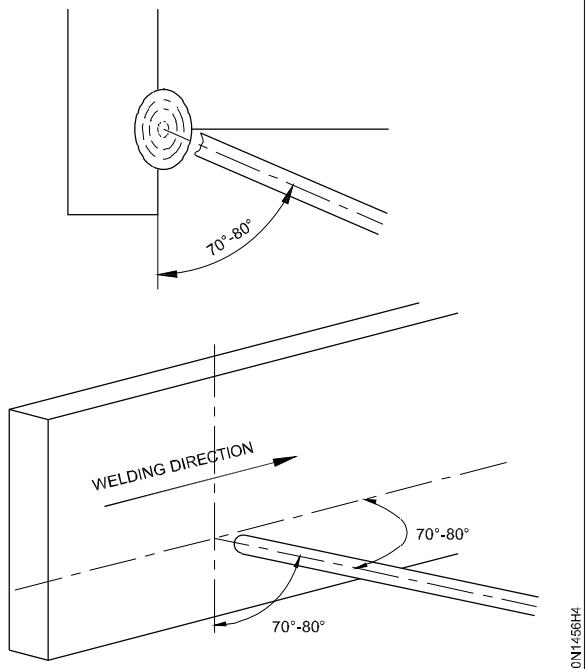
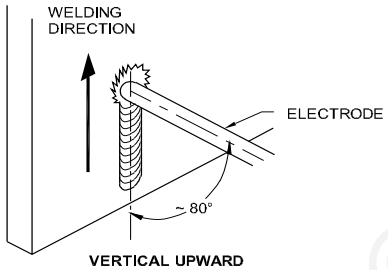


Fig 4



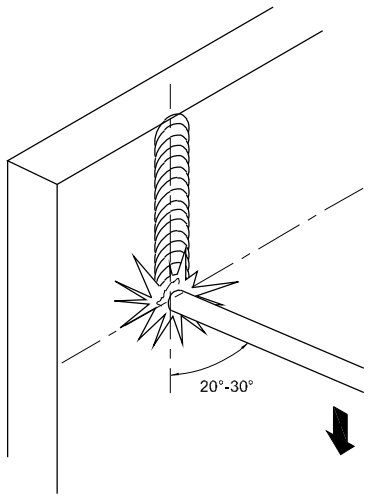
HORIZONTAL POSITION

Fig 5



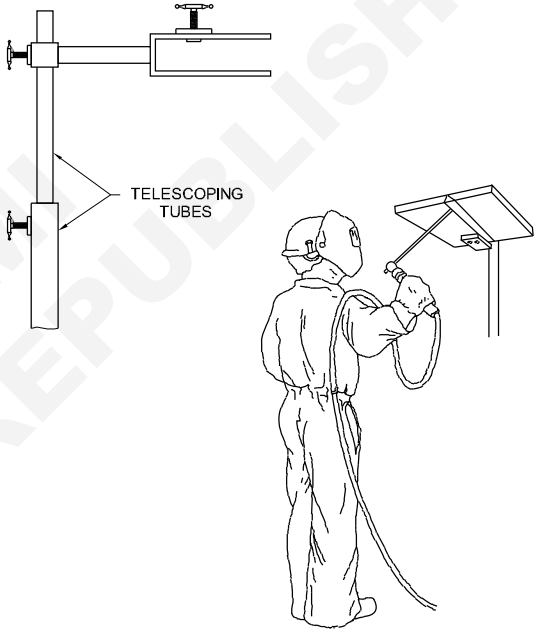
VERTICAL UPWARD

Fig 6



VERTICAL DOWNWARD

Fig 7



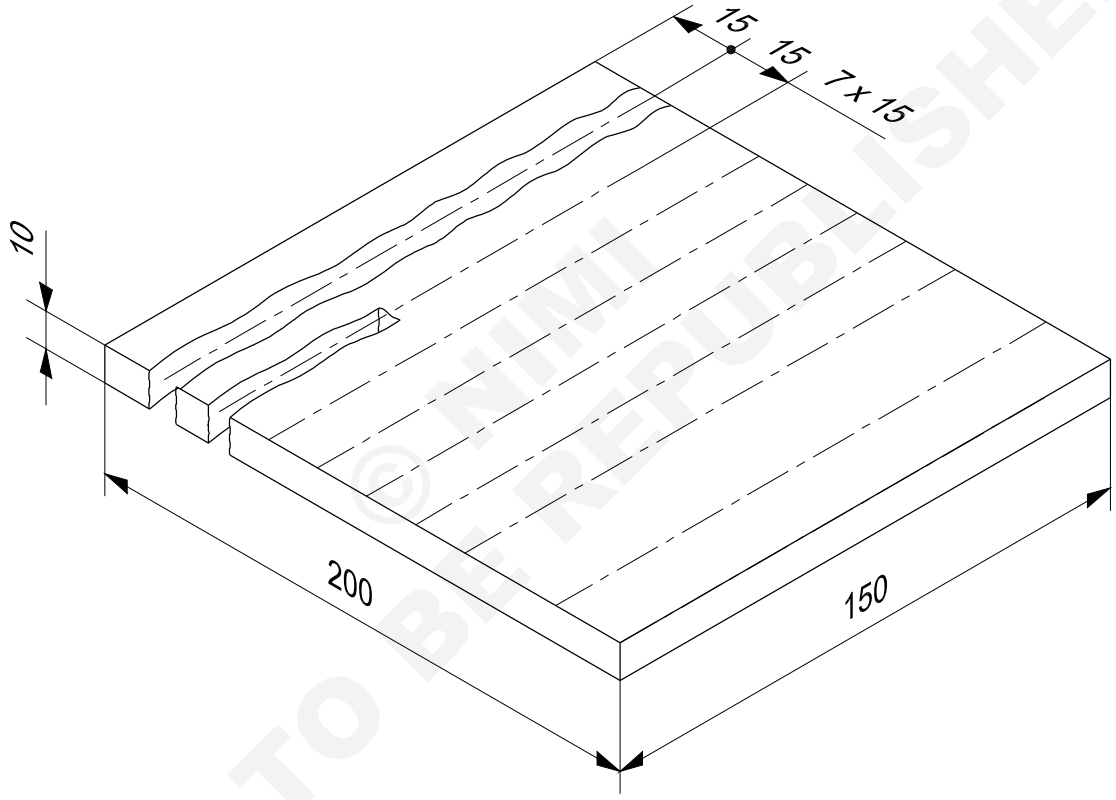
OVER HEAD POSITION

Plasma Straight Cutting on Ferrous Metal

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

- **mark cutting lines on the plate (job) by keeping proper cutting allowance**
- **set the job for straight cutting**
- **clean the edges and inspect for defects**

TASK :3



1	150 ISF 10 - 200		M.S			1.4.56
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**PLASMA STRAIGHT CUTTING ON FERROUS METAL**				TOLERANCE ±1	TIME:
					CODE NO. WS20N1456E2	

Job Sequence

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

2 Pull the trigger to ignite the pilot arc.

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

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

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

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

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

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

Proper safety procedures

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

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

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

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

Skill Sequence

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

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

Pre - cut checklist

A few final words of advice before cutting:

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

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

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

6 Turn on the plasma machine.

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

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

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

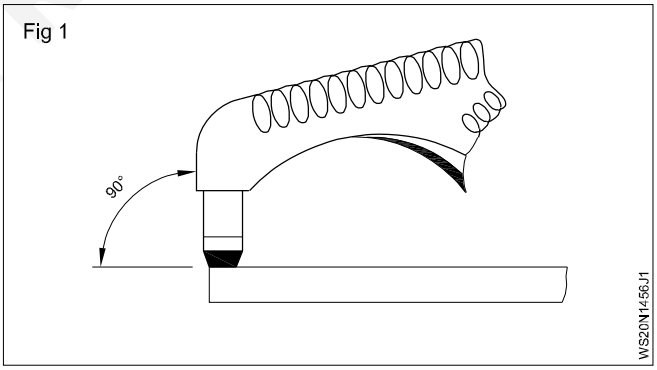
10 Relax-don't hold the torch too firmly or your hand will shake more

11 Begin cutting.

Cutting technique

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

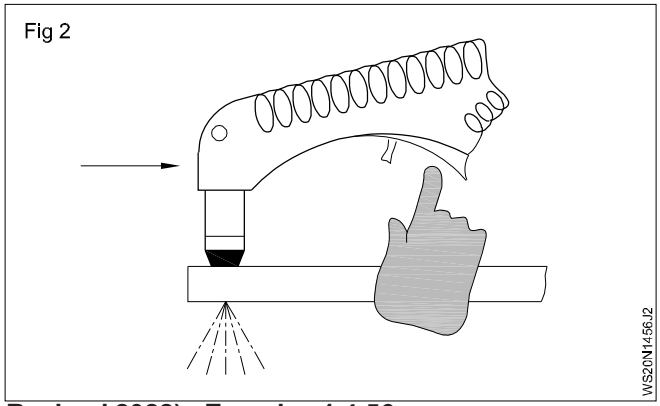
Fig 1



The arc starts immediately when trigger is pressed.

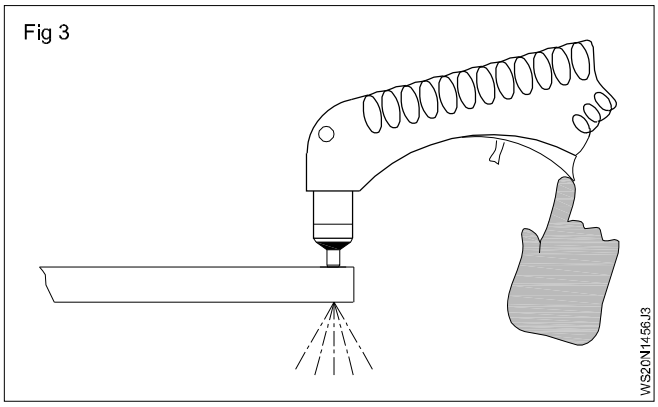
Step 2: Raise the trigger lock, press the trigger and the pilot arc starts immediately.(Fig 2)

Fig 2



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

Fig 3

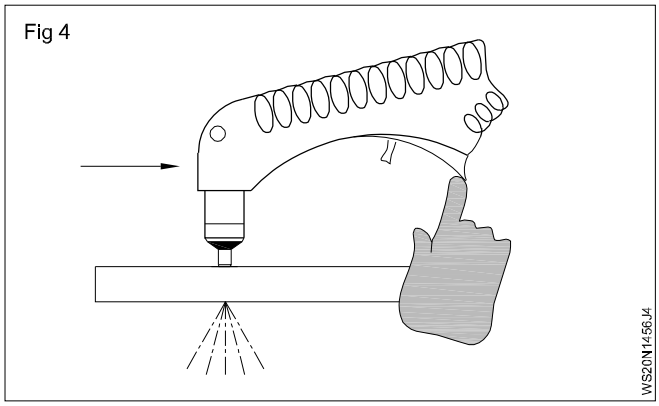


Step 4: Adjust your speed so sparks go through metal and out bottom of cut.

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

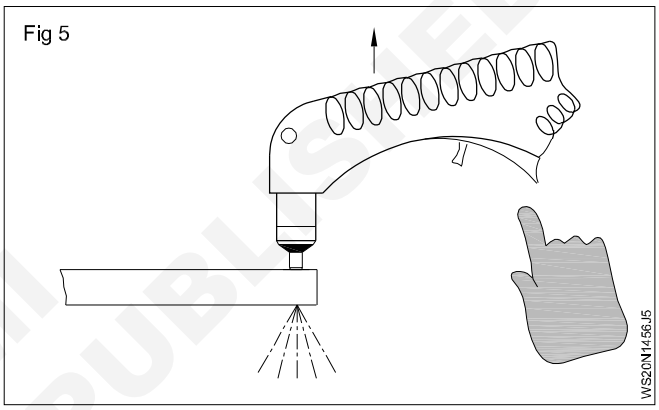
Step 5: At the end of a cut, angle the torch slightly towards the final edge or pause briefly before releasing trigger to completely sever the metal. (Fig 4)

Fig 4



Step 6: To cool torch, post-flow air continues for 20-30 seconds after releasing the trigger; pressing the trigger during post-flow instantly restart the arc.(Fig 5)

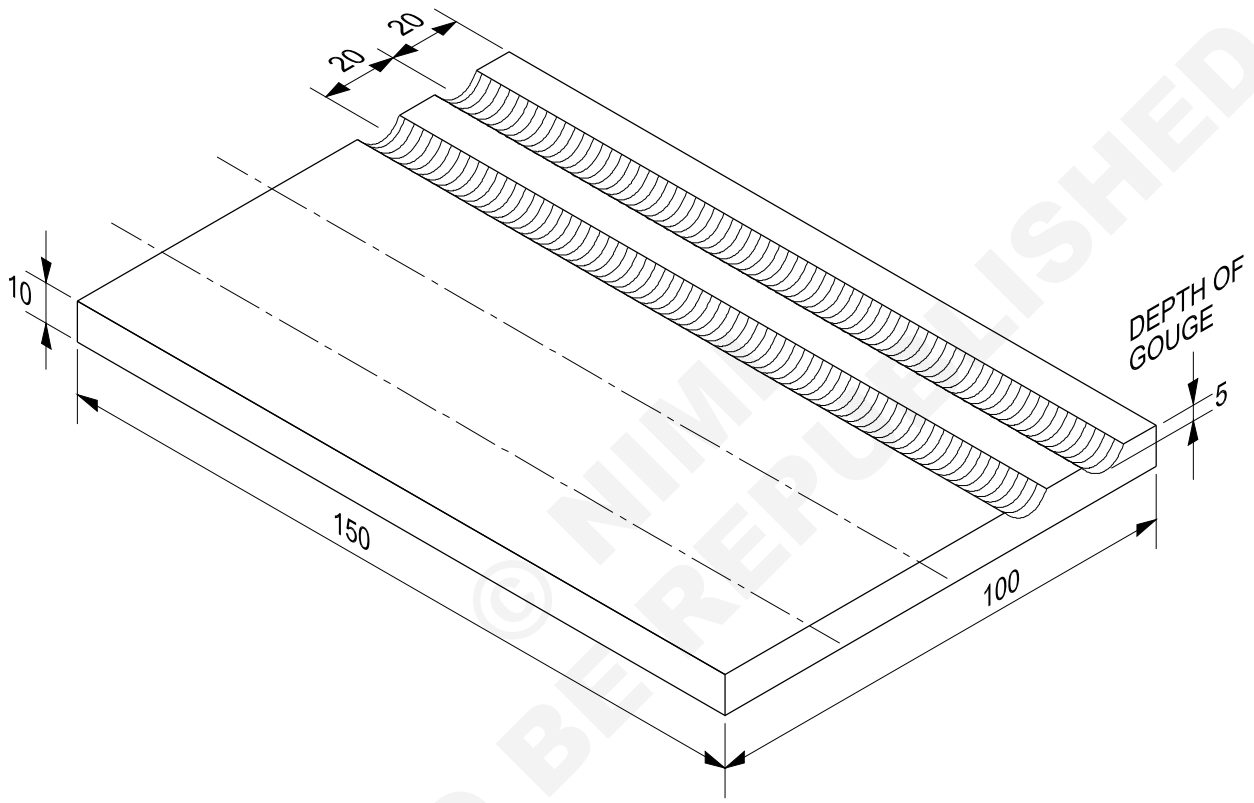
Fig 5



Arc Gouging on M.S.plate

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.**

TASK : 4



1	100 ISF 10 - 150	-	Fe310 - W	-	-	1.4.56
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	ARC GOUGING ON M.S.PLATE 10mm THICK IN FLAT POSITION.				TOLERANCE ±1	TIME:
					CODE NO. WS20N1456E3	

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

Objective: This shall help you 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.

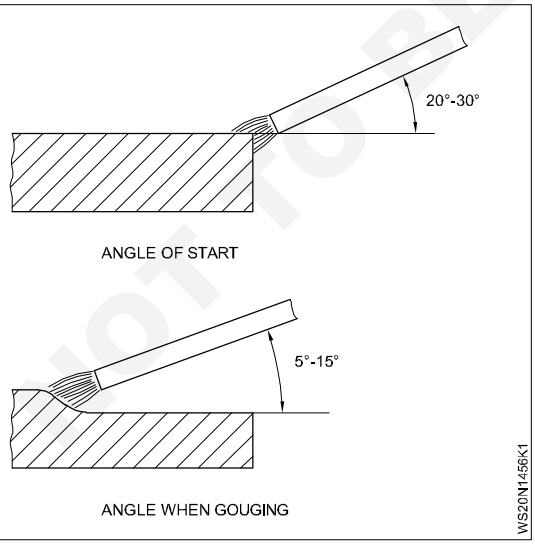
Select the electrode and set the current.

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.

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.

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

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.

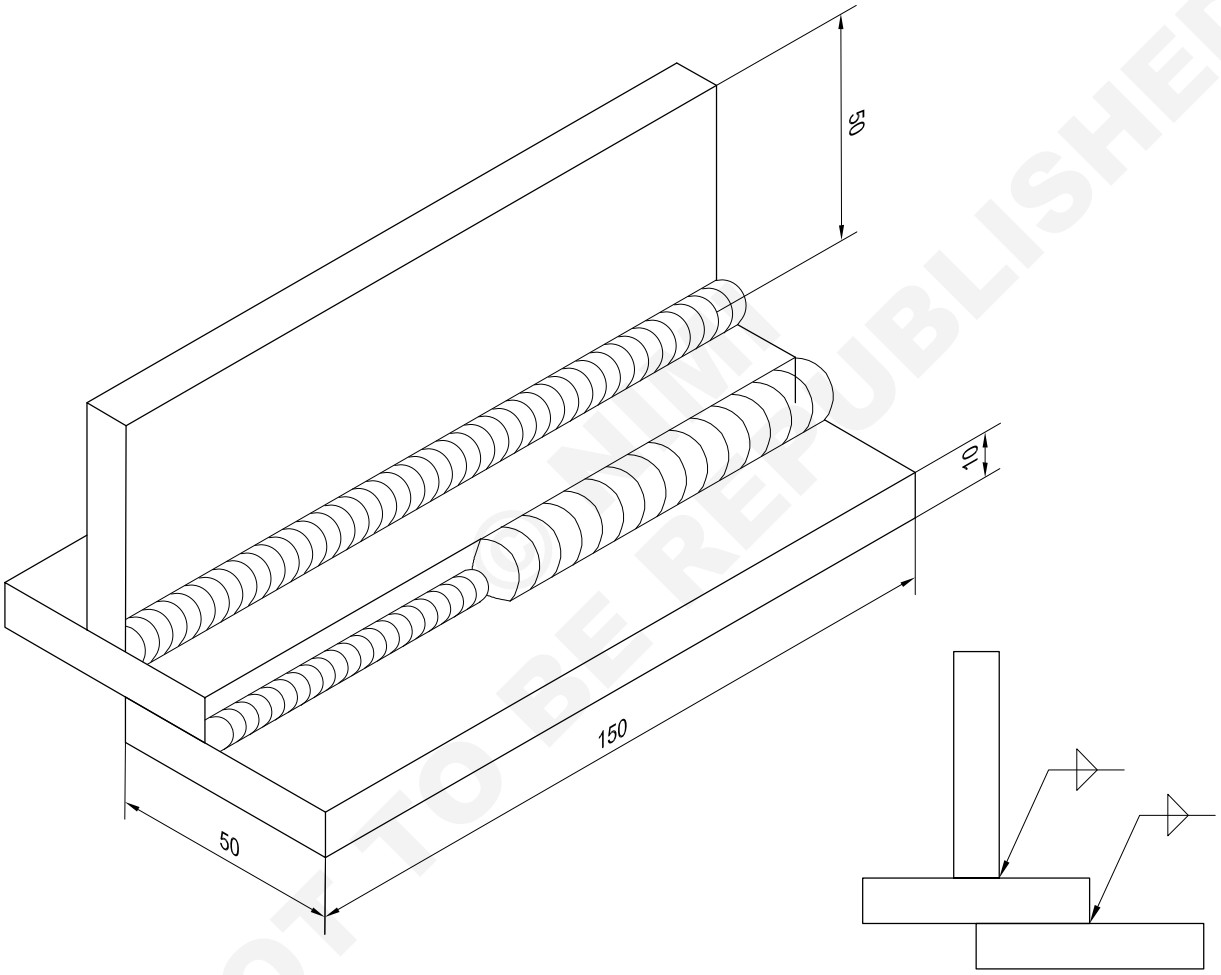
Inspect the gouging.

Check the smoothness, depth and uniformity of gouging.

Welder (Structural) - Gas Cutting and Welding Practice

Weld joint preparation for fillet weld (cutting to size, fit up, tack weld etc.) fillet, lap and T joint on MS flat by SMAW, position - 1F.

Objectives: At the end of this exercise you shall be able to
- **prepare plate pieces by gas cutting and by grinding to size**
- **set plate as a lap & 'T' joint and tack weld at both ends**
- **place the lap & 'T' joint in a flat position for welding**



3	-		-			1.4.57
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**FILLET LAP AND 'T' JOINT ON MS FLAT BY SMAW POSITION (1F)**				TOLERANCE ±1	TIME:
					CODE NO. WS20N1457E1	

Job sequence

- Cut the plate 150 x 150 x 10 by gas cutting/hacksaw cutting as per drawing.
- Grind and filling the edges square.
- Wear protective clothing
- Remove the grinding burrs and clean the surfaces by wire brush
- Set the pieces in the form of Tee and Tack-weld on both ends. (92° to 93° angle between the plate)
- Set the another pieces in the form of a lap joint and tack weld on both ends.
- Set the job in a flat position on the table
- Deposit root run by using a 3.15mm dia. Medium coated M.S. electrode angle with 110 current.
- Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.
- 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 with a chipping hammer and clean with a wire brush.
- Check the leg length of weld by using weld gauge
- Inspect the weld for surface defects and size.

Skill sequence

Fillet "T" and Lap joint in Flat position

Objectives: This shall help you to

- **prepare and weld T and Lap joint on M.S. plat in Flat position.**

Setting of tacking of a lap and T joint

- 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 and set the lap joint with an overlap of 25mm.
- Track-weld the pieces at both ends of the Lap and Tee joint by using a 3.15mm dia. Medium coated M.S. electrode and 110-120amps welding current

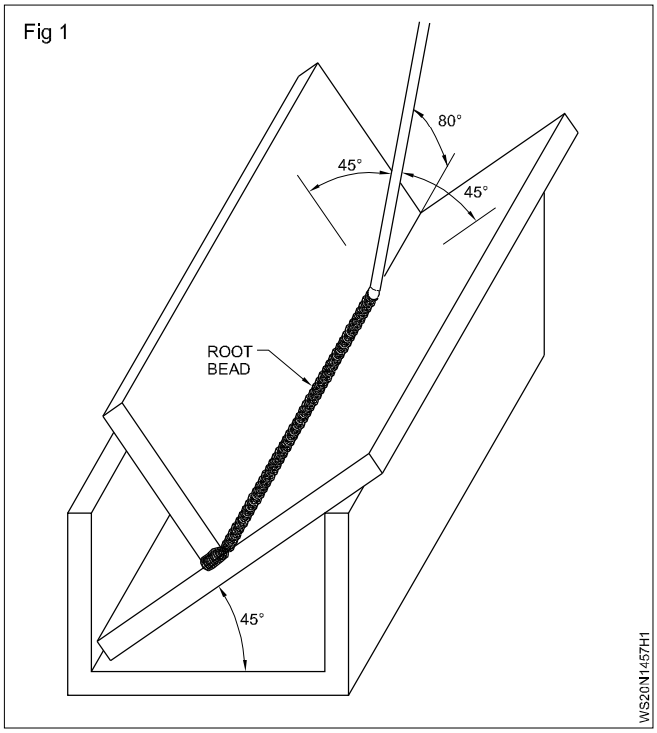
Welding a lap & T joint (Fig 2 - 6)

- Set the job and place on the table in a flat position 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.
- Deslag and clean the root bead thoroughly and Deposit the second and I covering run.
- Use a slightly side-to-side weaving motion. The width of weave should give a leg size of 10mm.
- Stop the electrod

e weaving for a moment at the toes of the weld to avoid undercut.

- Fill the crater at the end of the bead.

Fig 1

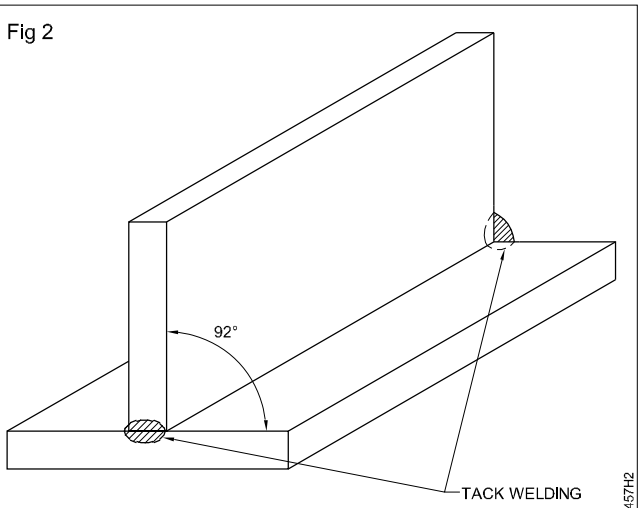


- Clean the weld with a steel wire brush.

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.

Fig 2



SETTING AND TACKING A TEE JOINT

Fig 3

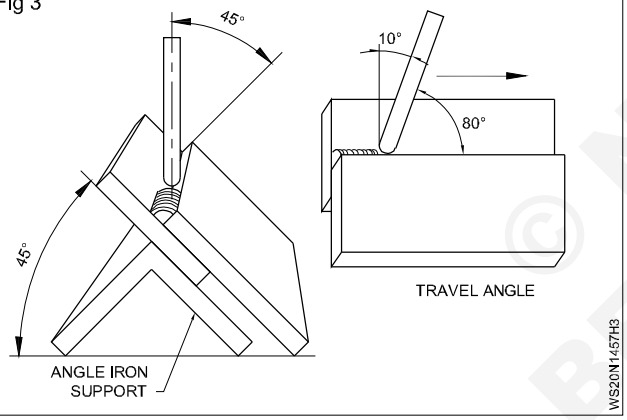
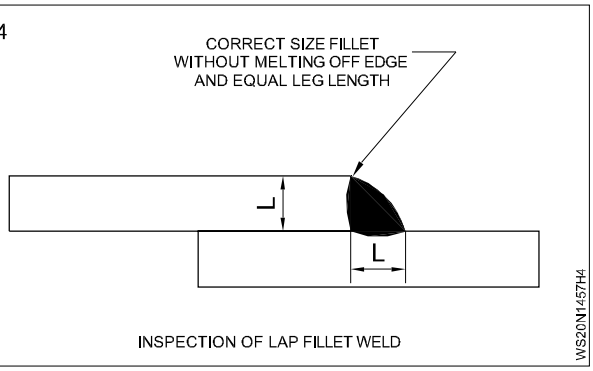
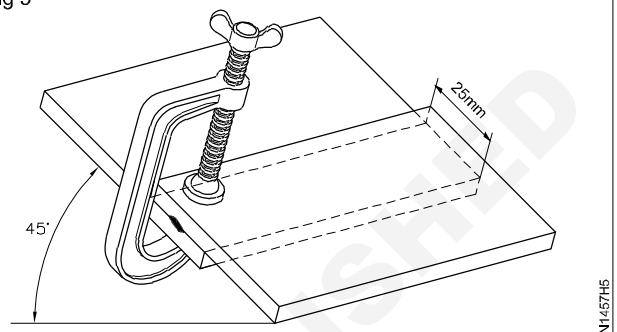


Fig 4



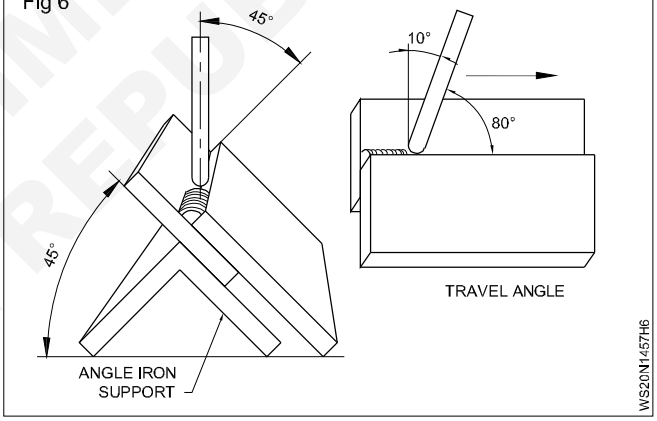
INSPECTION OF LAP FILLET WELD

Fig 5



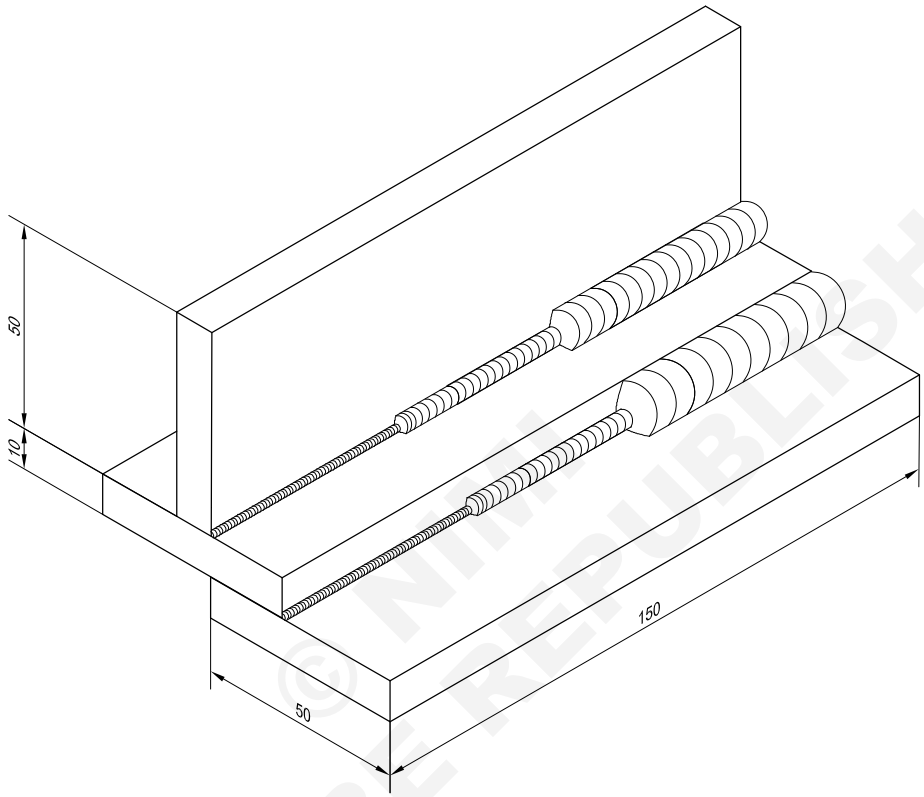
SETTING TACKING A LAP JOINT.

Fig 6



Fillet, lap and T joint on MS flat by SMAW, position - 2F.

Objectives: At the end of this exercise you shall be able to
- **select electrode, current, polarity and arc length**
- **weld the lap joint with a short arc and uniform travel speed**
- **inspect the weldments for external defects**



3	-		M.S			1.4.58
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**FILLET LAP & 'T' JOINT ON MS FLAT BY SMAW POSITION (2F)**				TOLERANCE ±1	TIME :
					CODE NO. WS20N1458E1	

Job sequence

- Cut the plate 150x50x10 3 piece by gas cutting/ hacksaw cutting as per drawing.
- Grind and filling the edges square.
- Wear protective clothing.
- Remove the grinding burrs and clean the surfaces by wire brush
- Set the pieces in the form of Tee and Tack-weld on both ends. (92° to 93° angle between the plate)

  Set the another pieces in the form of a lap joint and tack weld on both ends
- Fix the joint in horizontal position
- 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 with a chipping hammer and clean with a wire brush.
- Check the leg length of weld by using weld gauge
- Inspect the weld for surface defects and size.

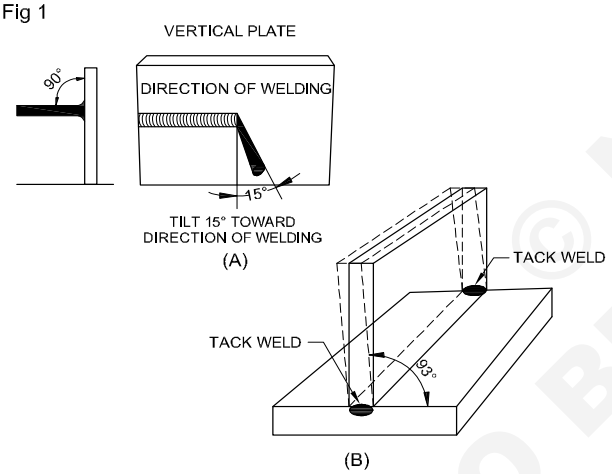
Skill Sequence

Fillet "T" and lap joint weld on M.S. plate in horizontal position.

Objectives : This shall you to

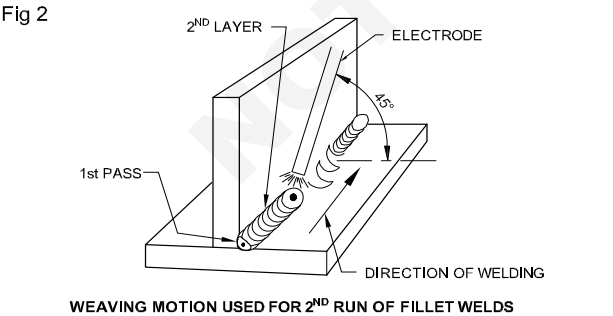
• prepare and weld T and Lap joint on M.S. plate in horizontal position.

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

Fig 2



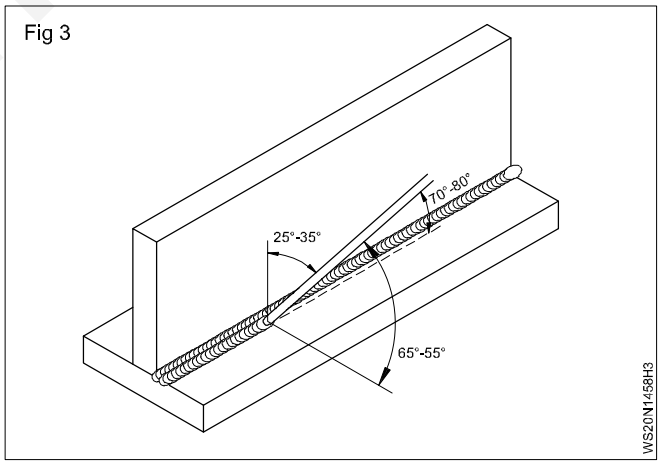
WEAVING MOTION USED FOR 2ND RUN OF FILLET WELDS (HORIZONTAL POSITION)

Setting of tacking of a lap and T joint

- 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 and set the lap joint with an overlap of 25mm.
- Tack-weld the pieces at both ends of the Lap and Tee joint by using a 3.15mm dia. Medium coated M.S. electrode and 110-120 amps welding current.

Welding a lap & T joint Fig 3 & 4

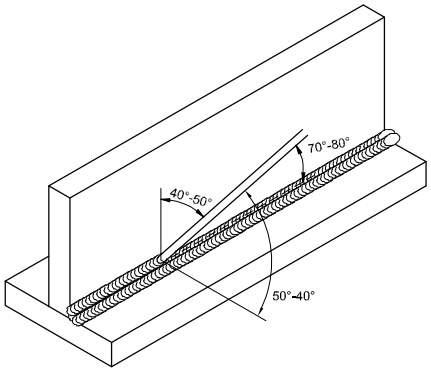
Fig 3



- Set the job and place on the table in horizontal the electrode angle of 45° will help to fuse both plates equally and the 80° angle will help to get a good weld bead.
- Proceed along the welding line with uniform travel speed and short arc to get uniform fusion and root penetration.
- Horizontal position of welding electrode angle 70°-80° TILE 15° towards direction of welding.

- Deslag and clean the root bead thoroughly and deposit the second and I covering run.
- Use a slightly side-to-side weaving motion. The width of weave should give a leg size of 10mm.
- 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.
- Clean the weld with a steel wire brush.er side of the weld.

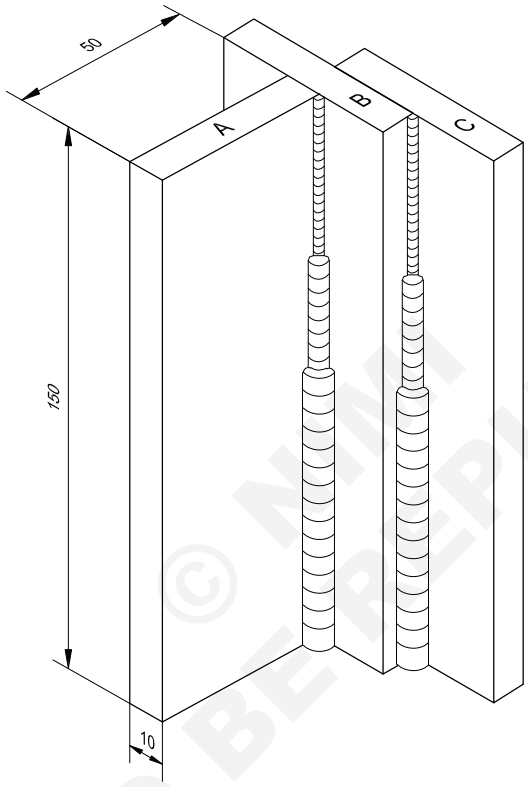
Fig 4



Weld joint preparation for fillet weld (cutting to size, fit up, tack weld etc.) fillet, lap and T joint on MS flat by SMAW, position - 3F.

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

- **fix the joint in vertical position**
- **deposit the second run evenly to get the required fillet size without defects**
- **inspect for surface defects like undercut, lack of penetration etc.**



3	50 ISF 10 - 150	TO EX.NO.28	Fe 310 - W			1.4.59
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**FILLET , LAP AND 'T' JOINT ON MS FLAT BY (SMAW) , POSITION - 3F**				TOLERANCE ±1	TIME:
					CODE NO.WS20N1459E1	

Job sequence

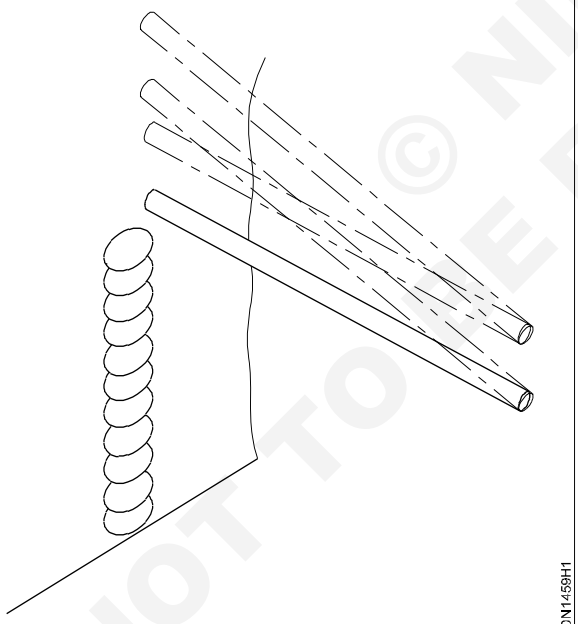
- Cut the plate by gas cutting/hacksaw cutting as per drawing.
- Grind and filling the edges square.
- Wear protective clothing.
- Remove the grinding burrs and clean the surfaces by wire brush
- Set the pieces in the form of Tee and Tack-weld on both ends. (92° to 93° angle between the plate)
- Set the another pieces in the form of a lap joint and tack weld on both ends.
- Fix the joint in vertical position.
- Deposit root run by using a 3.15mm dia.Medium coated M.S. electrode with 110 amps current.
- Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.
- 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 with a chipping hammer and clean with a wire brush.
- Check the leg length of weld by using weld gauge
- Inspect the weld for surface defects and size.

Skill sequence

Fillet “T” and Lab joint on M.S. plate in vertical position

Objectives: This shall help you to
- **prepare the weld plate**
- **fillet T & Lab on M.S plate in vertical position.**

Fig 1



WHIPPING ACTIONS

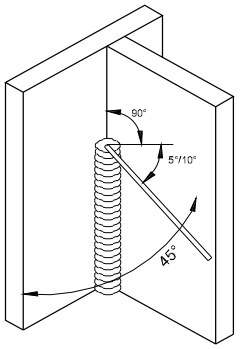
WS20N1459H1

Setting of tacking of a lap and T joint

- 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 and set the lap joint with an overlap of 25mm.
- Tack-weld the pieces at both ends of the Lap and Tee joint by using a 3.15mm dia. Medium coated M.S. electrode and 110-120 amps welding current.

Welding a lap & T joint (Fig 2 - 9)

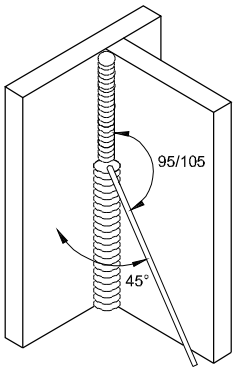
Fig 2



VERTICAL 'T' FILLET ELECTRODE ANGLES

WS20N1459H2

Fig 3



VERTICAL ' T ' FILLET

WS20N1459H3

- Set the job and place on the table in a vertical position the electrode angle of 45° will help to fuse both plates equally and the 80° angle will help to get a good welding bead.

- Proceed along the welding line with uniform travel speed and short arc to get uniform fusion.
- Vertical position of welding electrode angle should be 80° upward (or) downward direction.
- Deslag and clean the root bead thoroughly and Deposit the second and I covering run.
- Use a slightly side-to-side weaving motion. The width of weave should give a leg size of 10mm.
- 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.Clean the weld with a steel wire.

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.

Fig 4

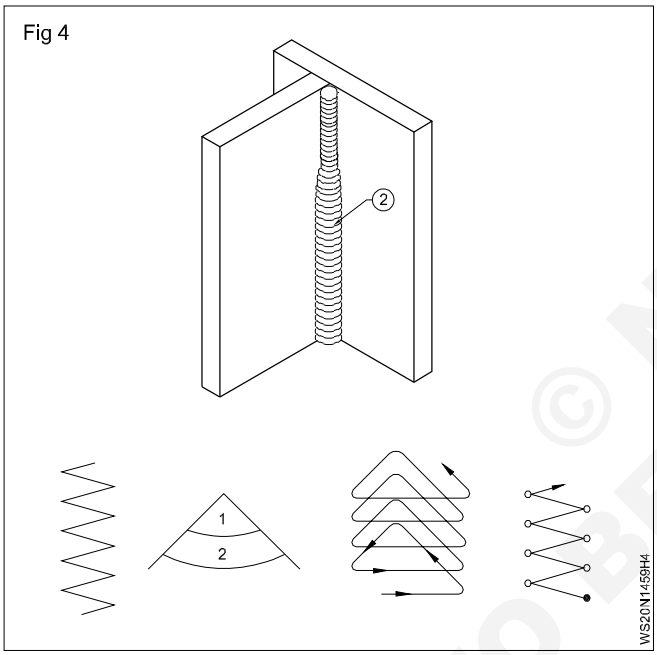


Fig 5

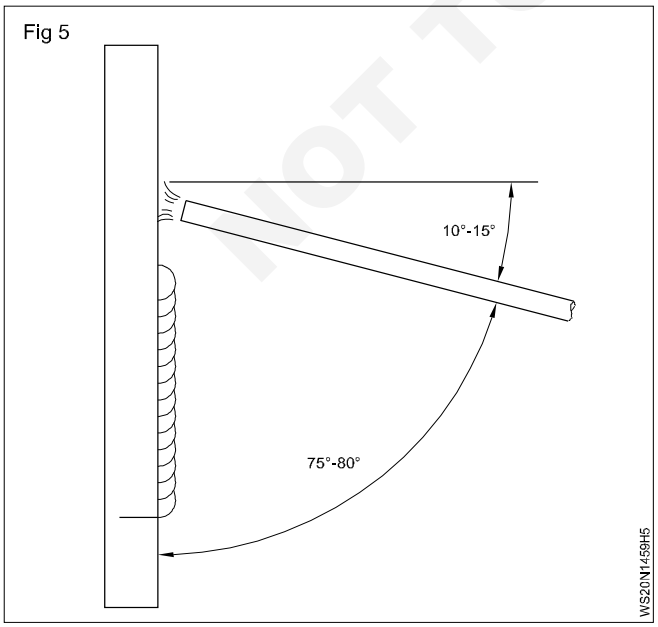


Fig 6

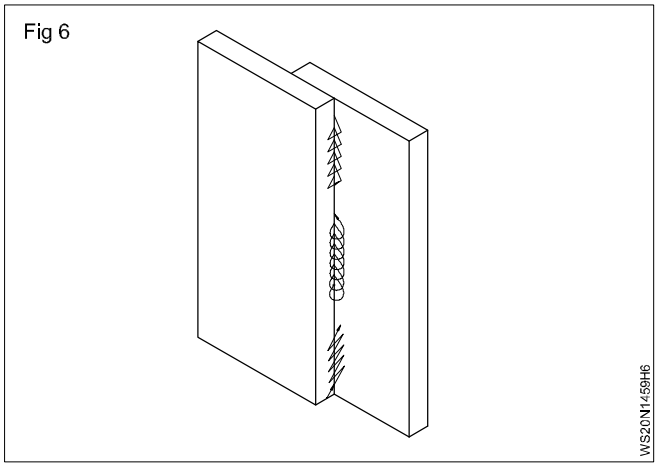
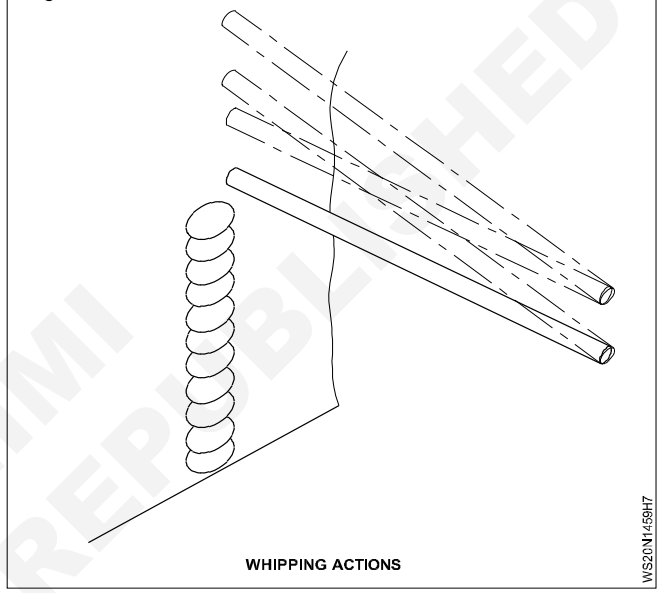
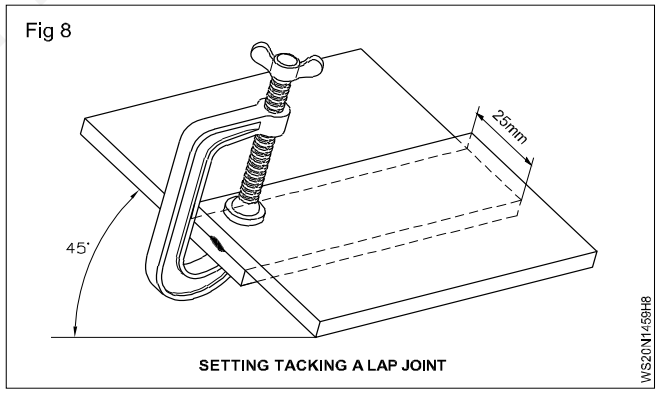


Fig 7



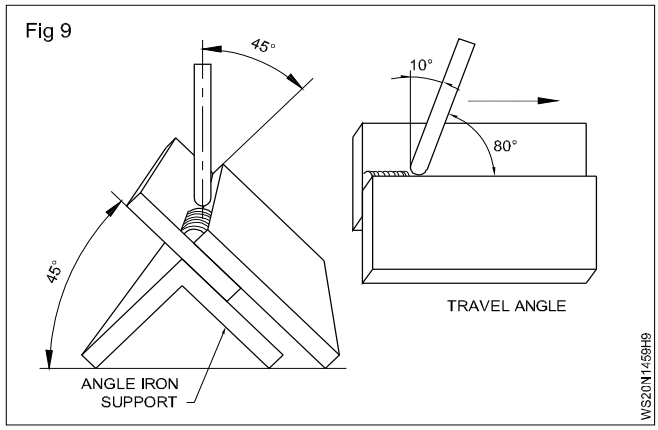
WHIPPING ACTIONS

Fig 8



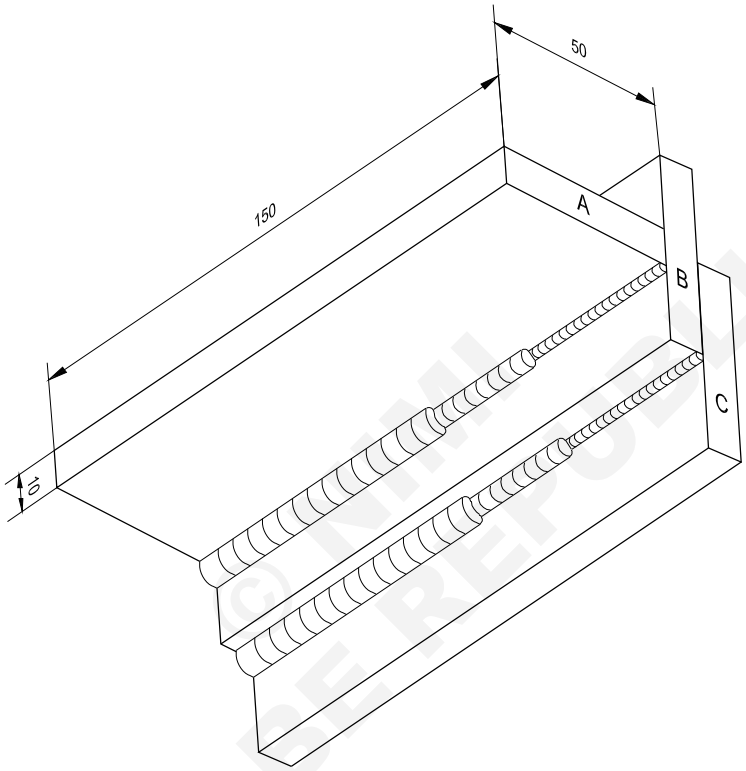
SETTING TACKING A LAP JOINT

Fig 9



Weld joint preparation for fillet weld (cutting to size, fit up, tack weld etc.)

Objectives: At the end of this exercise you shall be able to
- **weld fillet lap & 'T' joint in overhead position**
- **clean and inspect the job for surface defects**

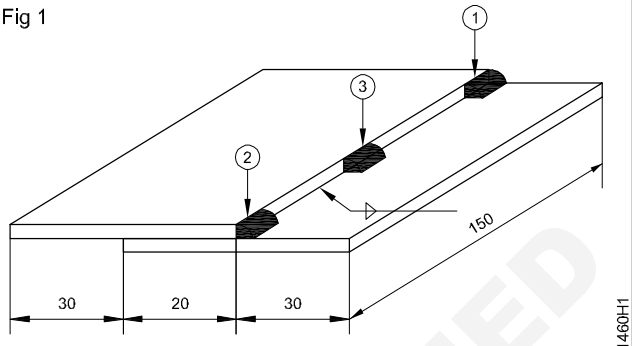


3	50 ISF 10 - 150	-	Fe 310 - W	-	-	1.4.60
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	FILLET LAP JOINT ON M.S. PLATE 10mm THICK IN OVERHEAD POSITION. (4 F)				TOLERANCE ±1	TIME:
					CODE NO. WS20N1460E1	

Job sequence

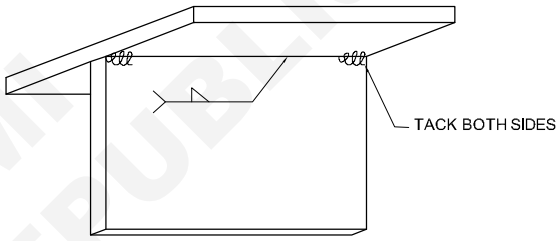
- Cut the plate by gas cutting/hacksaw cutting as per drawing.
- Grind and filling the edges square.
- Wear protective clothing
- Remove the grinding burrs and clean the surfaces by wire brush
- Set the pieces in the form at Tee and Tack-weld on both ends. (92° to 93° angle between the plate)(Fig 1)
- Set the another pieces in the form of a lap joint and tack weld on both ends.
- Fix the joint in overhead position.(Fig 2)
- Deposit root run by using a 3.15mm dia. Medium coated M.S. electrode with 110 amps current.
- Ensure an electrode angle of 45° with the fillet corner and 80° with the welding line.
- 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 with a chipping hammer and clean with a wire brush.
- Check the leg length of weld by using weld gauge
- Inspect the weld for surface defects and size.

Fig 1



TACKING A LAP JOINT

Fig 2



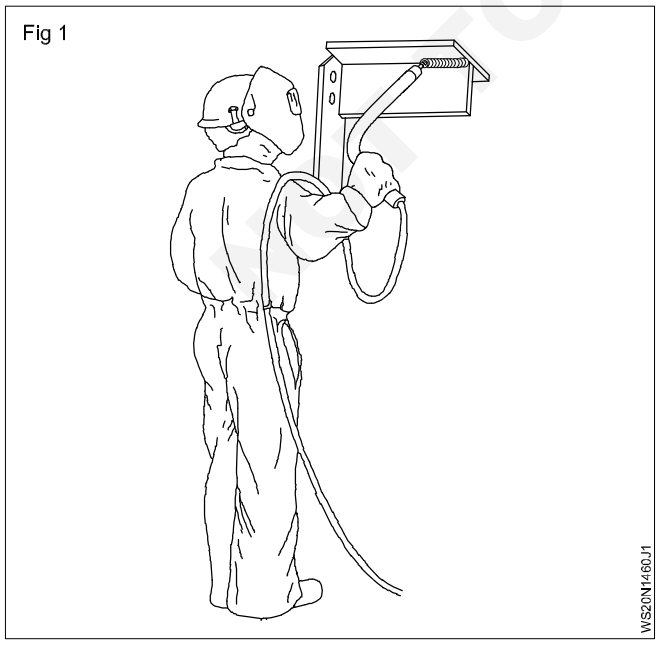
Skill sequence

Fillet “T” and lap joint on M.S. plate in overhead position

Objectives: This shall help you to

• prepare and weld fillet “Lap & T” joint on M.S. plate 10mmm thick in overhead position.

Fig 1



(Job setting)

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

Use a drag angle of approximately 10-15° to the direction of the weld.

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

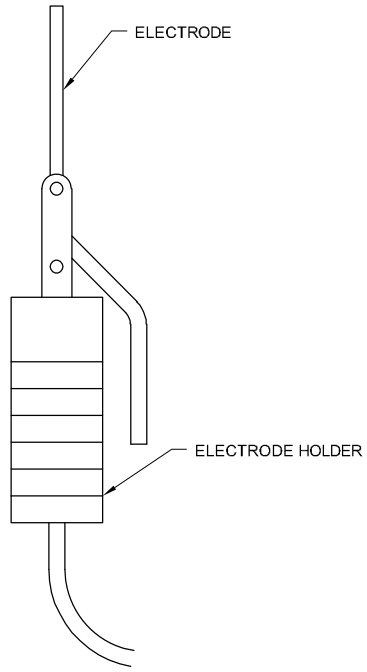
Maintain a short arc all the time.

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

Use a 30° work angle off the vertical plate as shown in (Fig3).

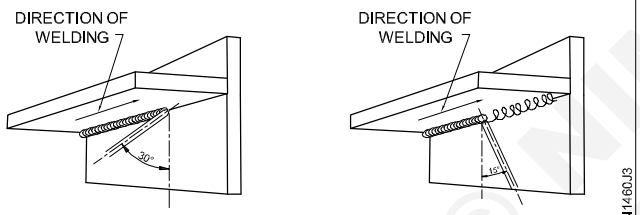
Work angle is the angle between the electrode and the job surface.

Fig 2



ELECTRODE ANGLE IN HOLDER.

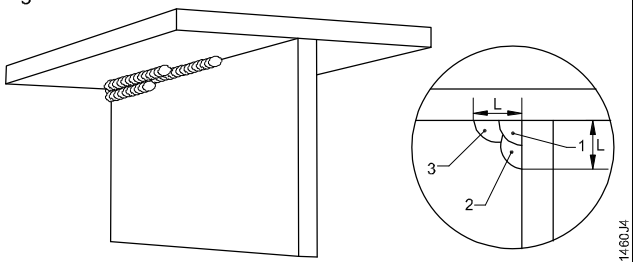
Fig 3



FILLET WELD IN THE OVERHEAD POSITION

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.

Fig 4



T-JOINT IN AN OVERHEAD POSITION

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)

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,

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 harardous 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.

Capital Goods & Manufacturing — Excercise 1.4.61
Welder (Structural) - Gas Cutting and Welding Practice

Fillet, lap and T joint on MS flat by SMAW, position - 4 F.

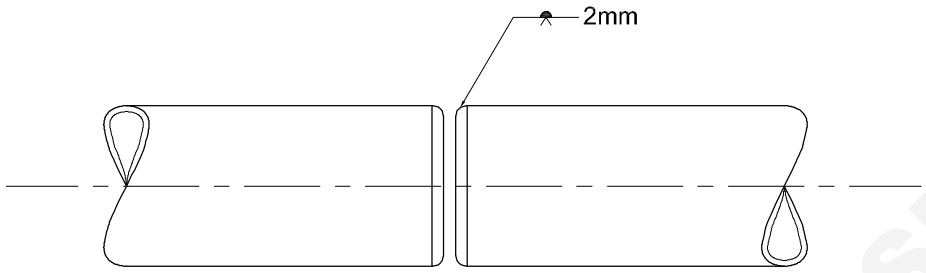
Objectives: At the end of this exercise you shall be able to
- **weld fillet lap & 'T' joint in overhead position**
- **clean and inspect the job for surface defects**

Refer Excercise No: 1.4.60

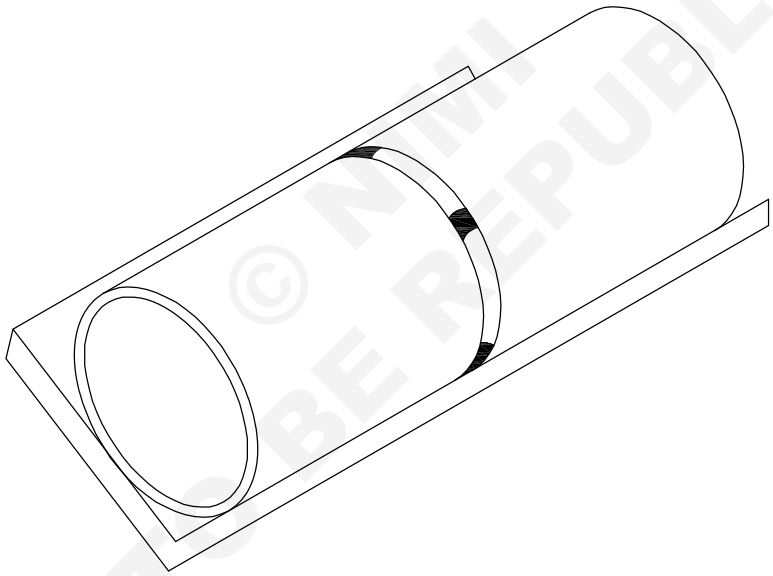
Weld joint preparation for pipe fillet welding

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

- **methods of cutting pipes as per diagram**
- **bevel the edge of pipe to enable tack weld tack weld the pipe joints aligned with iron angle.**



WELD POSITION 1G



2	-		-			1.4.62
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**PIPE TO PIPE FILLET WELD ON MS PIPES BY SMAW,POSITION -5F**				TOLERANCE ±1	TIME:
					CODE NO. WS20N1462E1	

Job sequence

- cut the tubes according to the size in gas cutting (or) plasma cutting.
- Remove the deburrs from the ends with a file.
- Prepare suitable end for connection of pipes.
- Clean pipe ends free or chemicals.

Skill sequence

Pipe weld joint preparation

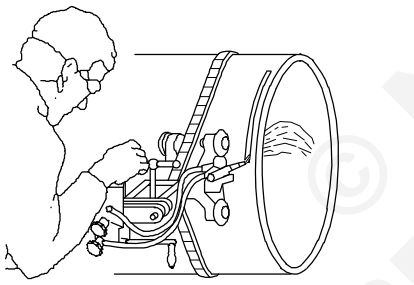
Objective : This shall help you to
• prepare pipe fillet joint & edge preparation.

Edge preparation and cleaning: If the wall thickness is 3mm and below the edges of the pipe end is filled square i.e. perpendicular to the pipe axis. The welding of the joint is complete in one pass using the down hill method or by segmental method.

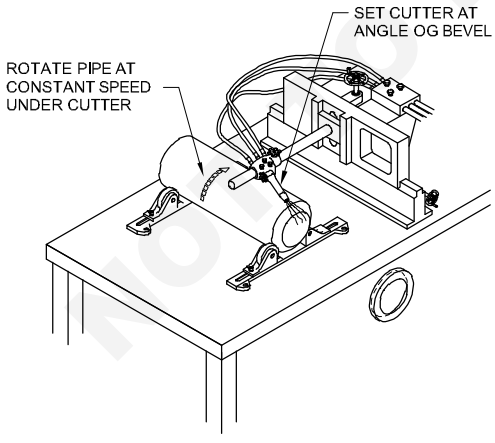
For welding pipes with higher wall thickness the following procedure is to be followed.

Edge preparation: The pipe ends are beveled by flame cutting or machining in the shop (Fig 1) The including angles the root face and root gap are 1.5mm. All traces of oxide from and other contaminations must be removed before starting the weld.

Fig 1



ROTATED PIPE CUTTING HEAD

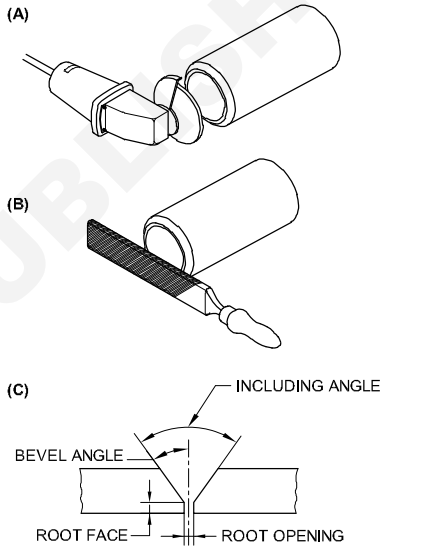


CUTTING BEVEL ON PIPE

Setting of pipe: Pipe to be joined together must be accurately aligned prior to welding. The inside surface of the pipe must be blended together smoothly as in the outer surface. Maintain the root opening 1.5 mm, use a M.S angle and strength bar for checking the alignment of the pipe.

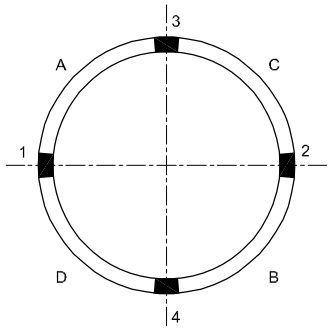
Tacking: Place a 1.5 mm bend wire between the edges. The tack length should be 3 times the metal thickness. Put the first tack at the root side and the second tack at the opposite side of the first tack. Arrange the third and fourth tacks at 90° from the first and second tacks.

Fig 2



WELD JOINT DEFINITIONS

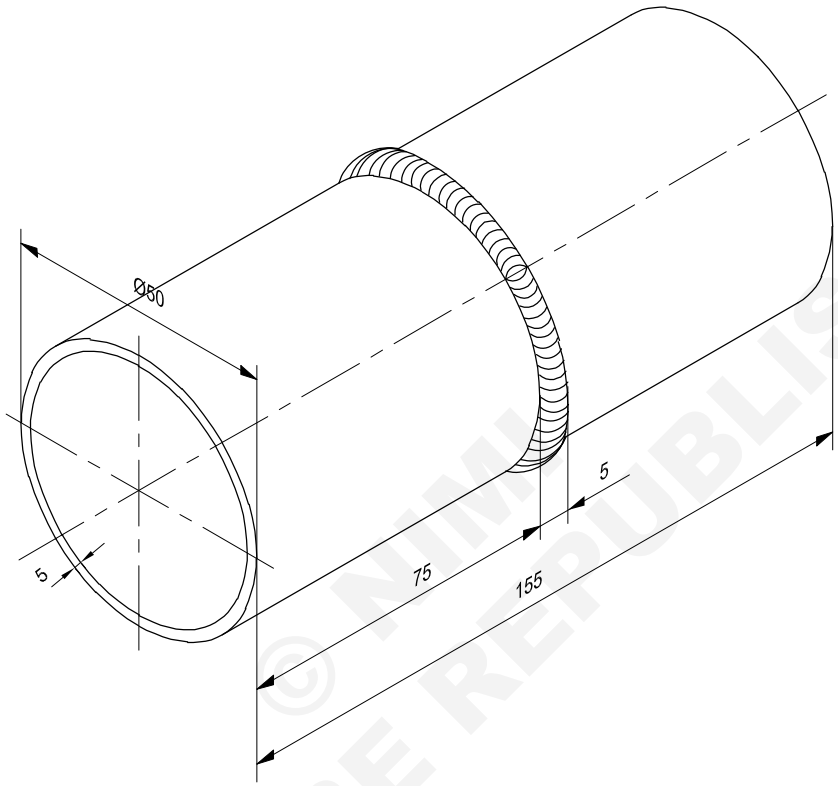
Fig 3



Pipe to pipe fillet weld on MS Pipes by SMAW, position - 5 F.

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

- **make root run by rotation method**
- **make filling run by rotation**
- **clean the job and inspect for defects**



2	Ø 50 x 5 x 75		-			1.4.63
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**PIPE TO PIPE FILLET WELD ON MS PIPES BY SMAW, POSITION -5F**				TOLERANCE ±1	TIME :
					CODE NO. WS20N1463E1	

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 fixture or V profile of an angle iron to align pipes.

  Wear protective clothing.
- 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 intervals 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 3.15 mmØ electrode for root run.
- Deposit the root run in flat position by without rotating the pipe.
- Welding using the keyhole technique ensures not penetration.
- Remove slag from the root thoroughly.
- Deposit the second and third run using a 3.15 mm Ø electrode i.e. the same as for the root run.
- Clean and inspect the joint.

Skill Sequence

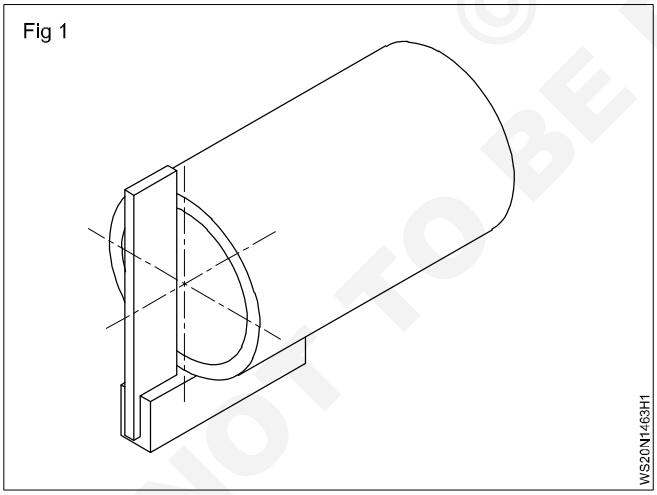
Pipe to pipe fillet weld by SMAW

Objectives: This shall help you to
• prepare & pipe setting and welding in IFF method

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



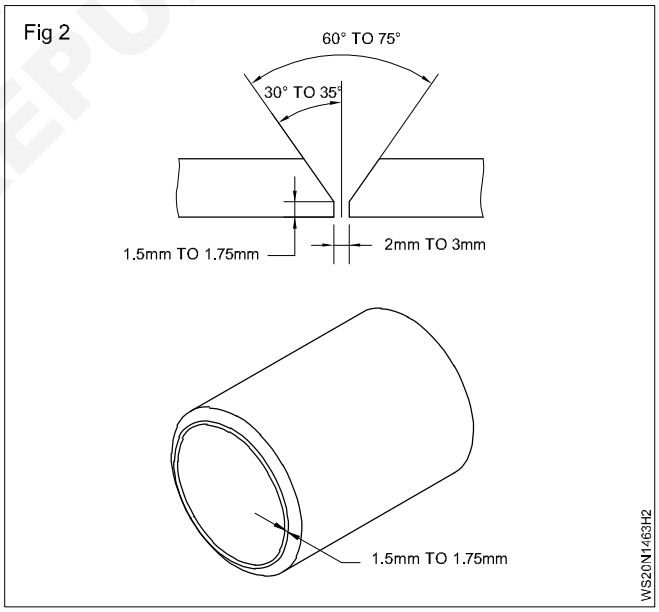
Prepare 30 to 35° bevel on one end of pipe leaving 1.5 to 1.75 mm root face by grinding or by filing. (Fig 2)

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.

Before tacking, align the pipes iron using a 3.15 mm rod.

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

Fig 2



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. Then reverse your electrode direction.

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, Whip upward, taking care not to damage the surface of the pipe on either side. Stop when you reach 1 o'clock, as 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.

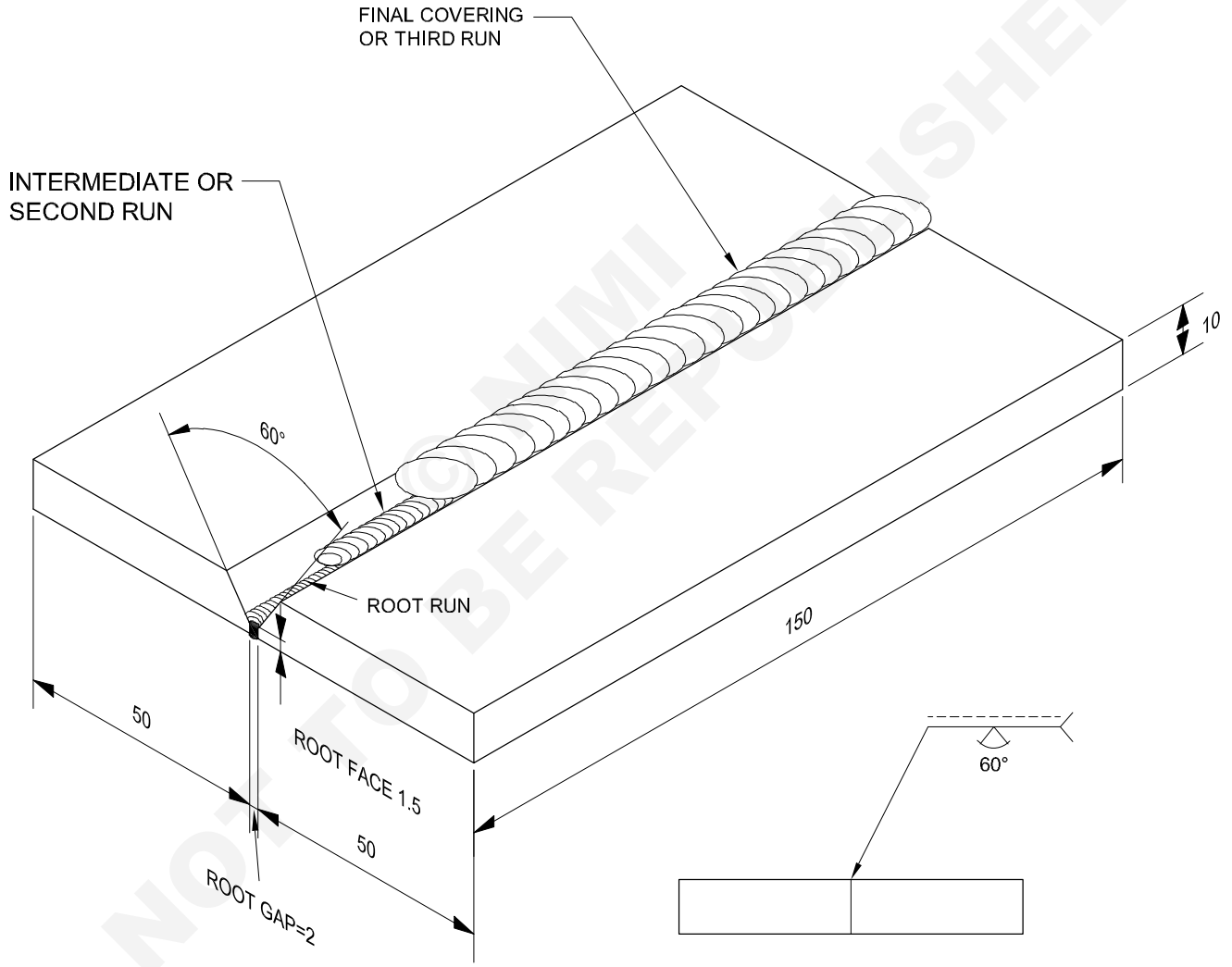
The second pass (hot pass) and third pass (cover pass)can be welded using 3.15 mm electrode with either the triangle motion or the alternate weave, as in vertical plate welding.Takecare to pause at the sides of the joint.Burn out any entrapped slag and fill in any undesirable undercut.

When you make the connection on completing the pass,be sure to overlap sllighlty.Break the arc by slowly drawing it away from the puddle

Weld joint preparation for plate groove welding.full penetration single “V” butt joint on MS flat by SMAW in 1G positions.Root pass welding & LPI testing.cover pass welding & inspection.

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

- **bevel the plate edges by gas cutting for single V butt joint**
- **control arc blow**
- **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**



2	50 ISF 12 - 150		Fe 310 - W			1.4.64
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**SINGLE "V" BUTT JOINT M.S. PLATE 12mmTHICK IN POSITION FLAT POSITION (1G)**				TOLERANCE ±1	TIME:
					CODE NO. WS20N1464E1	

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 cut-ting and file the root face as per drawing. Refer Ex.No.2.04 for cutting the bevel.
- 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.
- 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.

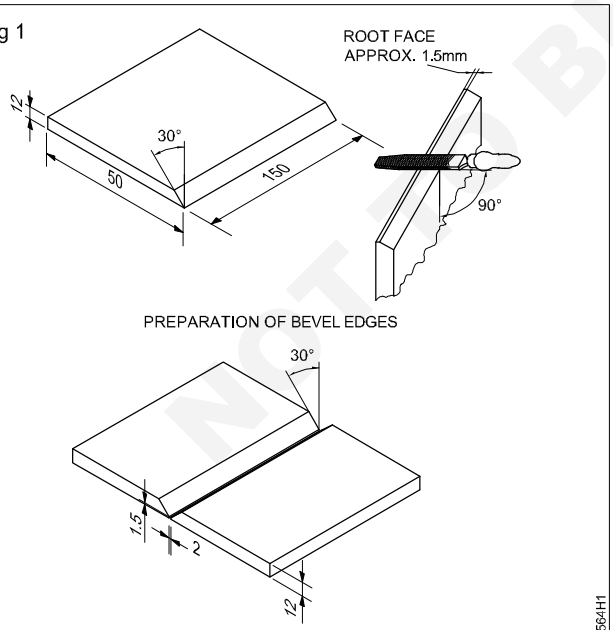
Skill Sequence

Welding of single 'V' butt joint MS plate 12mm thickness in flat position

Objectives: This shall help you to
• **weld single V butt joints MS plate 12mm in flat position (1G)** Prepare LPI Testing method

.Preparation of the pieces (Fig 1)

Fig 1



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

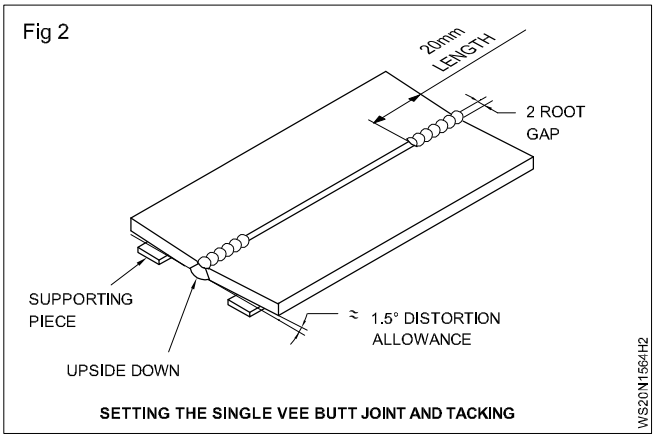
Grind the bevel edges to remove oxide deposits on the bevel.

Prepare a uniform root faces 1.5 mm by filling 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.

Fig 2



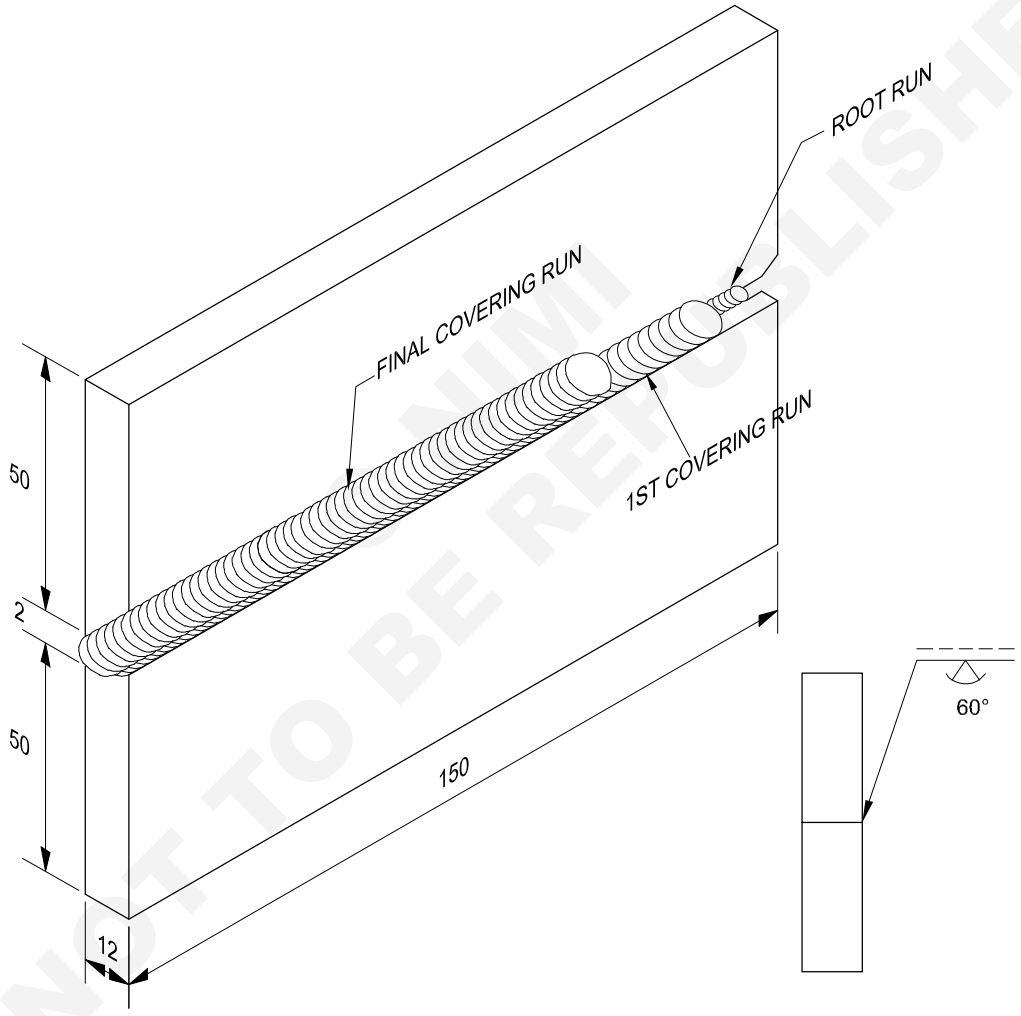
LPI Testing

- Clean the welded bead usinh chemical agents
- Make it dry
- Apply penetrant on the surface of welded beads
- Wait 5 to 15 min till the penetrant enter the defected area.
- Remove the excess penetrant using cotton cloth
- Apply the developer or the welded surface
- Wait for 10 minutes, it is known as dwelling period.This time the mixture of penetrant and developer comes out or use defected repion
- Mark the defected repion
- Clean the surface and reweld on the defected surface

Weld joint preparation for plate groove welding.full penetration single “V” butt joint on MS flat by SMAW in 2G positions.Root pass welding & LPI testing.cover pass welding & inspection.

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**



2	50 ISF 10 - 150	-	Fe 310 - W	-	-	1.4.65
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SINGLE "V" BUTT JOINT ON M.S PLATE 10mm THICK IN HORIZONTAL POSITION (2G)	TOLERANCE ±1	TIME:
		CODE NO. WS20N1465E1	

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.

Wear safety clothing

- Tack the beveled plates with a root gap of 2mm.
- 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 inspect the root pass by LPI and post cleaning. (Ref 1.5.63)
- Deposit 2 nd 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

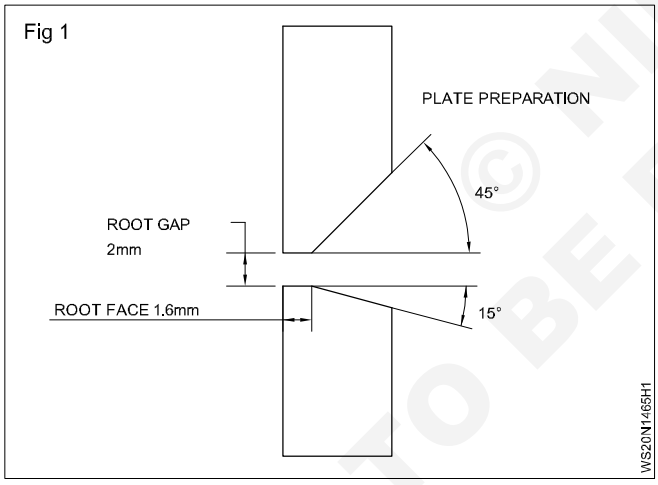
objectives : This shall help you to

• 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 1.5mm by filling. (Fig 1)

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 on both 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.

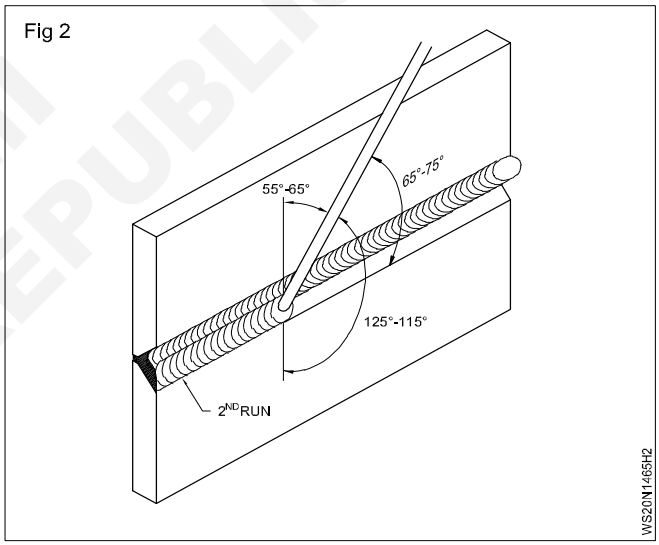
Maintain the keyhole to obtain uniform penetration.

Ref : 1.5.67 1.5.63 inspect the root pass by LPI testing.

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

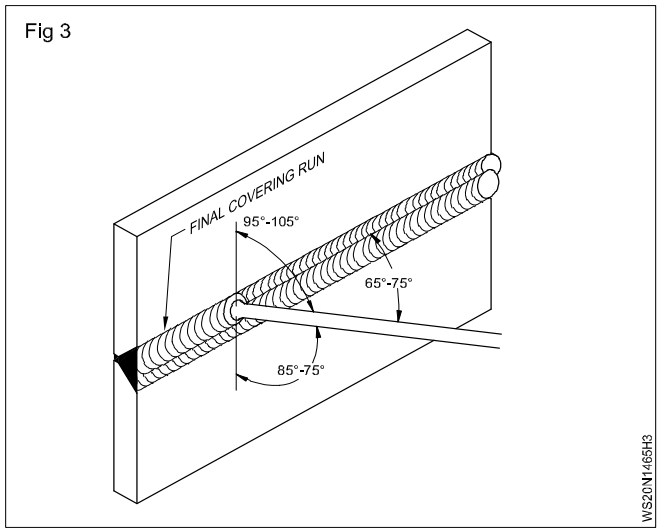
Deposit the 3rd run by increasing the electrode angle 95° to 105° to the upper vertical plate using slight weaving

Fig 2



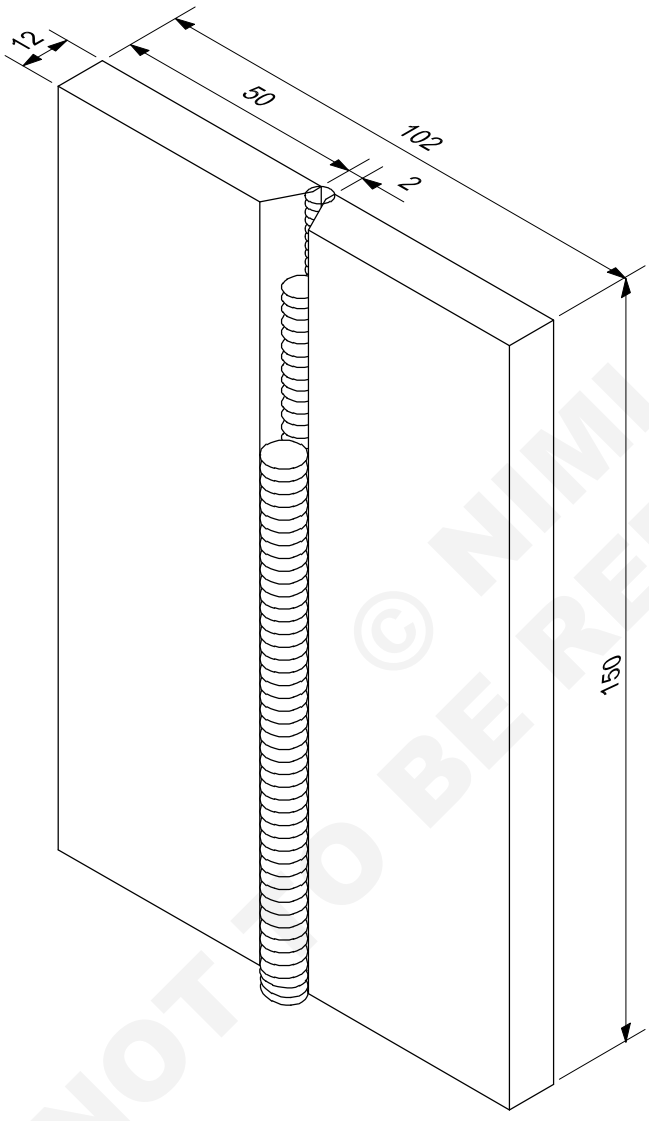
motion. (Fig 3) Deposit the outer edge of the upper fusion face and the junction of the 2nd run

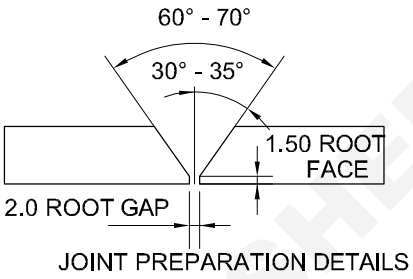
Fig 3

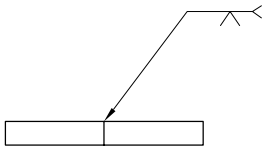


Full penetration single “V” butt joint on MS flat by SMAW in 3G positions

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.**







2	50 ISF 12 x 150	-	Fe 310 - W	-	-	1.5.66
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**SINGLE "V" BUTT JOINT ON MS PLATE 10mm THICK IN VERTICAL POSITION (3G)**	TOLERANCE ±1	TIME:
		CODE NO. WS20N1566E1	

Job sequence

- Cut the MS plate 12 mm thick to size (2 Nos)
- Bevel the edges as per drawing
- Both plates will have 30 to 35° bevel angle and 1.5 mm root face and with no burr at th edges
- Using spacers maintain a uniform gap of 2mm through out 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 σ 3.15 mm 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 σ 4 mm MS electrode and 150 - amp current
- Deposit 2nd, 3rd run using proper weaving techniques 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 on 12mm thick in vertical position

Objective: This shall help you to
• prepare and weld single 'V' butt joint on MS plate of 12 mm thick in vertical position

Preparation of piece

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

Grind the bevel edges to remove oxides, and get smoothness

Use goggles while cutting and grinding

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

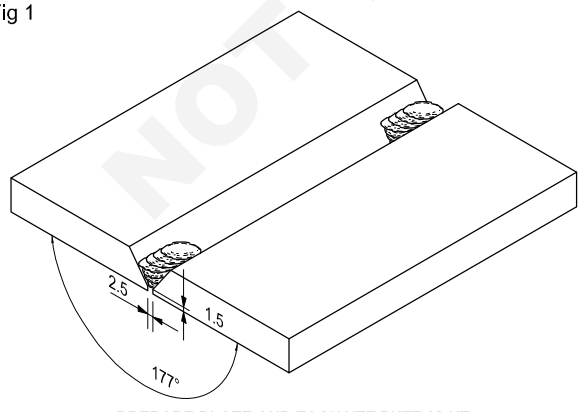
Setting and tacking of single 'V" butt joint

Keep the bevel edhes parellel with the 2.5 mm root gap,

The 2.5 mm thick spacers are used to get a uniform and parellel root gap.

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

Fig 1



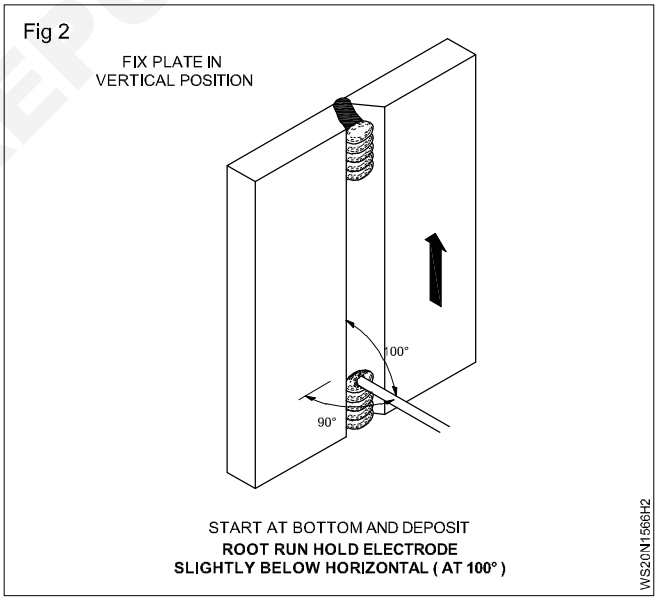
PREPARE PLATE AND TACK VEE BUTT JOINT

Position the joint in vertical using the weld positioner.

Deposit 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)

Fig 2



START AT BOTTOM AND DEPOSIT
ROOT RUN HOLD ELECTRODE
SLIGHTLY BELOW HORIZONTAL (AT 100°)

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.

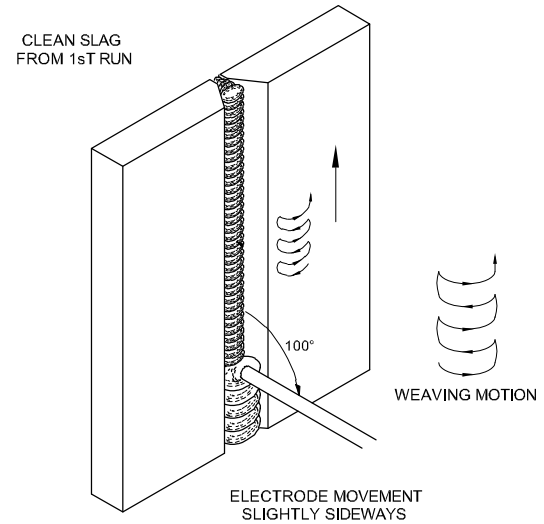
The arc length should be short.

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)

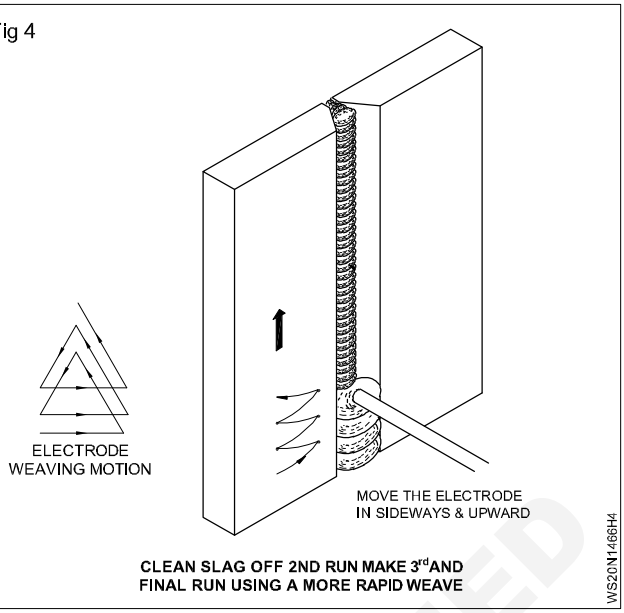
Fig 3



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.

Fig 4



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.

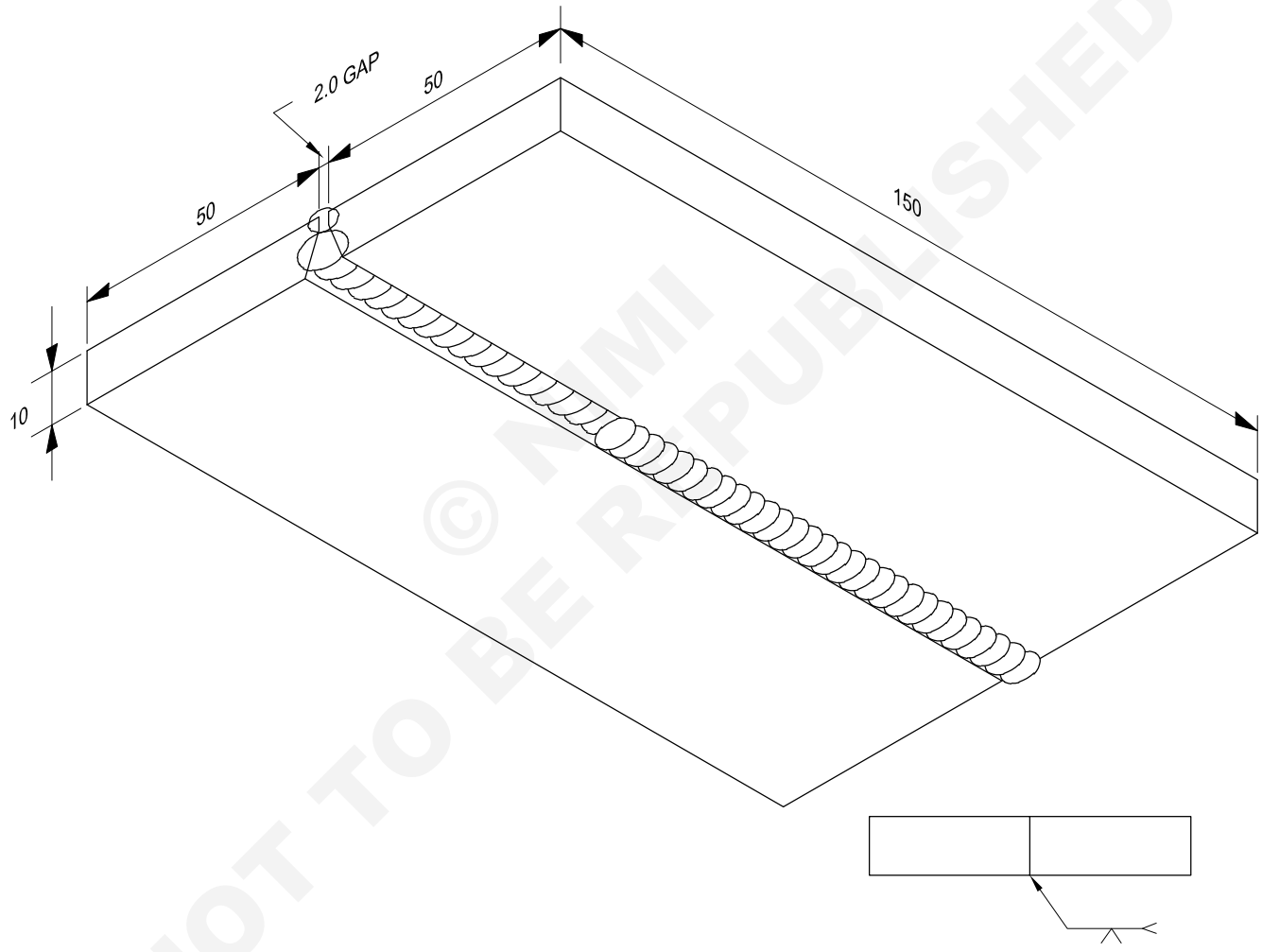
Remove slags with a chipping hammer and clean the weld bead throughly with a wire brush.

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

MS Flat by SMAW in 4G positions

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

- **select electrode, current, polarity and arc length**
- **preset and tack the beloved 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**



2	50 ISF x 10 - 150	-	Fe 310 - W	-	-	1.4.67
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : NTS	**SINGLE 'V' BUTT JOINT ON M.S. PLATE 10mm THICK IN OVERHEAD POSITION. (4G)**				TOLERANCE ±1	TIME :
					CODE NO. WS20N1467E1	

Job sequence

- Prepare the plates to sizes 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

Ensure safety apparels are won.

- 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.

Use a pair of tongs to hold the jobs.

Use a chipping hammer and wire brush for cleaning

Use chipping googles 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.(Refer to skill sequence)

Skill sequence

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

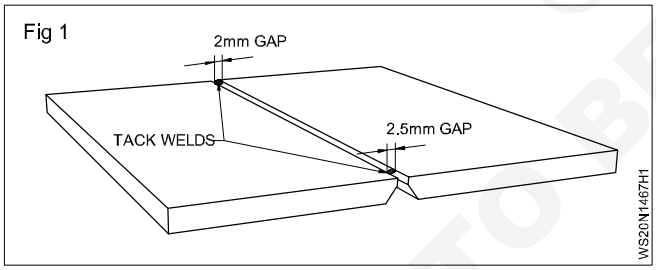
Objective: This shall help you to
• prepare and weld single 'V' butt joint on MS plate 10mm thick in over head position

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 2.5mm root gap.(Fig 1) Tack at both ends

Fig 1



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

Preset the plates

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

Adjust it to a suitable height

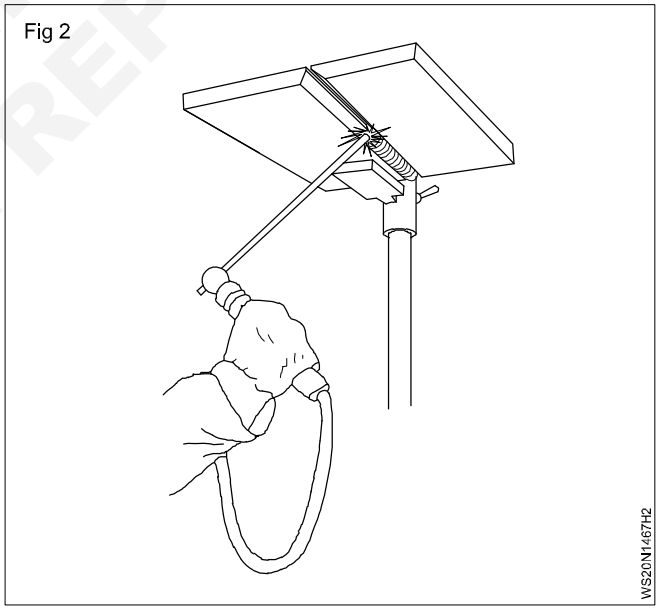
Use a light welding cable to reduce the load on your arms.

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 'key-hole' to get a small reinforcement on the weld on the root size.(Fig 3 and 4)

Fig 2



keep a short arc length.(Fig 4)

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.

Fig 3

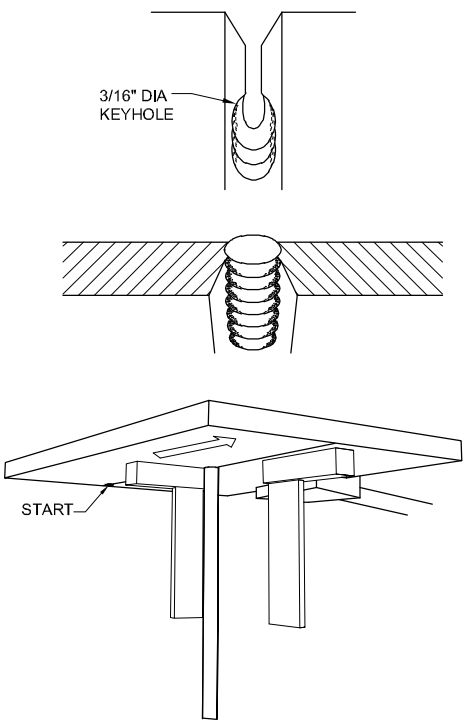
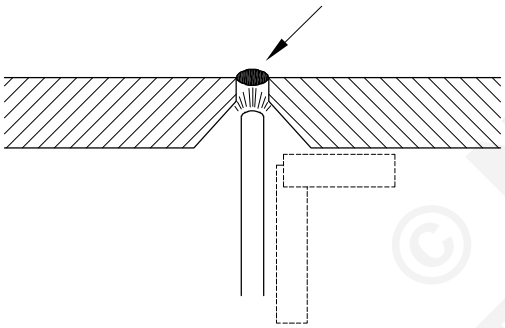


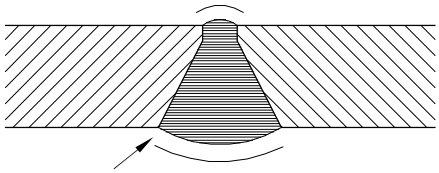
Fig 4



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)

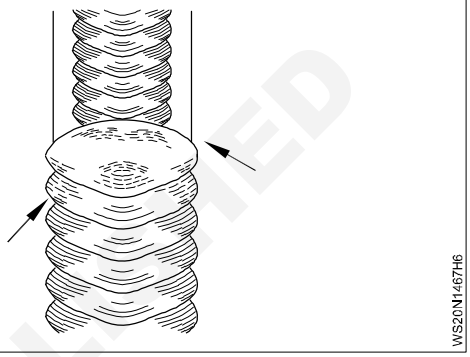
Fig 5



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

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

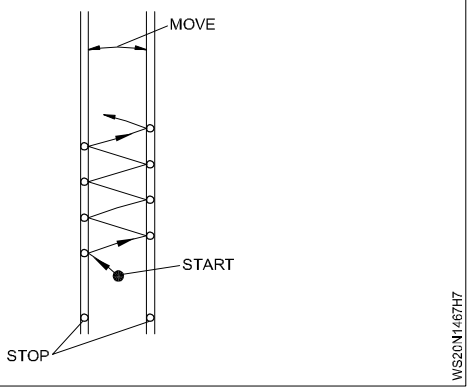
Fig 6



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

chip off the slag and inspect the weld.

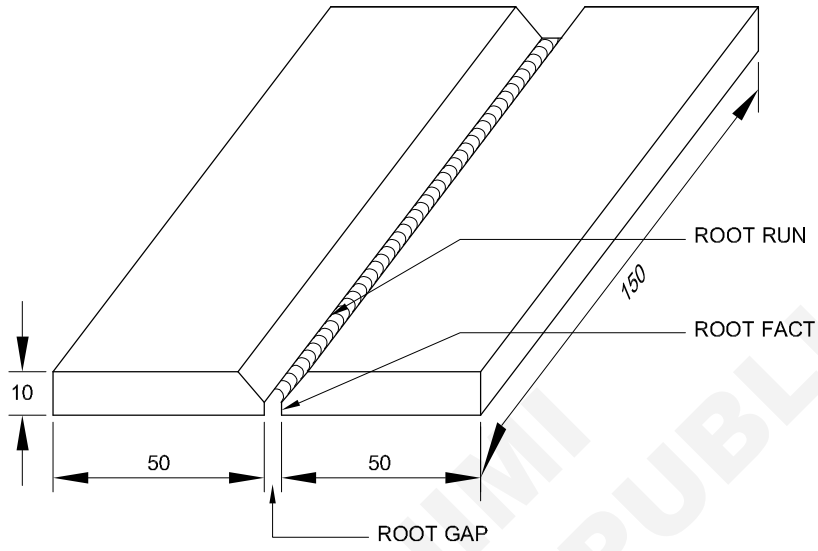
Fig 7

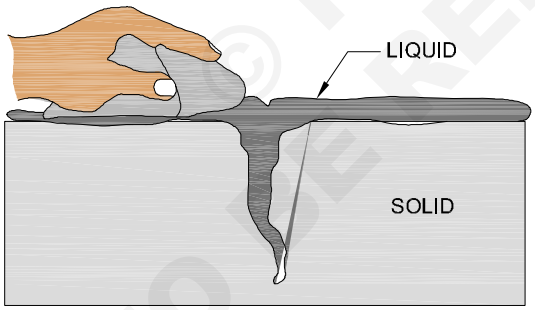


Root pass welding & LPI Testing

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

- **prepare the MS plate for root pass welding**
- **deposit root run in single 'V' butt joint to ensure complete penetration**
- **clean and inspect root pass welding & LPI testing**





CRACK FILLED WITH DIRT IDEALLY CLEANED

APPLICATIONOF PENETRANT INTERMEDIATE CLEANING

APPLICATION OF DEVELOPER CRACK INDICATION

WS20N1468H1

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 for cutting the bevel.
- 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 position facing up)
- Deposit the root run and fill the crater as done for welding square butt joint
- Take special care to maintain key hole to ensure proper melting of root face and root penetration.
- Inspect the root pass by LPI and Post cleaning (Ref 1.5.63)

Skill Sequence

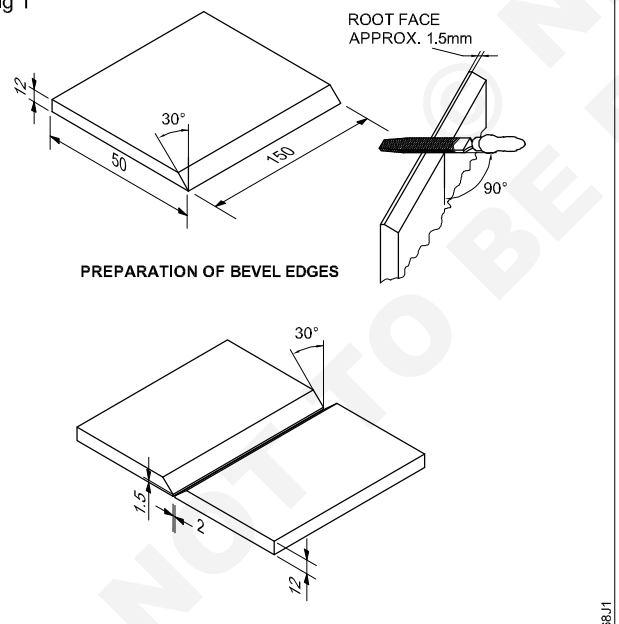
Welding of single 'V' butt joint MS plate 10mm thickness in flat position

Objectives: This shall help you to

- **weld single V butt joint MS plate 10mm in flat position (1G)**

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 filling 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&3) using suitable support i.e. 1.5° on each side of the joint.

Fig 2

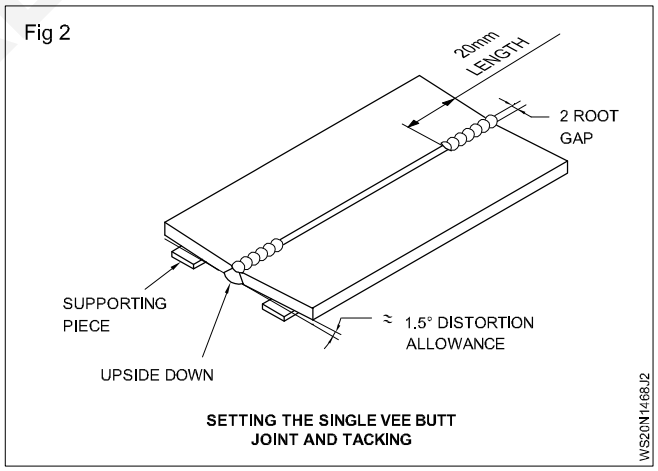
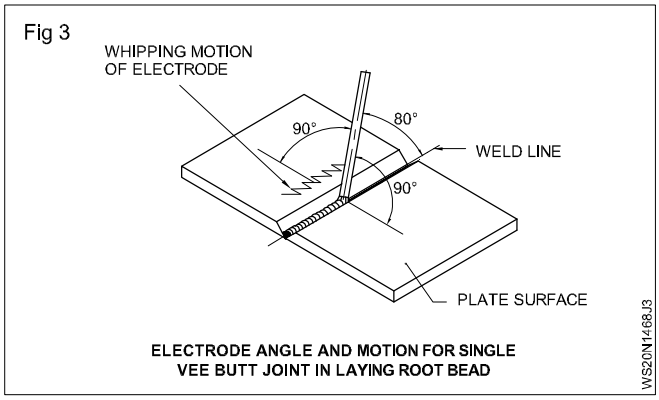


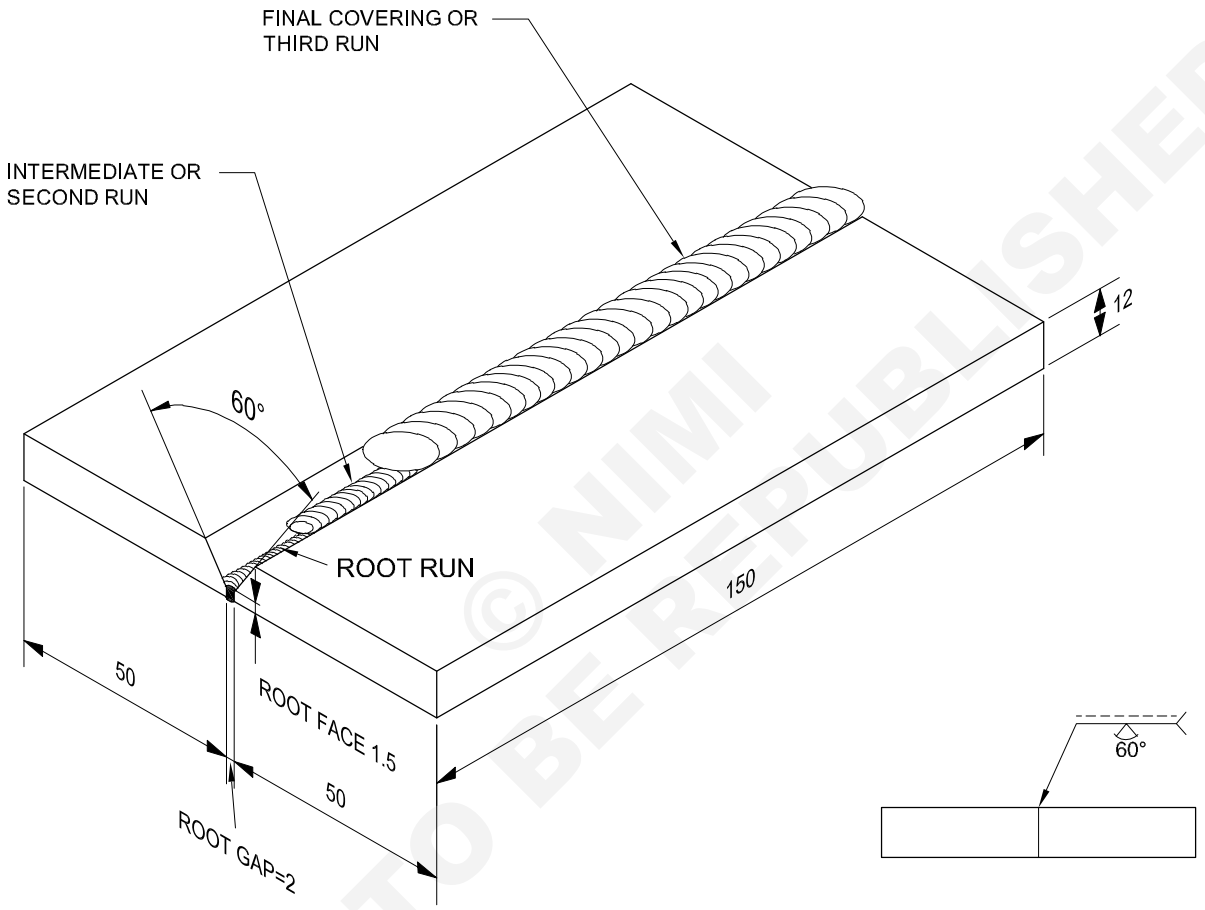
Fig 3



Cover pass welding & inspection

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

- **prepare the plate for cover pass welding**
- **deposit intermediate and final covering runs in single Vee butt joint proper fusion and reinforcement**
- **clean and inspect the groove weld for surface defects and uniform root penetration**



2	50 ISF 12 - 150		Fe 310 - W			1.4.69
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**BUTT WELD SINGLE 'V' BUTT JOINT M.S. PLATE 10mm POSITION FLAT**				TOLERANCE ±1	TIME:
					CODE NO. WS20N1469E1	

Job sequence

- Deposit the second run/intermittent run using 4mm θ medium coated electrode and 150 - 160 ampere current, short arc and proper weaving of the electrode.Avoid excessive weaving and ensure normal travel speed.
- Inspect the hot pass by LPI and post cleaning
- Fill the crater wherever necessary
- Deslag
- Deposit the third run/ covering run using the same pa rameter and technique used for 2nd run.Ensure a proper reinforcement of 1 to 1.5mm and avoid undercut.
- Inspect for any surface weld defect

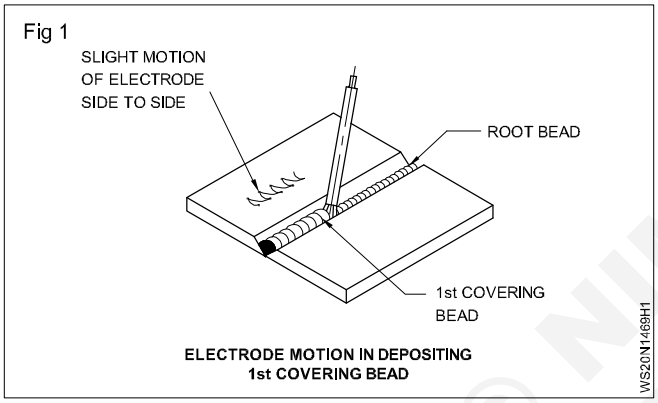
Skill sequence

Cover pass welding and inspection

Objectives: This shall help you to
• deposit cover pass bead and inspecting

Deposition of covering and intermediate beads (Fig 4)

Fig 1



ELECTRODE MOTION IN DEPOSITING
1st COVERING BEAD

Deposit the 1st covering bead (hot pass) using a 3.15mm dia medium coated M.S. electrode and 110 amps welding current.

Proceed with a uniform speed, holding a normal arc and 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)

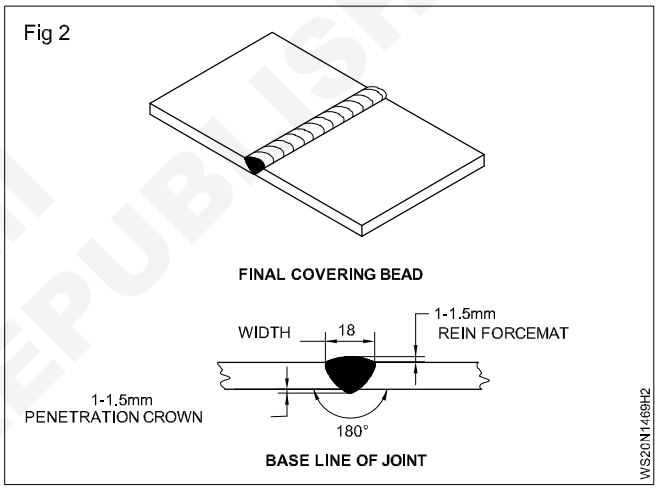
Rectify possible defects, if any.

Use LPI to detect discontinuities that are open to the surface.

Welds that are subject to LPI in addition to visual inspection shall be evaluated.

Deposition of final bead (Fig 5)

Fig 2



Deposit the final covering bead using a 4.00mm M.S. electrode, 160 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.

The final bead made by SMAW should be slightly convex.

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

Cleaning and inspection

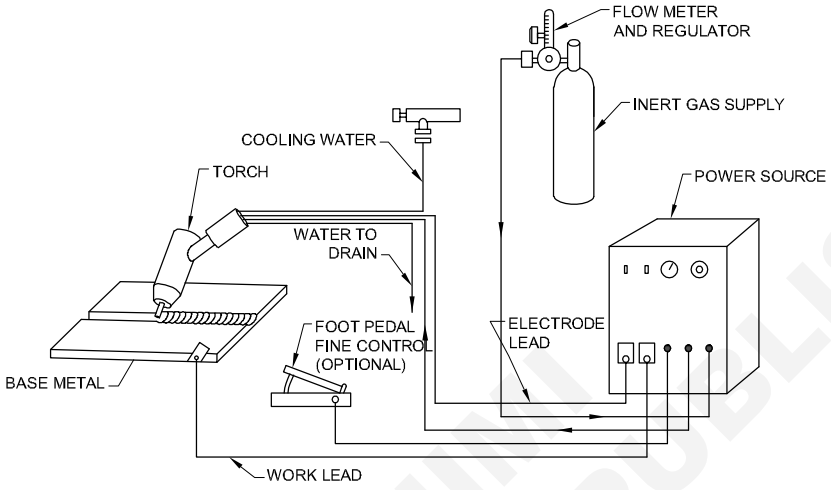
Clean the welded joint thoroughly from both sides.

Inspect the weld size, surface defects, root penetration and distortion. (Ex.No.I&T -01)

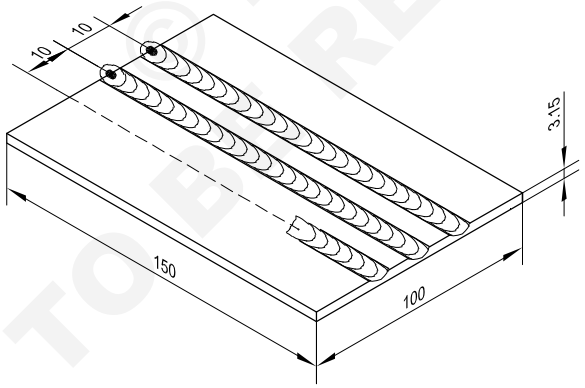
Setting up GTAW welding equipment and making beading practice on MS in down hand position.

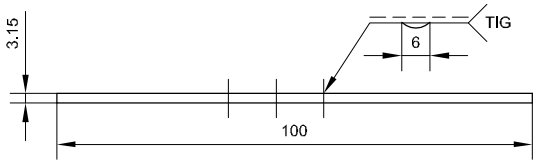
Objectives: At the end of this lesson you shall be able to

- **setup the TIG welding plant**
- **strike the arc and maintain the molten pool to make fusion run without filler rod**
- **clean the fusion bead and inspect the weld defects.**



A DIAGRAMMATIC DRAWING OF A COMPLETE GAS TUNGSTEN ARC WELDING





1	ISST 100x3.15-150	--	Fe 310	--	--	1.5.70
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SETTING UP GTAW WELDING EQUIPMENT AND MAKING BEADING PRACTICE ON M.S IN DOWN HAND POSITION	TOLERANCE ±0.1	TIME :
		CODE NO. WS20N1770E1	

Job sequence

1 Prepare the M.S. sheet as per dimensions.

2 Clean the surface with the steel wire brush.

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

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

5 Set the job in flat position.

6 Select the power supply as follow:

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

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

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

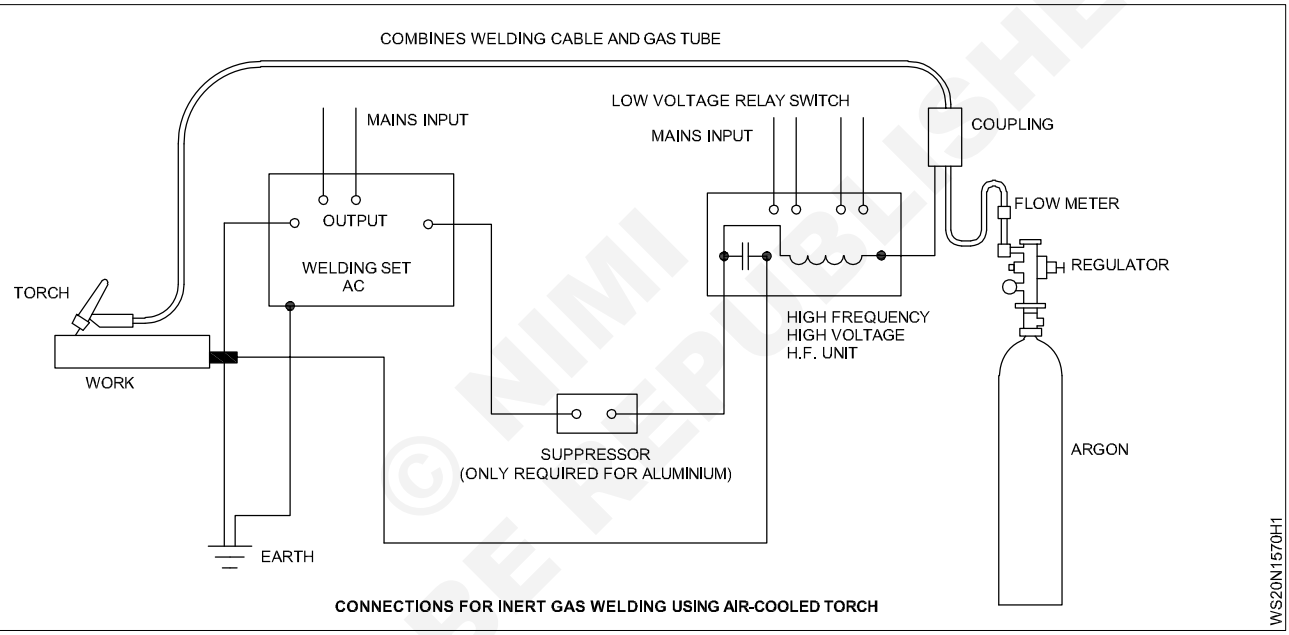
9 Select CCMS filler wire. 1.6mmf with 5% silicon.

10 Switch on the machine and strike the arc.

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

12 Clean and inspect the weld job.

Fig 1



CONNECTIONS FOR INERT GAS WELDING USING AIR-COOLED TORCH

Skill Sequence

Making beading practice on M.S plate in down hand position

Objective: This shall help you to

- **set an GTAW welding eqipment & beading on MS in down hand position**

Ensure to use correct size of the sheet for welding.

Select C.C.M.S. filler wire 1.6mmf.

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

Open the gas cylinder valve slowly,

Follow leftward technique.

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

Finish welding and ensure to fill the crater

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

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

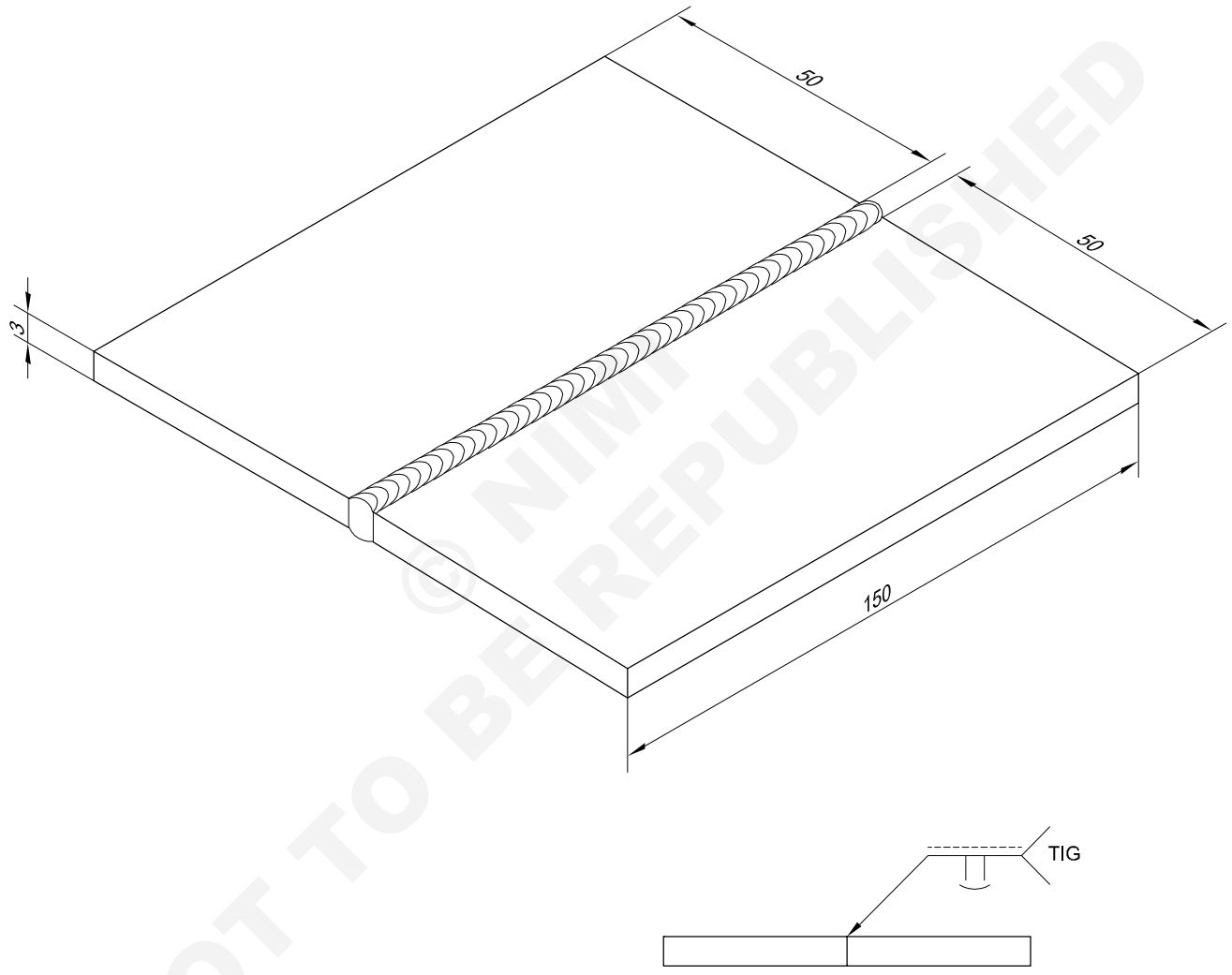
Table 1

Metal thickness	Joint type	Diameter of tungsten alloy electrode with 1 yo 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	1.6mm	1.6 mm	75 - 100	Argon	7
3.15 mm	Butt & Corner	3.15 mm	24 mm	120 - 150	Argon	9.5
	Fillet	3.15 mm	2.4 mm	130 - 160	Argon	9.5
5 mm	Butt & Corner	3.15 mm or 4mm	3.15 mm	120 - 150	Argon	12
	Fillet	13.15 mm or 4mm	3.15 mm	130 - 160	Argon	12

Square Butt Joint on M.S Sheet in Down hand Position.

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

- **select and set the 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 distortion, weld defects.**



2	ISST 50x3.00x150	--	Fe 310	--	--	1.5.71
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	BUTT JOINT ON MS SHEET 3.15mm IN FLAT POSITION	TOLERANCE ±1	TIME :
		CODE NO. WS20N1571E1	

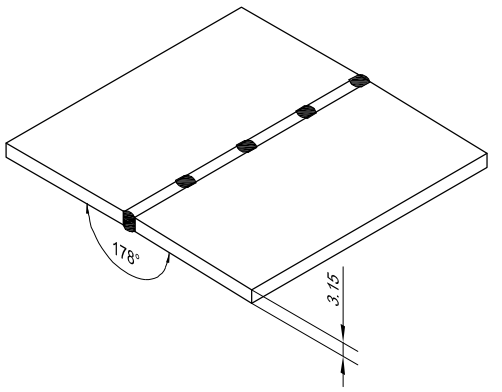
Job Sequence

- Prepare the job pieces of size 150 x 50 x 3mm - 2 Nos.
- Setting and tacking
- Set the prepared job pieces on the welding table with a uniform root gap and in alignment. (Fig. 1)

Ensure that there is a uniform gap of 1.5mm Preset the sheets; give an allowance of 2°.

- Tack-weld the joint at equal intervals of 50mm to hold them together, maintaining the alignment. (Fig. 1)
- Ensure that the
  - distance between the tack-welds is 50mm.
  - length of the tack-weld is 6mm and with full penetration.
  - Tack welds should be on the side to be welded and in line with the joint.

Fig 1



- Weld the tack welded job from right to left holding the
- torch and filler rod at proper angle and using uniform
- travel speed.
- Ensure root penetration using keyhole technique.

Fill the crater

Skill Sequence

Square Butt Joint on M.S Sheet in Down hand Position.

Objective: This shall help you to

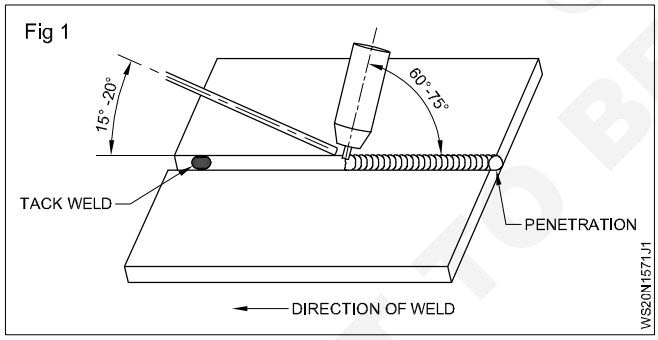
- **prepare and weld square butt joint on M.S sheet in down hand position.**

Welding:

keep free space under the joint for complete penetration

Start the weld from the right end of the joint. (Fig 1)

Fig 1



Manipulate the hold the torch and filler wire as shown in (Fig 1)

weld a well fused uniform bead with complete penetration using left ward technique (Fig1)

Maintain uniform travel speed 15cm/min.For the torch and piston like motion to the filler rod. (Fig 2)

Maintain a key hole for better root penetration.

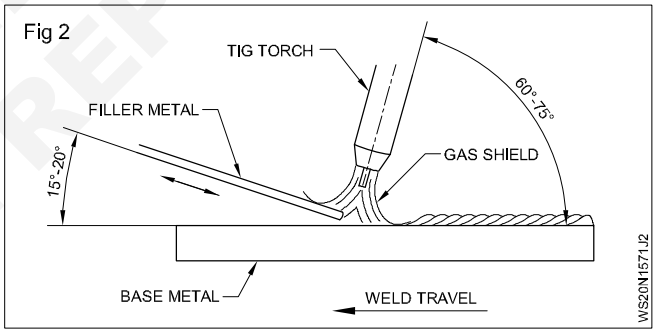
Clean the deposit bead.

Inspect the pealing of weld by:

- Check the finesh of the job

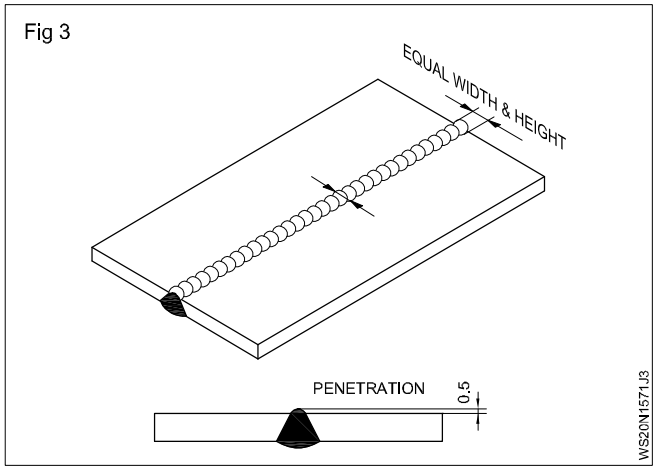
Checking the alignment (remove distortion if any)

Fig 2



- Checking the uniformity of width and height of the weld bead in size.
- Checking the uniformly of the ripples fusion and complete penetration.(Fig 3).

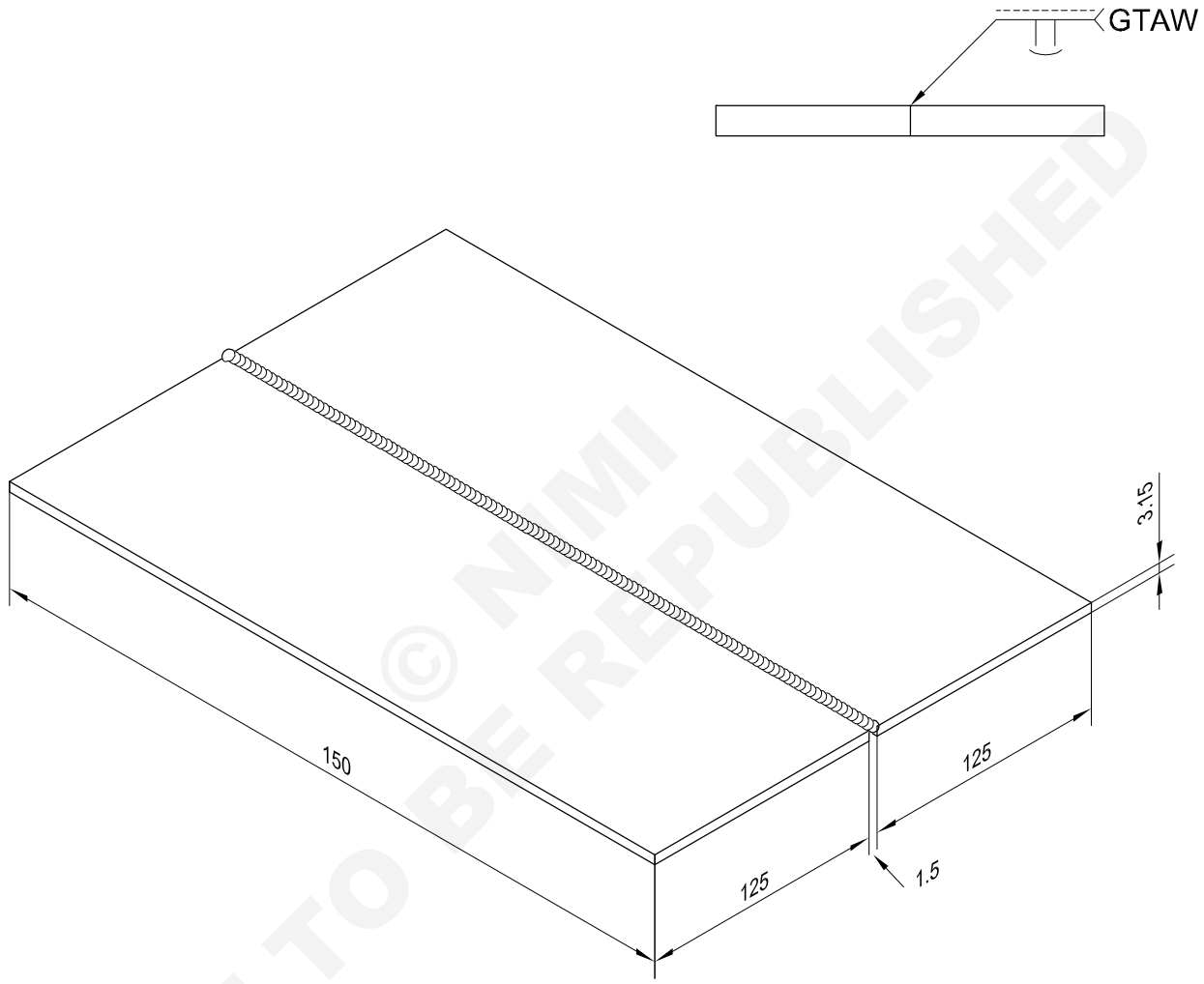
Fig 3



Square butt joint on S.S Sheet in down hand position.

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

- **weld Square butt joint on stainless steel sheet 3.15mm thick flat position.**



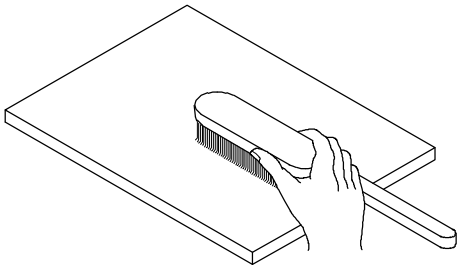
2	125 x 1.6 - 150	--	X 04 Cr 19 Ni 9	--	--	1.5.72
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	BUTT WELD SQUARE BUTT JOINT ON STAINLESS STEEL SHEET 1.6 mm - POSITION FLAT WITH PURGING GAS (1G)	TOLERANCE ±1	TIME :
		CODE NO. WS20N1572E1	

Job Sequence

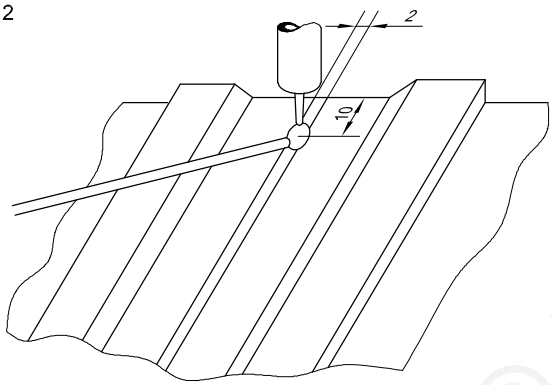
- Clean the base metal surface with the SS wire brush
- Clean the base metal surface with alcohol
- Adjust the current to about 80 to 90A.(Fig 1)

Fig 1



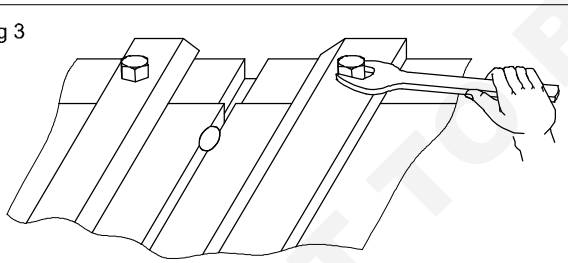
- Adjust the gas flow rate to 6-8 LPM
- Set the root gap to 2 mm.(Fig 2)

Fig 2



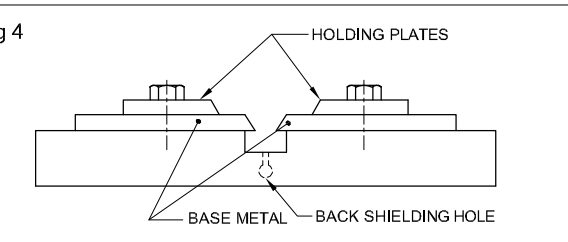
- Fix the base metal with the jig.
- Flow the back shielding gas by 4LPM.(Fig 3)

Fig 3



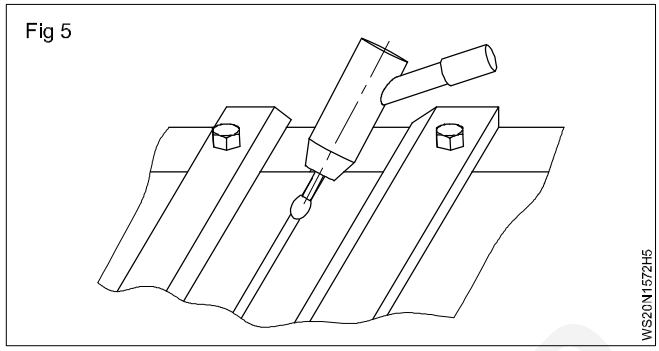
- Tack weld at 10mm inside from both ends of the joint.
- Stop the back shielding gas.
- Remove the base metal from the jig.(Fig 4)

Fig 4



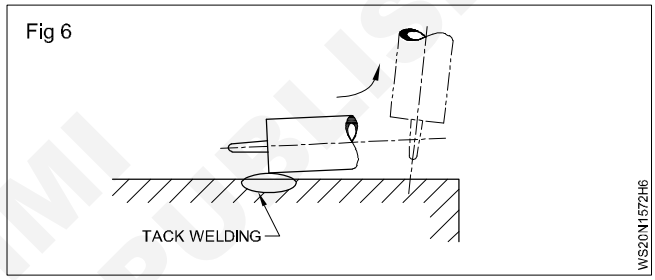
- Check if the joint has good alignment.
- Fasten the base metal securely to the jig.(Fig 5)

Fig 5



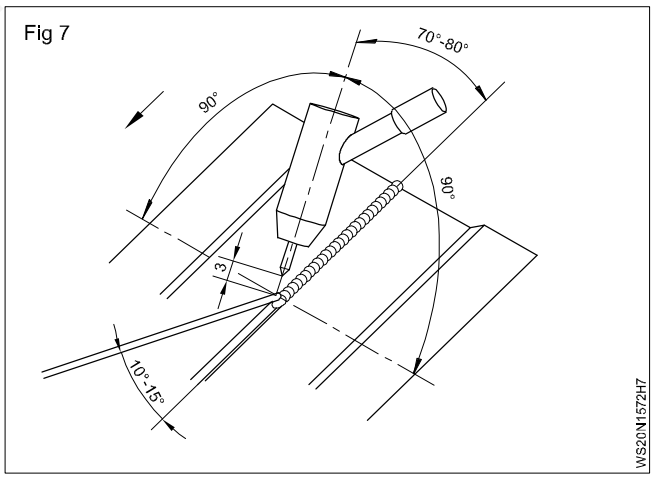
- Polish the base metal with the ss wire brush.
- Adjust the back shielding gas to 4 LPM.
- Generate an arc at the tack welding position.(Fig 6)

Fig 6



- Return to the start end.
- Hold the torch to about 70 to 80" against the welding direction and 90° against the base metal surface.
- Keep the arc length about 3 to 5mm.(Fig 7)

Fig 7



Skill Sequence

Gas tungsten arc welding of square butt joint on S.S sheet in down ward position.

Objective: This shall help you to

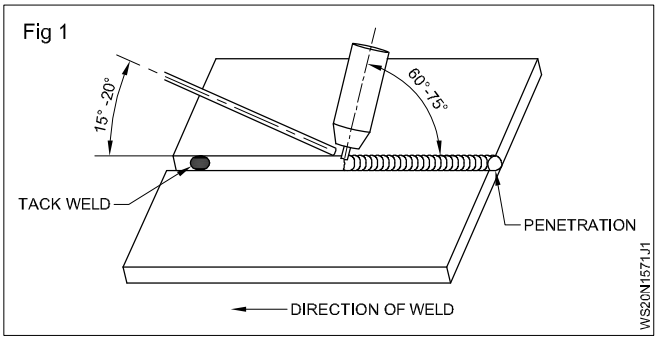
- **to prepare and welding the square butt joint on SS sheet in down hand position.**

Welding:

keep free space under the joint for complete penetration

Start the weld from the right end of the joint. (Fig 1)

Fig 1



Manipulate the hold the torch and filler wire as shown in (Fig 1)

weld a well fused uniform bead with complete penetration using left ward technique (Fig1)

Maintain uniform travel speed 15cm/min.For the torch and piston like motion to the filler rod.(Fig 2)

Fig 2

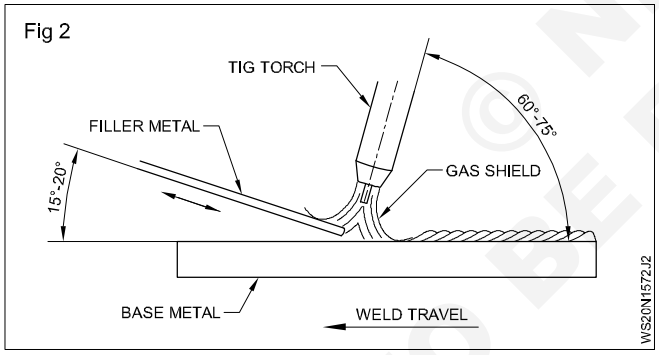
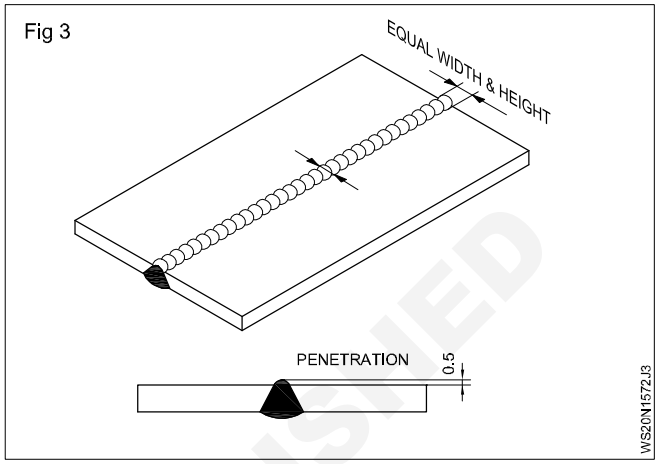


Fig 3



Maintain a key hole for better root penetration.

Clean the deposit bead.

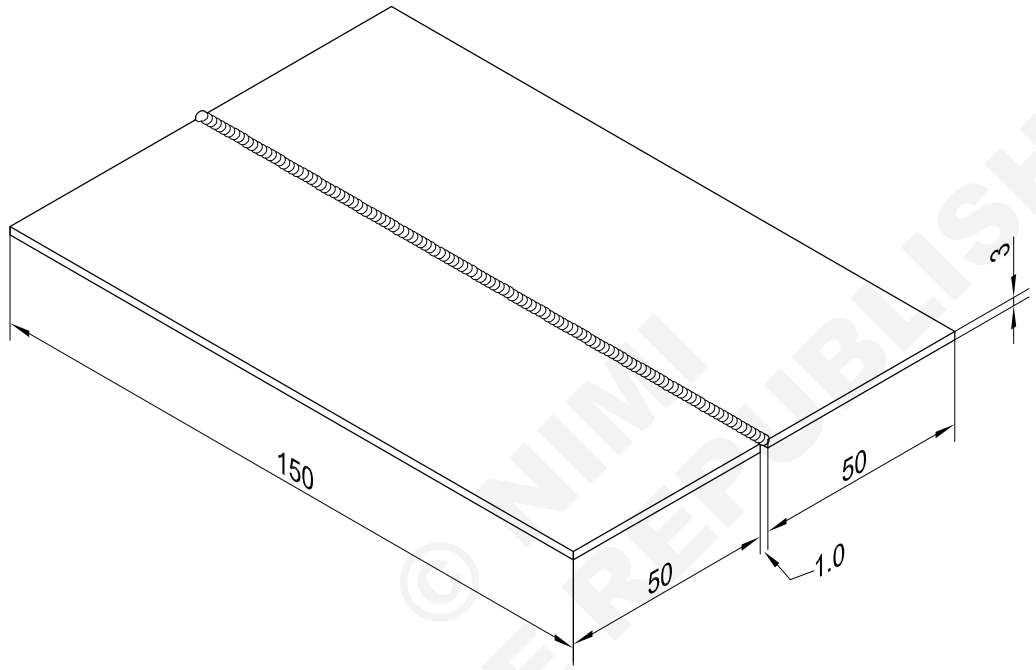
Inspect the pealing of weld by:

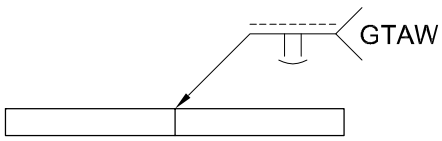
- Check the finesh of the job
- Checking the uniformity of width and height of the weld bead in size.
- Checking the uniformly of the ripples fusion and complete penetration.(Fig 3).

Square butt joint on Aluminium in down hand position.

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

- **weld Square butt joint on Aluminium sheet 3mm thick Using TIG welding process.**





2	50 x 3 x 150	- -	AL.199990 - IS 737	- -	- -	1.5.73
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**BUTT WELD SQUARE BUTT JOINT ON ALUMINIUM SHEET 2mm - POSITION FLAT**	TOLERANCE ±1	TIME :
		CODE NO. WS20N1573E1	

Job Sequence

1 Prepare aluminium sheets as per dimensions.

2 Use Tungsten (zirconium) 2.4mm dia electrode.

3 Clean the edges of the sheets.

4 Use the stainless steel wire brush for surface cleaning.

5 Set the square butt joint.

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

7 Weld the joint in flat position using leftward technique.

8 Fill the crater.

9 Clean the weld area throughly

10 Inspect the job for free from defects.

Skill Sequence

Gas tungsten arc welding of square butt joint on Aluminium sheet in down ward position.

Objective: This shall help you to

- **to prepare and welding the square butt joint on Aluminium Using TIG welding process.**

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.

TABLE 1

Guideline for Manual AC GTA welding of aluminium

Plate thickness (mm)	Welding position	Joint type	Current AC (Amp)	Electrode Dia.(mm)	Nozzle size 10 mm	Argon flow Rate (mm)	Filler rod Dia. LPM	Number of runs mm
2.mm	F	Square butt	70 - 100	2.4	8.0	10	2.4	1
	H,V	Square butt	70 - 100	2.4	8.0	10	2.4	1
	O	Square butt	60 - 90	2.4	8.0	13	2.4	1
3.2	F	Square butt	120 - 150	3.2	9.5	10	3.2	1
	H,V	Square butt	110 - 140	3.2	9.5	10	3.2	1
	O	Squarebutt	110 - 140	3.2	9.5	13	3.2	1
4.8	F	60° Single Vee	180 - 220	4.0	11	12	4.0	2
	H,V	60° Single Vee	160 - 200	4.0	11	12	4.0	2
	O	Single Vee	170 - 200	4.2	11	12	4.0	2
6.35	F	60° Single Vee	220 - 240	4.8	12.7	15	4.0	2
	H,V	60° Single Vee	220 - 240	4.8	12.7	15	4.0	2
	O	Squarebutt	210 - 250	4.8	12.7	18	4.0	2

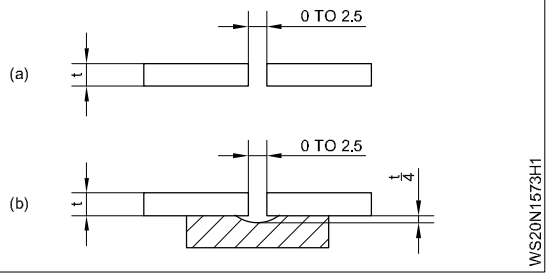
F - Flat, H - Horizontal, V - Vertical, O - Overhead

Maintain uniform short arc throughtout the welding.

Care to be taken to avoid end crater.

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

Fig 1



M.S Square Butt tube (Square or rectangular) welding

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

- **to practice on butt joint on M.S square butt tube by TIG**

Job Sequence

- Prepare the S.Tube to size (as per drawing) by Hacksaw cutting and grinding.
- Clean the tube surface (job) with wire brush and remove the burrs by filing.
- Adjust the current to about 80 to 90A and adjust the gas flow rate to 6-8 LPM.
- Set the root gap to 1.5mm. And Fix the base metal with the jig.
- Tack weld at ends of the joint. Remove the base metal from the jig.
- Check if the joint has good alignment.
- Weld butt joint in flat position.
- Clean the weld area thoroughly and inspect the job.

Skill Sequence

Joint on M.S Square tube in Flat position by GTAW.

Objective: This shall help you to

- **to prepare and welding the square butt joint on Aluminium Using TIG welding process.**

Ensure setting of Butt joint as per drawing.(Fig 1)

Set the GTA welding plant with argon gas.

Select the 1.6 mm electrode and 1.6mmf ccms filler wire and electrode tip be grinded for DC.

Set the current 60 amps to 90 amps.

Setting and tacking the job pieces on the welding table for butt joint with required root gap.

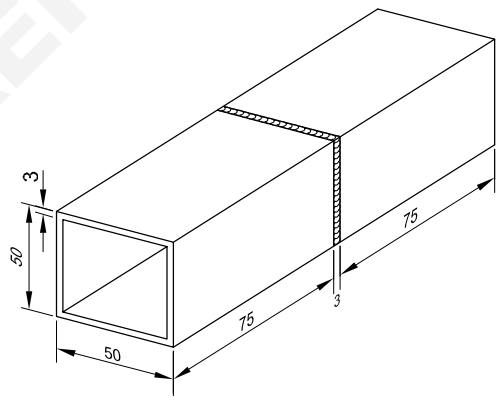
Tack-weld the joint at both ends

Hold the torch perpendicular to the joint and pointing at an angle of about 30® toward the direction of travel and Strike an arc and establish a puddle.

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

Complete the bead, cool the assembly.

Fig 1



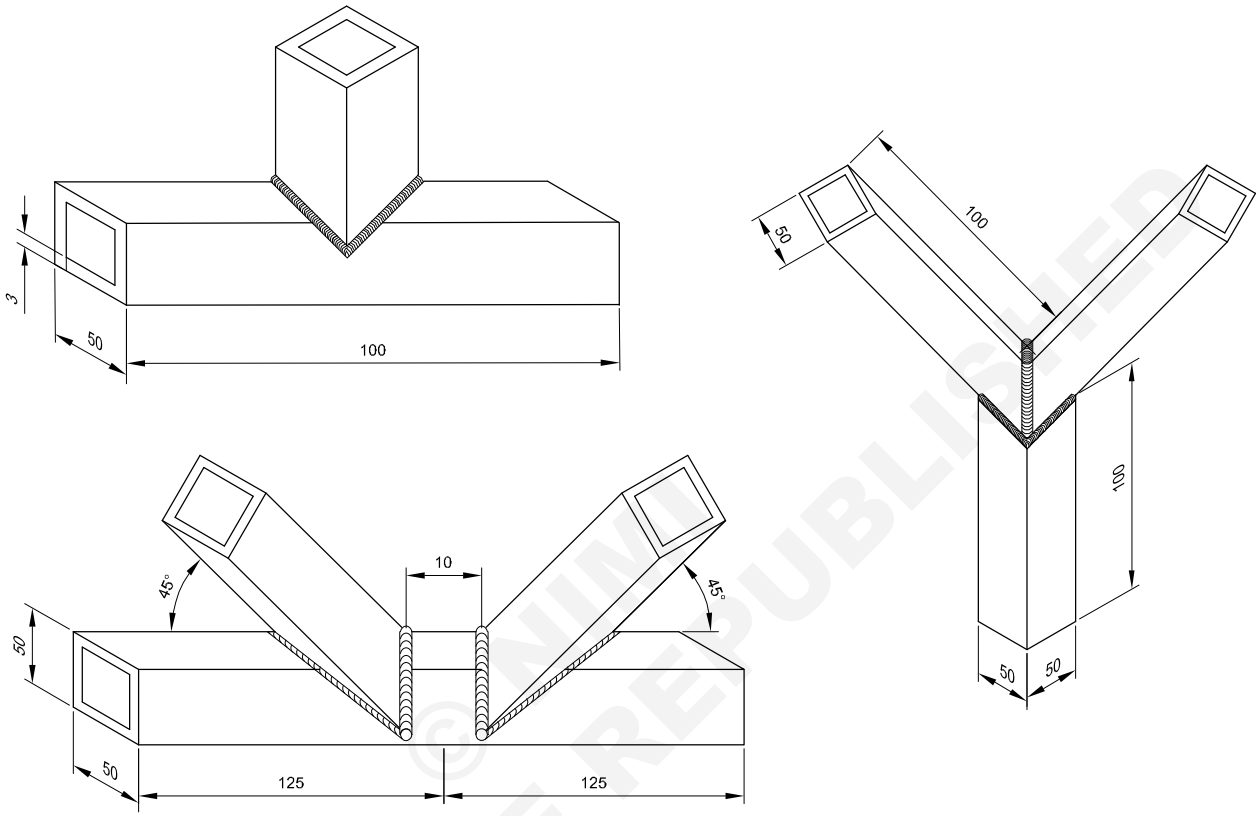
M.S SQUARE

WS20N1574H1

T,Y,K Tube (Square or Rectangular) joints by TIG welding

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

- **to practice T,Y,K joint on M.S square tube by TIG.**



1	-		-			1.5.75
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : NTS	T,Y,K TUBE (SQUARE OR RECTANGULAR) JOINT BY TIG WELDING				TOLERANCE ±1	TIME :
					CODE NO. WS20N1575E1	

Job Sequence

- Cut the tube by gas cutting/hacksaw cutting as per drawing
- Grind the edges square.
- Use goggles while grinding.
- Clean the joining edges and surface of the tubes.
- Prepare development for T,Y,K branch. (Fig 1) on a drawing sheet.
- Cut and paste it on the tubes.
- Punch mark the profile of the development on tubes and Cut the branch tube along the punch marked profile and file it. Cut the profile marked on the main tube by hacksaw cutting and file it.
- Clean the surface of the pipe to remove any oxide and other contaminants.
- Set the 2.4 mm dia tungsten electrode and ccms filler rod with 80 to 110 a current. 6.8rpm argon gas flow.
- Follow necessary safety precautions.
- Weld the joint by manipulating the blow pipe and filler rod without rotation of the tube.
- Complete the weld, Clean the weld inspect the weldment for defects.

Skill Sequence

T;Y,K Tube development

Objective: At the end of this lesson you shall be able to
- **to practice T,Y,K joint on M.S square tube by TIG.**

All the square tubes (T,Y,K) are of same side and intersecting each at equal angles.

Hence in this case the development of all the tube are same and so the development of one tube will represent other tubes

Draw the plan and elevation of the pipe 'A' and mark the division on the plan. Fig 1,2,3

Draw the vertical projectors from the plan to front view to meet the line of intersection.

Draw horizontal projectors from these points on to the development.

Mark the intersecting points and join with a smooth curve to complete the required development.

Fusing both the edges of the joint (which is 3mm thick) to the full depth and get food root penetration. Also the joint which in shape can be welded properly with good fusion and root penetration only if the tack welded in 2-4 segments. The segments are divided on the tacked joint under job sequence.

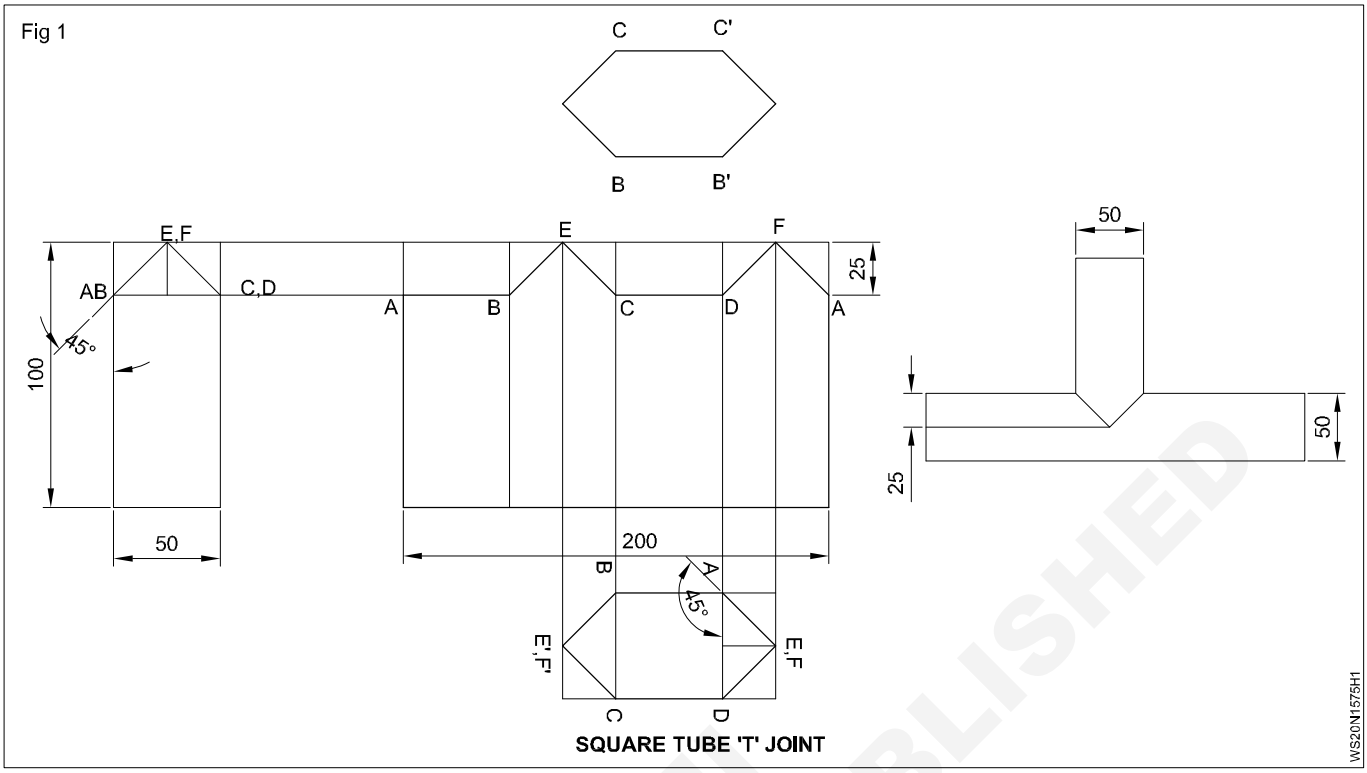
During welding fuse the tacks fully and also ensure proper fusion of edges and root of the joint of each segment. Use the torch and filler rod angles of 60 – 70° and 30 – 40° to the tangent at the point of welding. Give a very slight side to side motion to the torch.

1) Square tube " T " Joint

2) Square tube " Y " Joint

3) Square tube " K " Joint

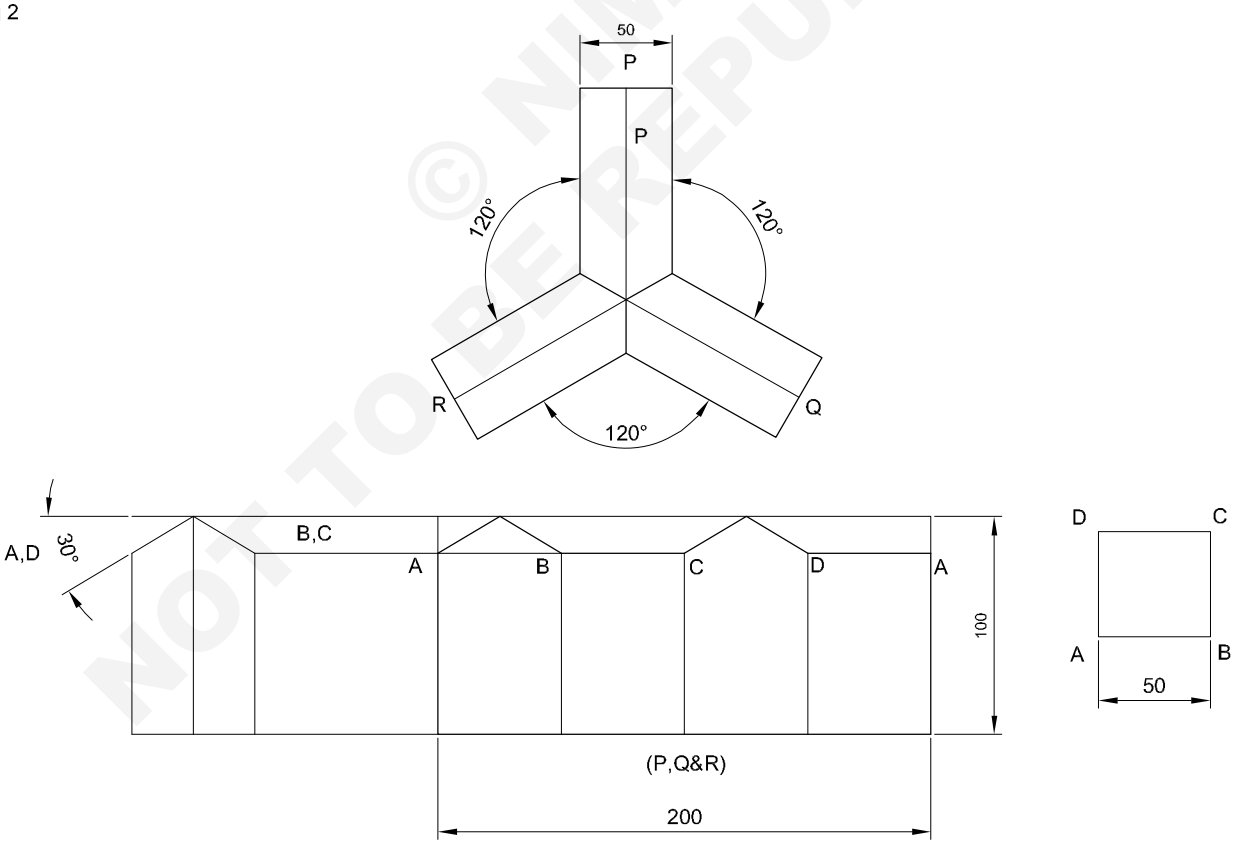
Fig 1



SQUARE TUBE 'T' JOINT

WS20N1575H1

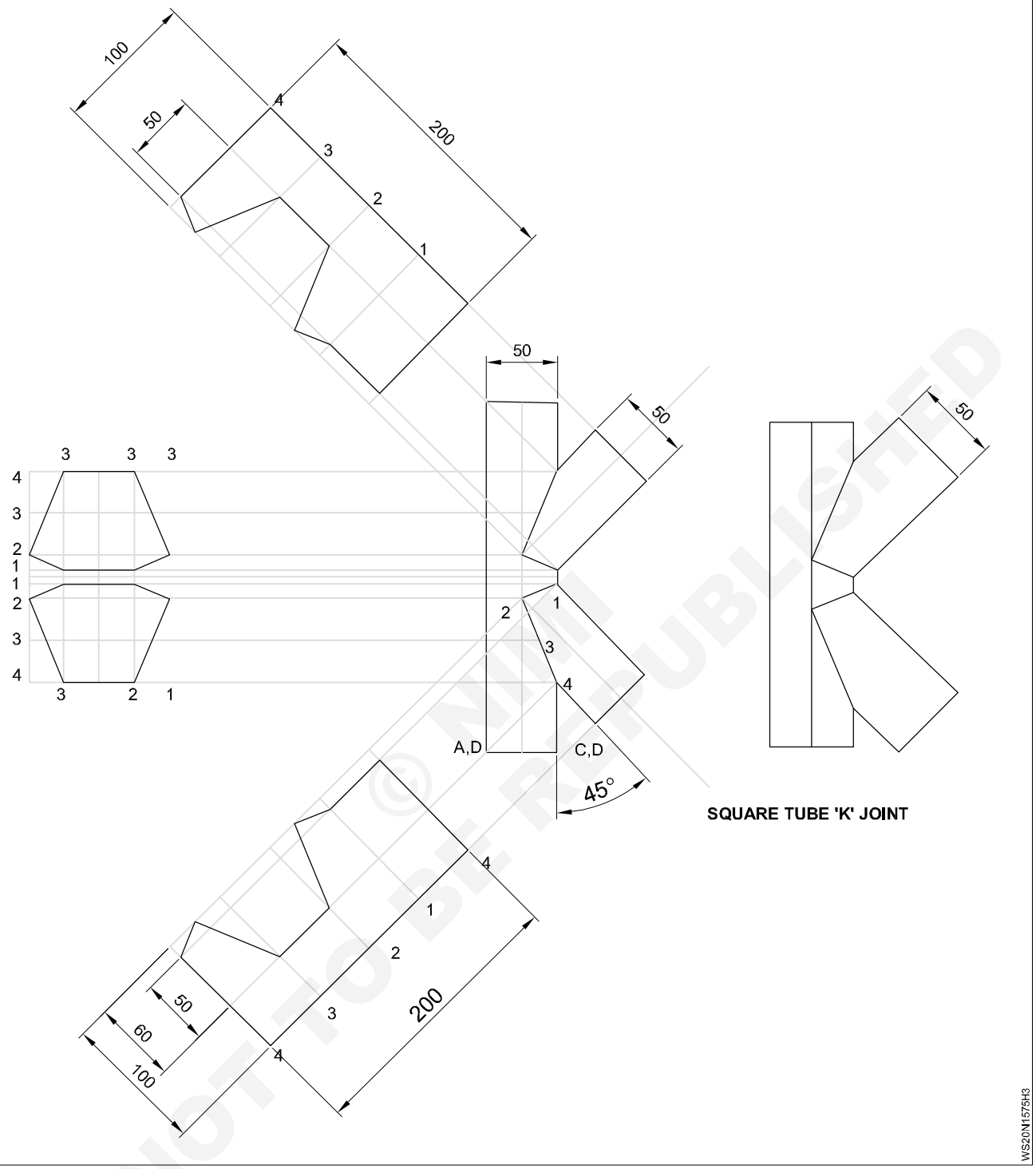
Fig 2



SQUARE TUBE 'Y' JOINT

WS20N1675H

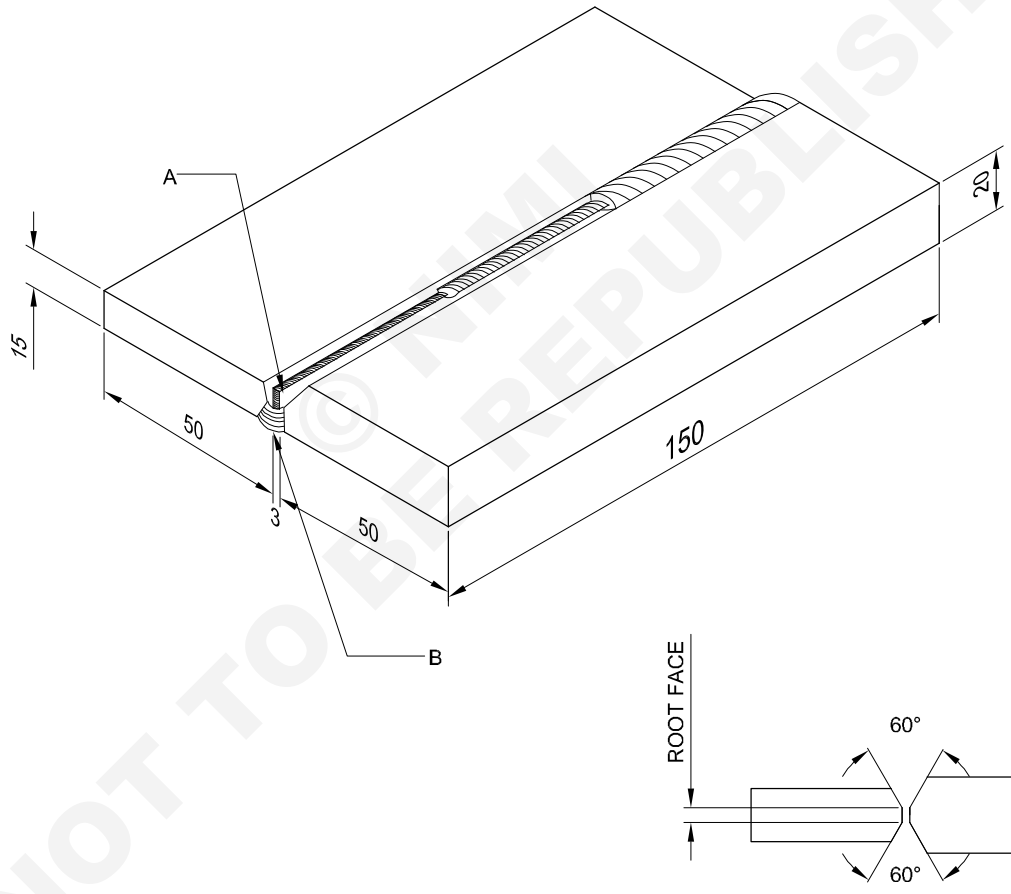
Fig 3



Double Bevel Butt joint on MS Flats in Dissimilar Thickness in Down hand position by SMAW. Root Inspection, BackGoughing, Adopting weld Sequence for controlling distortion.

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

- **select the joint design for heavy wall thickness**
- **weld a double bevel butt joint root welding, back grinding, filling and cover passes**
- **deposite root 2nd & 3rd run**
- **perform LPI on backgouged root surface**
- **controlling distortion.**



2	-		-			1.6.76
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	DOUBLE BEVEL BUTT JOINT ON MS FLAT IS DISSIMILAR THICKNESS IN DOWNHAND POSITION				TOLERANCE ±1	TIME:
					CODE NO : WS20N1676E1	

Job Sequence

1 Prepare plates as accurately as needed.

2 Mark clearly and accurately the plates and identity. (Part-A and Part-B).

3 Prepare the edges of plates by oxy-fuel gas cutting. (Fig 1)

4 Clean the cut surface by wire brush after chipping off any slag sticking to the cut edge.

5 Align the edge prepared plates properly and fit up with the recommended root gap.

6 Use temporary backing stiffners to control distortion.

7 Set the workpiece (job) on the work table in flat position. Tack weld using bridge pieces at either end of the plates.

8 Select the low hydrogen type E7018 w,3.15 mm size and use DCEP polarity.

During welding jobs, welders can reduce risks by always wearing protective clothing and equipment suitable for a particular task.

9 Inspect the fit-up before welding.

Double-bevel butt joint – Side 'A'

1 Deposit the root run using w,3.15 mm electrode ensuring root penetration.

2 Use power tools (chipping gun) to remove slag and clean the weld by wire brush the root (first) pass.

3 Deposit the second pass with slightly weaving motion with the same size of electrode along the groove.

4 Remove the slag and clean the weld by wire brush the second pass.

Double-bevel butt joint – Side 'B"

1 Turn the joint. The root of a weld may be gouged out to sound metal before commencing the weld on the second side by Air-Carbon-Arc gouging operation in the flat position.

2 Clean the backgouged or background root surface.

3 Perform liquid penetrant inspection to detect any surface opening discontinuities.

4 Post cleaning – Remove the developer on the surface and other chemicals on the test surface.

5 The root is then covered with a sealing pass-3 deposited with same (Side – B)

6 Then the plate is again turned over and the pass-4

7 Repeat the above sequence for each pass and turn the plate until completion of the welding to control distortion.

8 Perform visual inspection of the welds on both sides.

Skill Sequence

Double bevel butt joint on MS plate

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

- **select the joint design for heavy wall thickness**
- **weld a double bevel butt joint root welding, back grinding, filling and cover passes**
- **deposite root 2nd & 3rd run**
- **perform LPI on backgouged root surface**
- **controlling distortion.**

1 Select the joint design that requires the least amount of weld metal.

2 Use double-bevel groove welds on dissimilar thick plates to reduce the amount of weldmetal and to control distortion.

3 Double bevel groove butt joints are used in some areas where load demands are greater than can be met by square butt joints and less than values requiring V-groove butt joints. The cost of preparation is less than for V-groove butt joints since it is necessary to bevel only one plate edge.

a Joint preparation

Remove oil, moisture, rust, scale, sand, paint, metallic coatings or other foreign matter from the weld surface and atleast 25 mm of adjacent base metal prior to welding.

Thermally cut surfaces shall be power brushed or ground prior to welding.

b Welding power source

Select the proper equipment for the specified SMAW process.

c Joint Fit-up

Tack welds are required when a part requires support during welding. Tack welds shall be of sufficient size to maintain joint alignment.

Tack welds that are to be incorporated into the final weld shall be thoroughly cleaned, prepared at each end, and inspected for cracks. Any cracked tacks shall be removed before welding the joint.

Bridge tacks (located above the root area) are acceptable but such tacks must made completely within the weld groove and shall be completely removed prior to completion of the weld.

d Welding techniques

Maintain proper manipulation of the welding arc to avoid flux entrapment.

When welding from both sides, the root penetration is not important, because it is gouged out to sound metal form the 'B' side and the sealing pass deposited.

First two runs are made in the groove 'A' side.

Adopting weld sequence for controlling distortion

Adopting jig (or) Fixture for fixing of base welding plate to minimize the distortion.

The length of tack welding as to be specified by the AWS.

Welding clamp may be used to control the distortion.

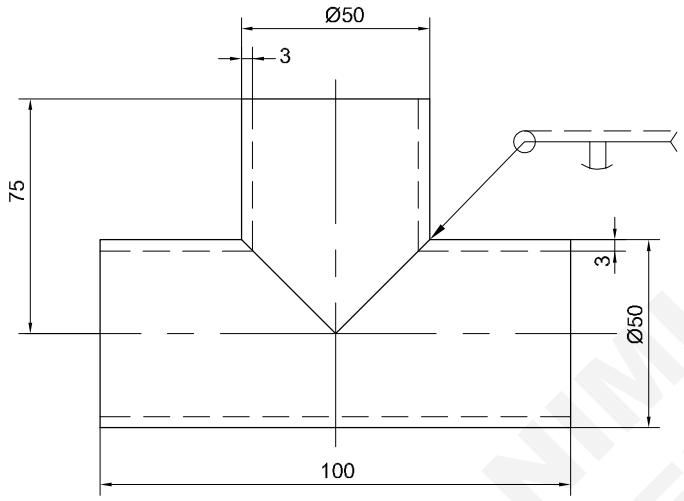
Flame straightening can be control the distortion.

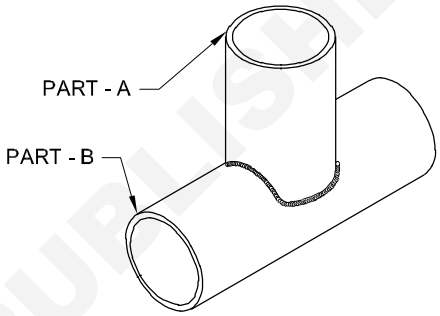
Adopting skip welding & back step welding method to control distortion.

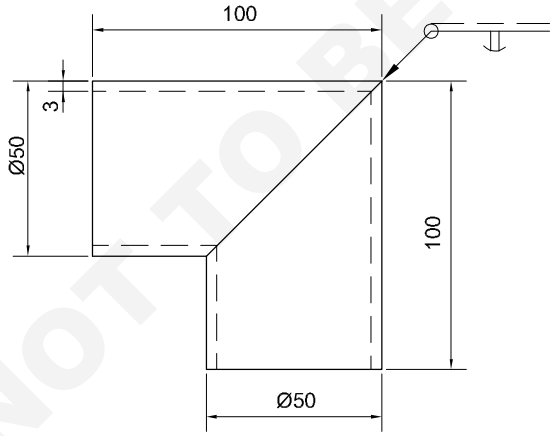
Pipe Elbow and T joints on MS pipes by SMAW in flat position

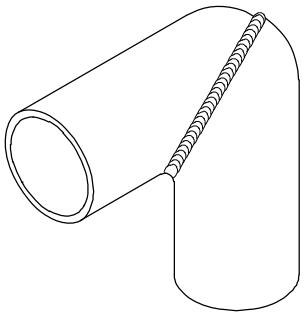
Objectives: At the end of this lesson you shall be able to

- **draw the development for "ELBOW" pipe joint & T joint**
- **cut and prepare the pipe as per the dimensions.**
- **set the pipes to form a pipe elbow joint & T joint.**
- **start the weld and complete it in two halves**
- **clean and inspect for weld defects.**









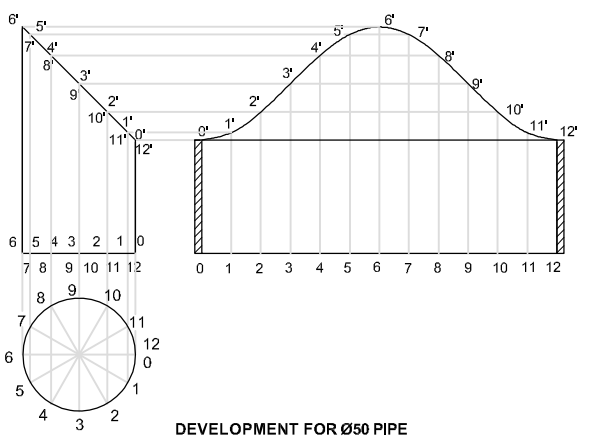
2	Ø50 x 3 - 100	-	Fe 310 - W	-	-	1.6.77
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**PIPE WELDING - ELBOW & JOINT ON MS PIPE Ø50mm AND 3mm WALL THICKNESS IN FLAT POSITION (1G)**	TOLERANCE	TIME :
		CODE NO. WS20N1677E1	

Job Sequence

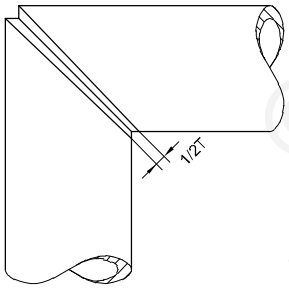
- Cut the pipe as per dimensions.(Fig 1)
- Draw the development drawing for Elbow & T joint.

Fig 1



- Using oxy-Acetylene cutting equipment cut on the punch mark of Elbow & T joint.
- Remove burs on the cutting edge
- Remove the oxides on the surface to be joint.
- Alignment the two pieces as per drawing.(Fig 2)

Fig 2



- Wear safety welding apron & PDE
- Tack weld on the two pieces, for root weld use 3.15 mm dia electrode & set 90 – 110 amps current.
- Use spacer 2mm in between the tubes, tack weld the joint with uniform distance.(Fig 3)

Fig 3

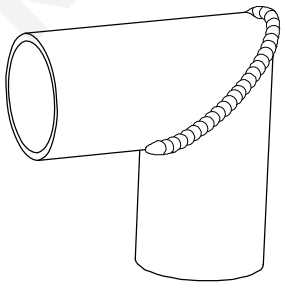
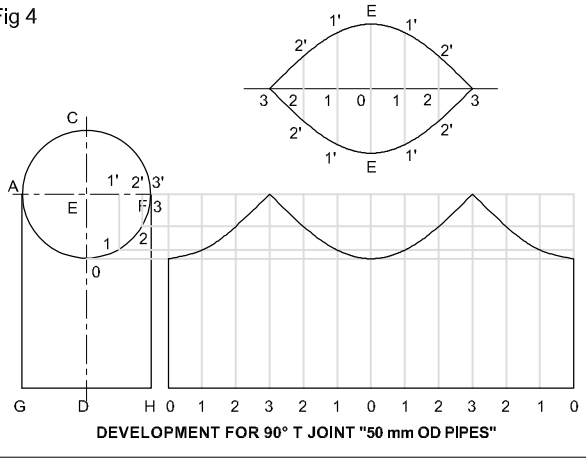
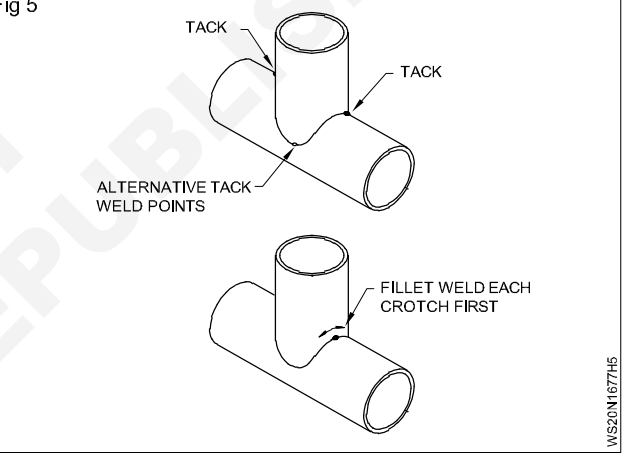


Fig 4



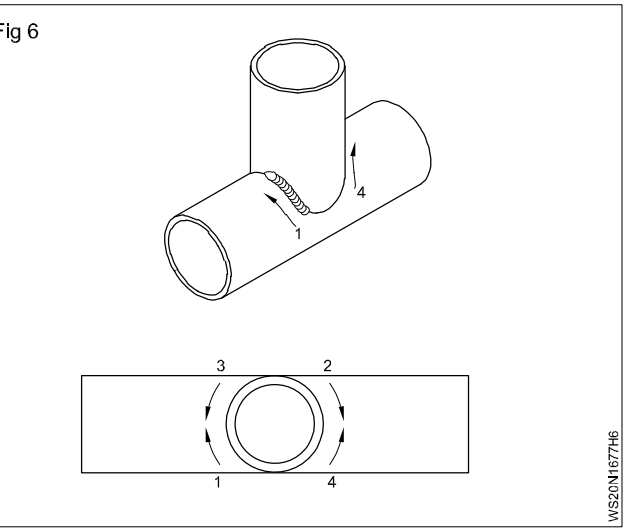
- Ensure keyhole for each tack weld.(Fig 5)
- After tack weld check the alignment of the pipe.
- Use 3.15mm dia electrode, and 110 amp current for root weld.

Fig 5



- On rotation methods root weld the joint on flat.
- Ensure the root weld on key hole technique.
- Remove the residence (slag) on the root run.(Fig 6)
- Use 3.15 mm electrode for second & third root run.
- Check the joint after cleaning.

Fig 6



Skill sequence

Elbow & T joint MS pipe ∅ 50 X 3mm wall thickness in flat position

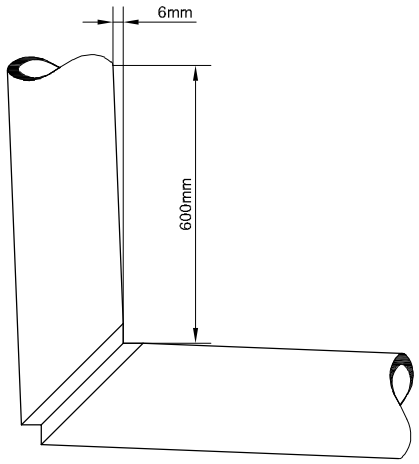
Objectives: This shall help you to

• prepare the elbow & T joint of MS pipe by using pipe development

To face the problem for Elbow welding is angle of Elbow will be less than 90° due to distortion. To eliminate the distortion weld the joint away from perpendicularity.

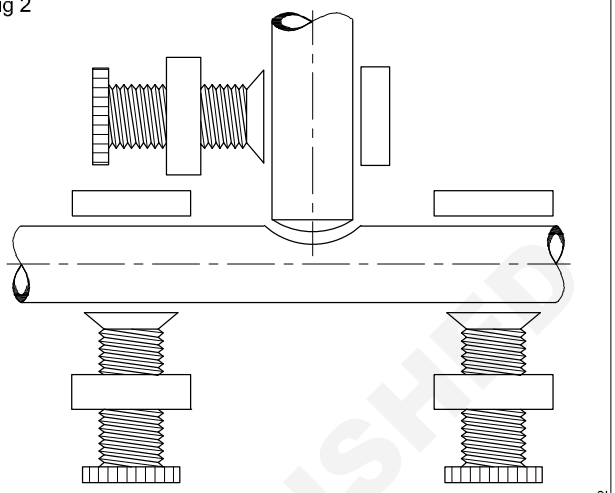
The problem faced for pipe welding is distortion arised. After welding of pipe due to mis alignment. To control the distortion use. Fixture for the pipe, and remove the joints. After reducing heat.

Fig 1



PIPE PLACED OUT OF LINE BEFORE WELDING

Fig 2

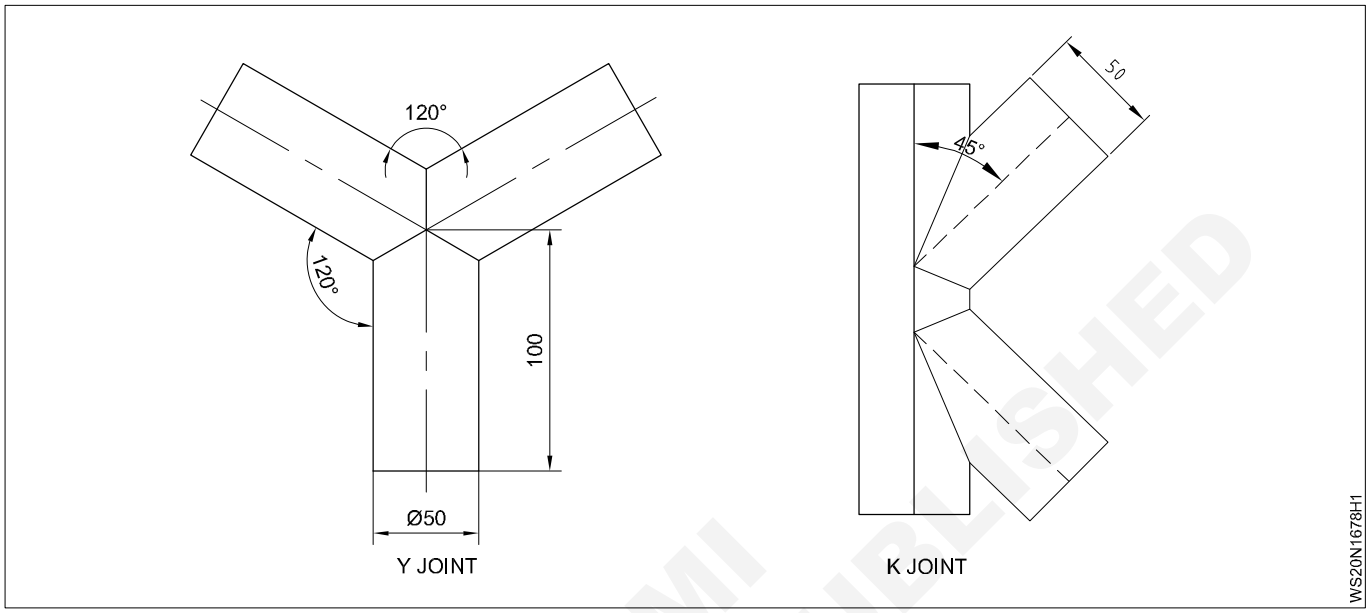


Pipe welding is a kind of other plate welding but it as curve of three dimension hence weld root penetration may not be reach. Tube inside of pipe. It's importance to fix quality of root penetration. Excess penetration and incomplete penetration are to defect for the pipe welding system.

It's important to prepare development pattern for pipe butt joint.

Pipe Y and K Connection on MS Pipe by SMAW joint

Objectives: At the end of this lesson you shall be able to
• state Y and K connection pipe joint on MS pipe by SMAW process.



Job Sequence

- Cut the pipes to the given size.
- File pipe ends to be at right angle
- Draw the expansion diagram for Y and K joint.
- Cut the two pipes belonging to the Y and K connectionswith a hacksaw frame (or) with an oxy acetylene flame.
- Remove the burrs and rust from the pipe ends.
- Align the two parts as shown in the picture (Fig 2)(attach rightside)
- Switch on the machine and select a 3.15mm dia. Electrode for tacking the root run and set an 100-110 amps current.
- Put the tacks at regular interval adjusting root gapbetween the pipes using spaces.
- Check and ensure that the pipes are in line in after tacking
- Remove slag from the root thoroughly
- Clean and inspect the joint.

Skill Sequence

Pipe Y and K Connection

Objectives: At the end of this lesson you shall be able to
• state Y and K connection pipe joint on MS pipe by SMAW process.

Cut the pipes to gives size by a Hacksaw / oxy Acetylene cutting.

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

Prepare pipe development drawing and template for Y and K joint and do the Hack saw cutting.Fig 1

Switch on the machine and adjust 110 amps current for 3.15 mm Ø medium coated. M.S electrode use DCEN polarity

Before tacking align the pipes and tack them.

To run the first pass uphill, utilize the whipping method as in vertical welding. Position use an electrode at a push angle of 5 to 15 degrees upward.

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.

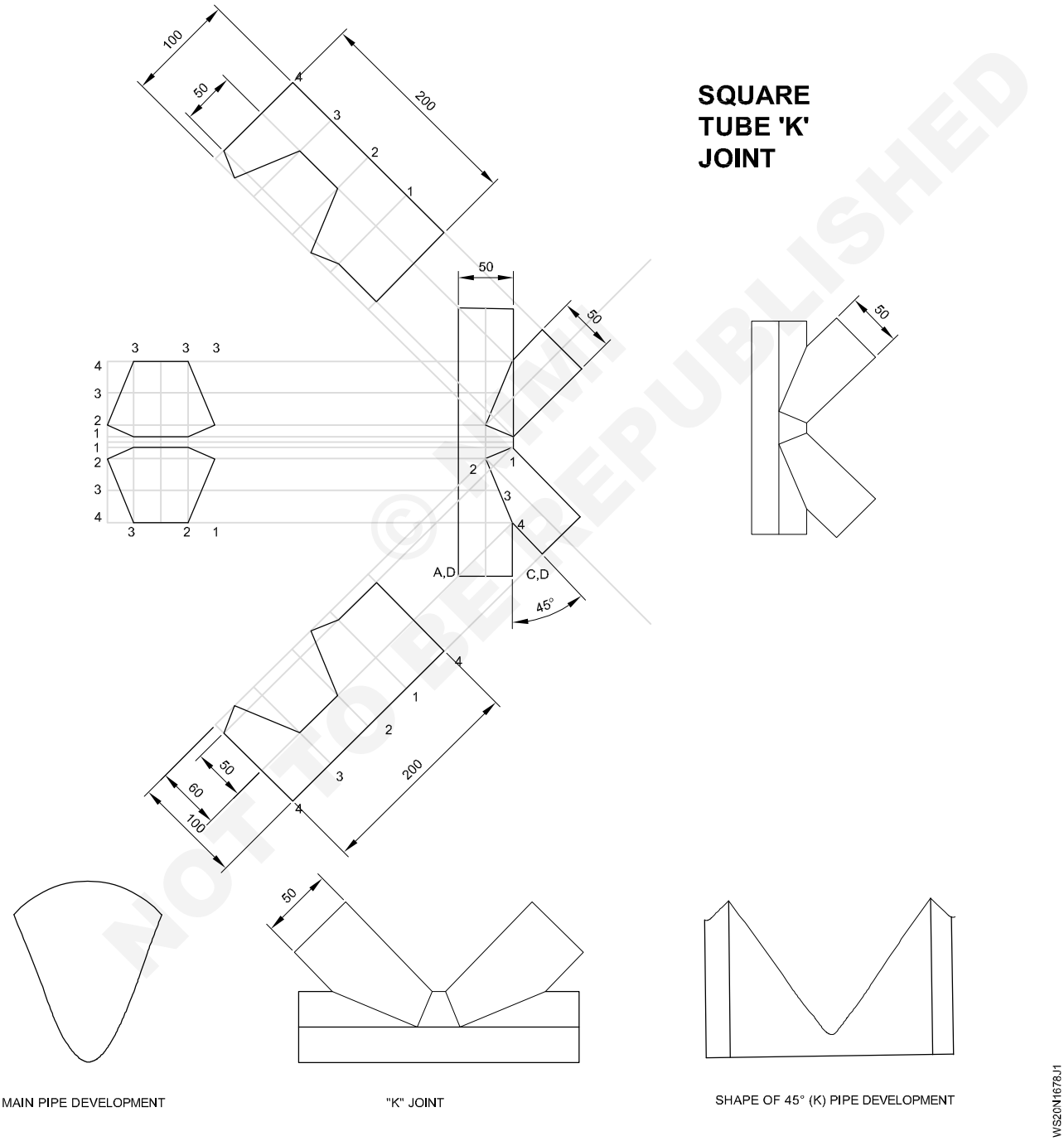
The second pass (hot pass) and third pass (cover pass) can be welded using 3.15mm electrode with either the triangle motion or the alternate weave, as in vertical plate welding. Take care to pause at the sides of the joint. Burn out any entrapped slag fill in any undesirable undercut.

The sequence of beads is shown in 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.

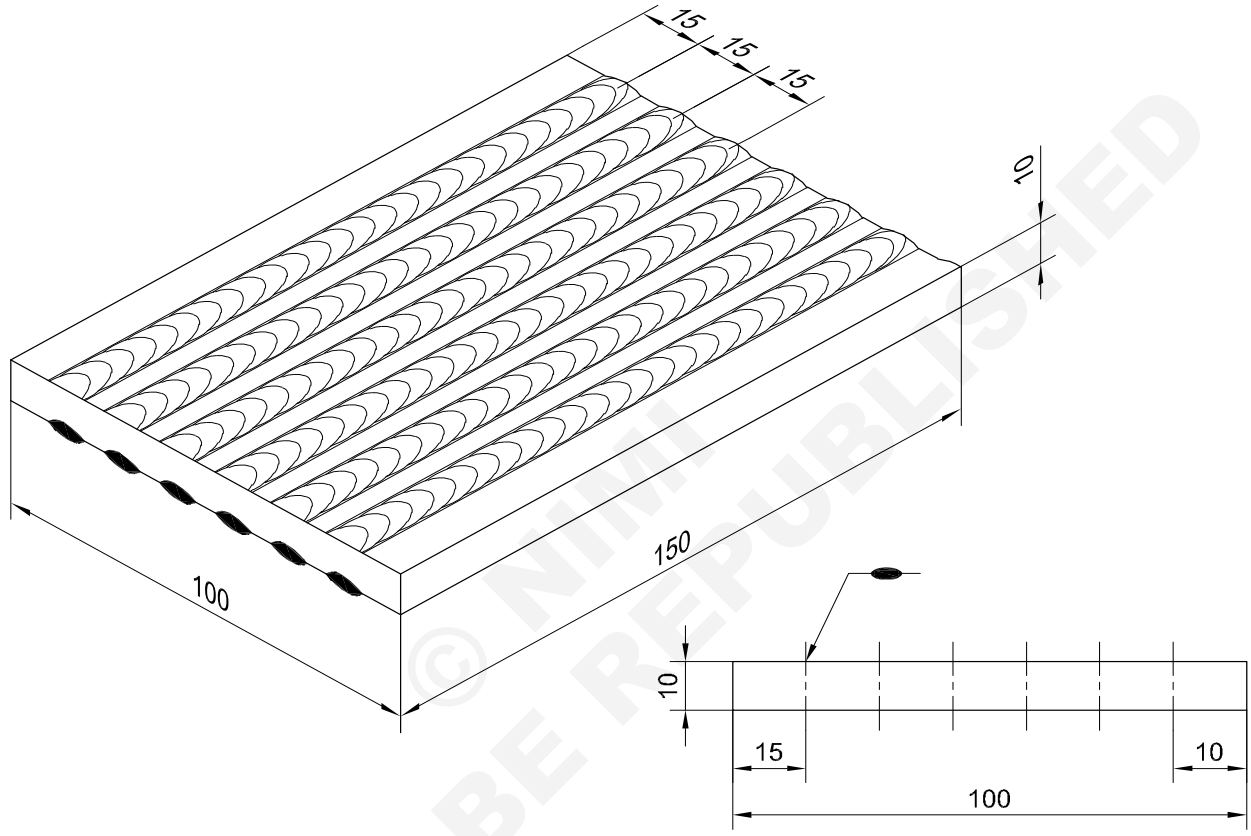
Fig 1



Practice on CO2 welding and Flux Cored Arc Welding

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

- **set up the FCA welding machine & CO2 machine and set welding parameters**
- **deposit uniform straight bead in flat position without weld defects**
- **inspect weld bead for finish and weld defects.**



1	100 ISF 10 - 150		Fe 310			1.6.79
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	PRACTICE ON C02 WELDING AND FLUX CORED ARC WELDING				TOLERANCE ±1	TIME :
					CODE NO . WS20N1679E1	

Job Sequence

- Prepare the job to size as per drawing.
- Clean the job surface with carbon 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 1.2mm diameter wire spool in position, lock it up and pull the wire through the guide tube, rollers, spiral (liner) and contact tip of the torch.
- Clean thoroughly or grind the surface of the metal table where attaching the earth clamp and use a tightly attached earth clamp so electricity can easily flow through the workpiece and back to the holder.

It is very important to get a good solid earth connection of welding machine.

- Set the welding voltage at 24-27V.
- Set the gas flow rate at 18 to 22 lpm (litres per minute)
- Set the wire feed rate at 4 to 10 metres/minute so as to get 170-230 amps by striking the arc on a scrap late.
- Wear protective clothing required.
- Make sure the contact tip looks good and it is tightened to the diffuser.
- Cut the flux cored wire at an angle to a point before starting to weld for better starts.

Maintain correct electrode stick out.

Safety: Flux cored arc welding may generate large volumes of welding fumes. Make proper ventilation and follow all welding safety precautions.

- Start the welding machine. Connect the torch to the positive (DC +ve) terminal (DCEN) of the machine.
- Deposit the bead on punched lines of the job from one end to other.
- Remove the slag and spatters with chipping hammer and clean the weld using carbon steel wire brush.
- Perform visual inspection of the welds for finish and defects.

Skill Sequence

Practice on CO2 welding and Flux Cored Arc Welding

Objective: This shall help you to
- **preparation and setting the job**
- **setting and welding FCAW system**

Setting up of the FCAW system:

Flux cored arc welding (FCAW) is normally a semi automatic process and combined characteristics of SMAW, GMAW and SAW processes.

FCAW process uses the same types of power sources and wire feeders as the gas metal arc / CO2 process.

Welding procedure (Depositing the beads)

Now we are ready to begin practice with the flux cored arc welding process.

Any skill is more readily mastered if the technical and related information is understood so that it can be applied while practicing the skill.

It is very important to clean the joint by carbon steel wire brush to avoid any non metallic inclusions before welding.

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

Maintain proper manipulation of the welding arc to avoid flux entrapment.

The maximum weave width of a single pass welded by FCAW shall not be exceeded 19mm.

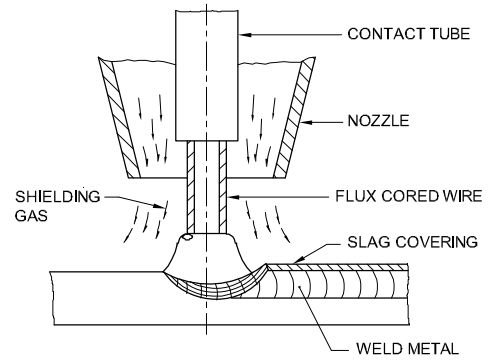
Ensure crater filling and avoid weld defects in the joint.

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

Repeat the above procedure for other runs.

Inspect the joint for required reinforcement (1.0 to 1.5mm), undercuts, bead profile, etc.

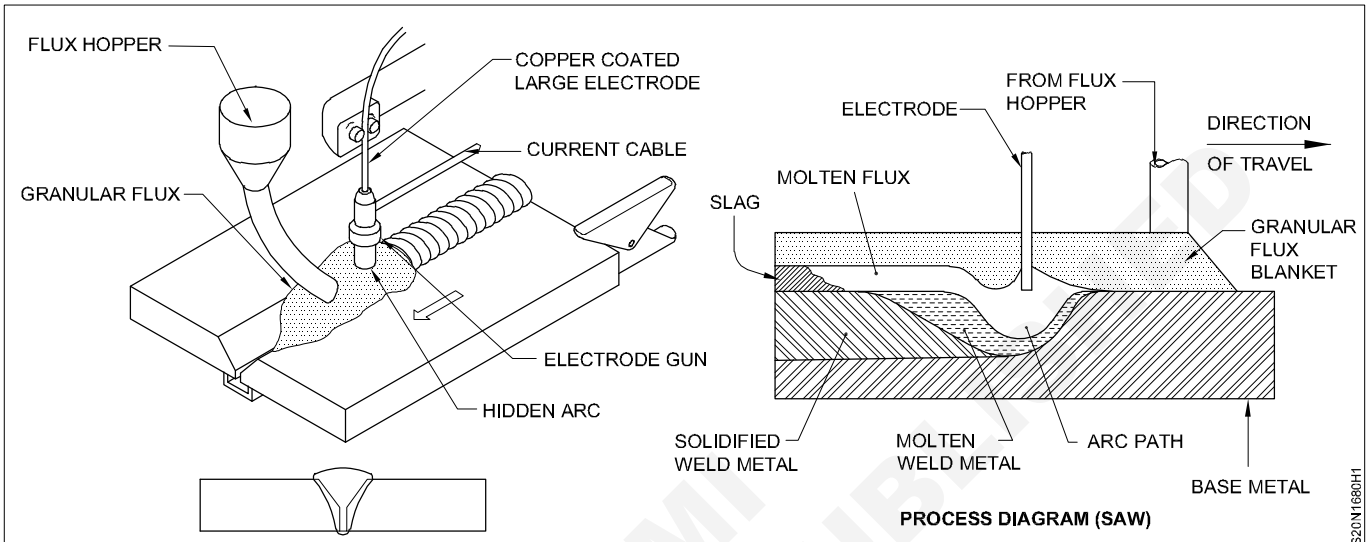
Fig 1



FLUX CORED ARC WELDING

Automatic Submerged Arc Welding Machine

Objectives: At the end of this lesson you shall be able to
- **set the automatic submerged arc welding machine.**
- **practice on welding by automatic submerged arc.**
- **deposite weld bead by using SAW.**



Job Sequence

- Prepare the job to size as per drawing.
- Clean the job surface with carbon steel wire brush.
- Set the work piece (job) on the work table for welding.
- To fill the required granular flux in the Hopper.
- Set the correct electrode wire and required current for metal thickness (Table 2)
- Turn on the welding machine and form the welding.
- Clean and inspect the job

Skill Sequence

Automatic Submerged Arc Welding Machine Setting

Objectives: At the end of this lesson you shall be able to
- **set the automatic submerged arc welding machine.**
- **practice on welding by automatic submerged arc.**
- **deposite weld bead by using SAW.**

The edge preparations for butt welds are shown in (fig 1)

For plate thickness higher than 25mm a double Vee or single U or double U edge preparation is done.

Tacking

Tack the pieces together and position as shown in (Fig 1). Put spacers under the plate so that you don't

weld the plate to your table.

WELDING PROCEDURE (for striking the arc)

It is important to start the weld at a specific point on the joint.

Method of starting arc by using steel wool or iron powder:

A rolled ball of steel wool 10 mm in dia. Is placed at the required spot on the joint and the electrode wire is lowered on to it till it is lightly compressed.

The flux is then applied and when the welding is commenced the steel wool or iron powder conducts the current from the wire to the workpiece, while at the same time it melts away rapidly as the arc is formed.

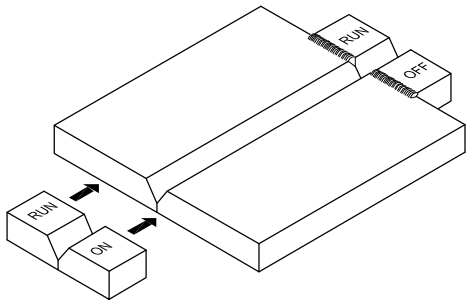
Clean the prepared workpiece and place it in position with provision for backing up.

Fill the hopper with flux and insert the electrode ends into the welding head. Adjust the voltage, the current and the welding speed as indicated in (Table 1 and 2.)

Start welding by striking an arc beneath the flux on the work.

The entire welding zone is buried under a blanket of flux and longitudinally it travels along the seam. Use ‘run on’ and ‘run off ’ pieces for starting and ending to avoid formation of crater and beginning and ending faults.

Fig 1



ATTACHING EXTENSION PIECES

WS20N1680J1

Electrode (For fillet welds by automatic welding Table - 1

Welder size (mm)	5	6	8	10	12	16	20
Plate thickness (mm)	6	8	10	12	16	20	25
Electrode Size (mm)	3.2	4	5	5	5	5	5
Current (amp) DC	520	620	720	800	870	920	970
Volts	30	32	34	36	38	39	40
Welding Speed (m/min.)	1.4	1	0.7	0.56	0.36	0.25	0.20
Electrode req'd (Kg/m)	0.10	0.18	0.28	0.40	0.70	1.1	1.6
Flux req'd (Kg/m)	0.05-0.09	0.75-0.12	0.14-0.18	0.18-0.27	0.33-0.45	0.53-0.75	0.83-1.2
Total time (hr/m of weld)	0.012	0.016	0.0024	0.03	0.047	0.67	0.09

Table 2

Submerged arc welding parameters for single electrode

(For Butt welds by Automatic welding)

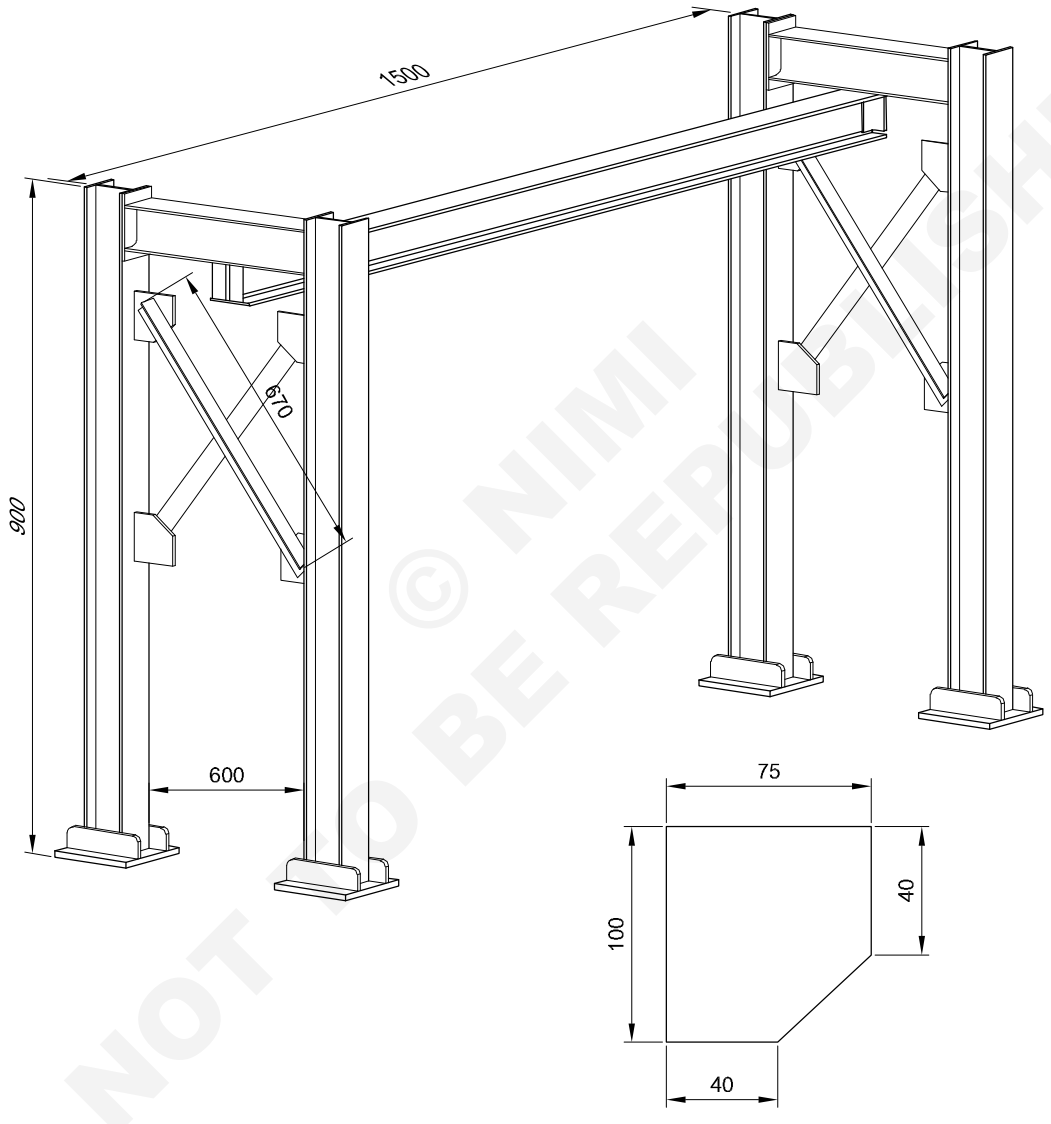
Plate thickness (mm)	6		10		12		16		20	
Pass	1	2	1	2	1	2	1	2	1	2
Electrode size (mm)	5		5		5		5		5	
Current (amp) DC+	600	750	650	800	750	850	750	850	800	900
Volts	31	33	33	35	35	36	35	36	36	37
Welding speed (m/min)	1.8	1.8	1.2	1.2	0.9	0.9	0.6	0.6	0.5	0.5
Electrode Consumed (Kg/m)	0.13		0.23		0.35		0.56		0.63	
Flux consumed (Kg/m)	0.14 - 0.16		0.19 - 0.25		0.3 - 0.4		0.5 - 0.65		0.55 - 0.72	
Total time (hr/m) of weld)	0.019		0.028		0.038		0.059		0.06	

Manufacturing of simple structures with L angles, I section and channel section using welding fixture by SMAW. Correction of distortion by cold & hot. Manufacturing of structures using M.S flat by SMAW

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

- **practice and manufacturing simple structure with L section and I section and channels**
- **correction of distortion**
- **M.S flat structures manufacturing by SMAW**

Fig 1



Job sequence

Task 1 :

- Cut the standard size of I section channel section and L angle to use required length shown in fig.
- Mark the size of gusset (8 mm thick plate)
- Weld the gusset plate in use I section shown n fig
- Fabricate the fixture for welding of structural steels.
- Locate the fixture in the horizontal plane.
- Erect the I section (4 nos) in the fixture using any adjusting the beam.
- Fix the channel in the mid part of the top of fixture.
- set the cross I beam on the channel.

- Weld caves use I section vertical beam and cross beam both sides.
- Weld the cross beam and channel beam
- Cut the L angle to the size given in the draining.
- Weld the L angle aross the gusset plate is shown in diagram.
- Fabricated structure of beam will be as per drawing
- Check the welded part from welded defects.

Correction of distortion by cold shot

- Heat the channel any where the bending arises till the red hotness hammering on the distorted part to get uniformity.
- Mild distorted part can be rectified by heating the section using blow lamp and cool naturally.
- By hammering the distorted part on cold condition to get normal condition of the part.Manufac

Fig 2

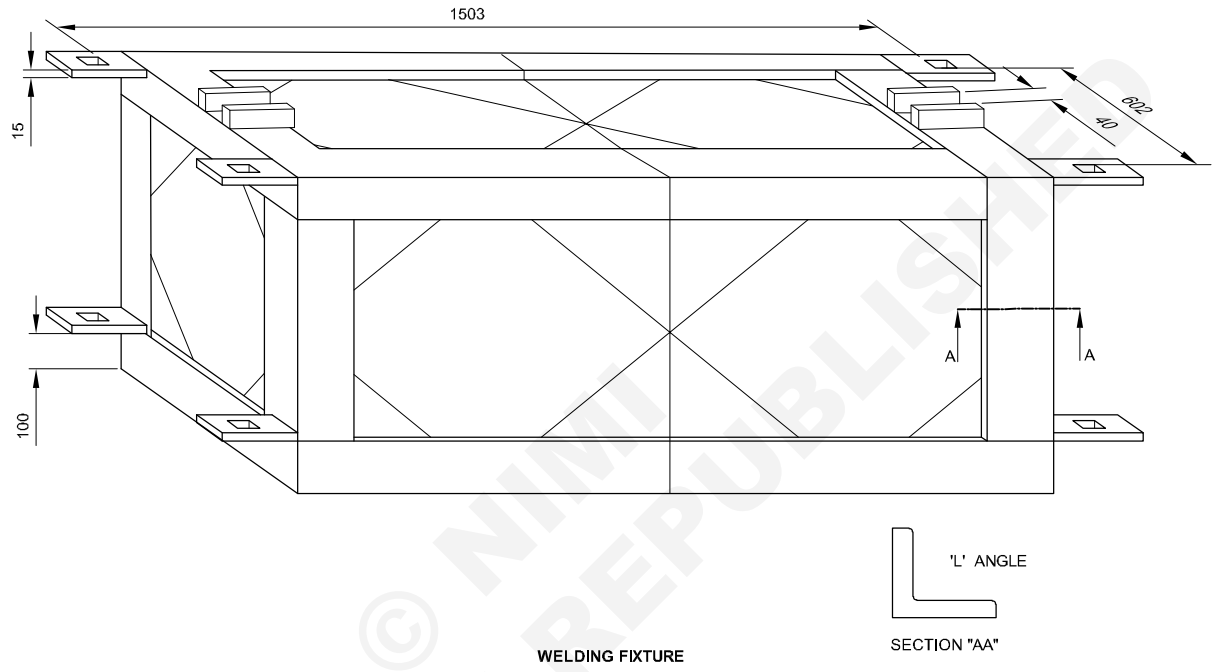
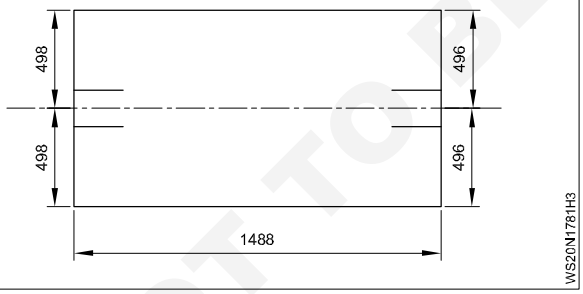


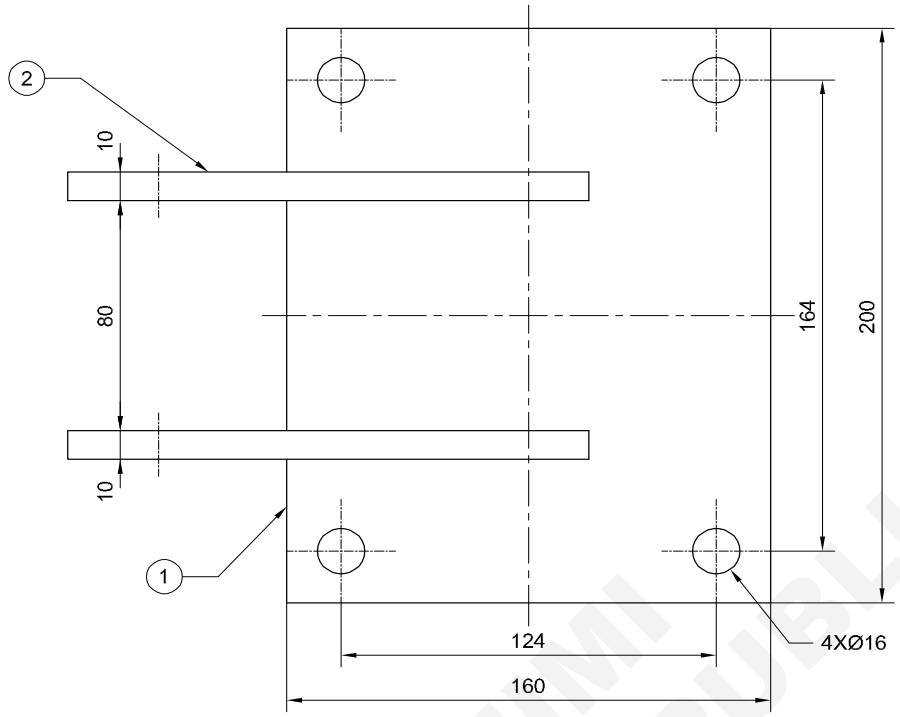
Fig 3

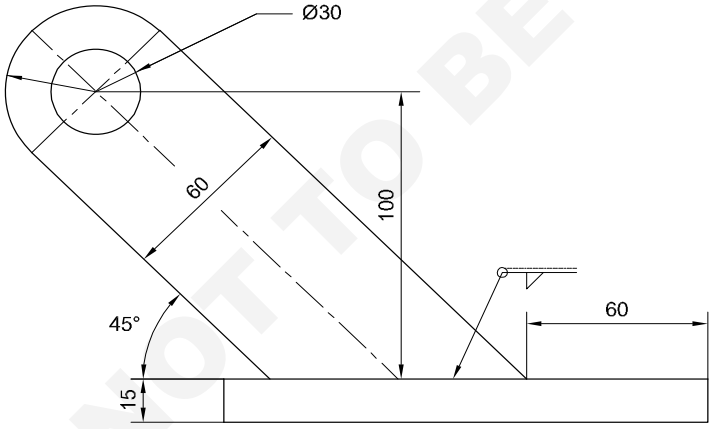


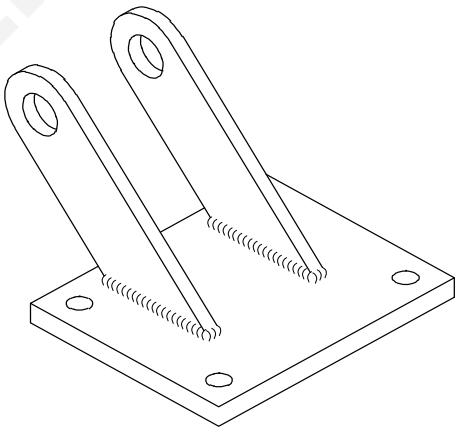
Manufacturing of structure using M.S flat by SMAW

Objectives: At the end od this lesson you shall be able to

- **prepare the plate given sizes**
- **Tack weld the prepared job**







-	-		-			1.7.81
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : NTS	**MANUFACTURING OF STRUCTURES USING MS FLAT BY SMAW**				TOLERANCE ±1	TIME :
					CODE NO : WS20N1781E1	

Job sequence

1 Cut the plate into 160x 200 mm size and file the edges

2 Mark the holes in the plate using scriber and centre punch as dimension given in the draining.

3 Make 4 holes 16 ϕ as per drawing using drilling process

4 Cut the 10 mm plate (2 nbs) by gas cutting as per drawing

5 Grind/ file the edges

6 Set the angle plate as per drawing and tank weld the angle plate with base plate using 3.15 mm electrode.

7 Deslay the tack weld and check the perpendicularity of angle plate with bar plate

8 Deposit root run on both sides of angle plate

9 Deslay the welded part and clean the components

10 Oil the part and display for evaluation.

Fig 1

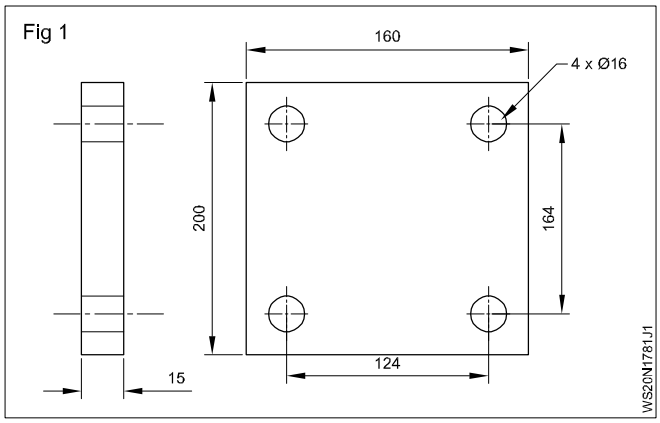
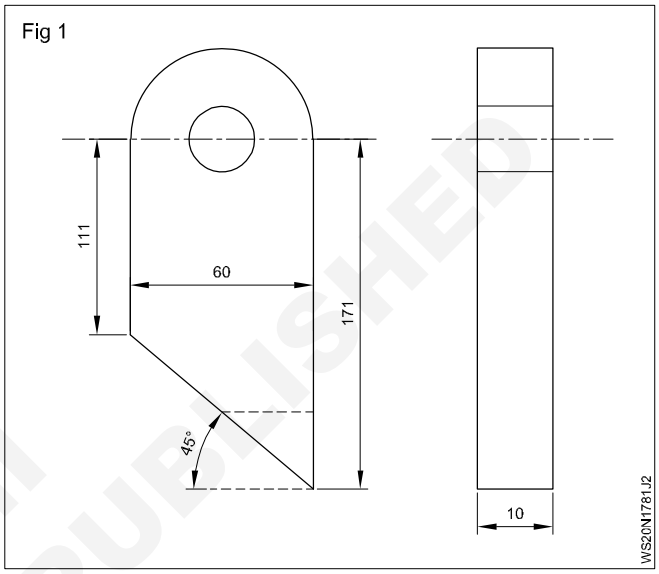


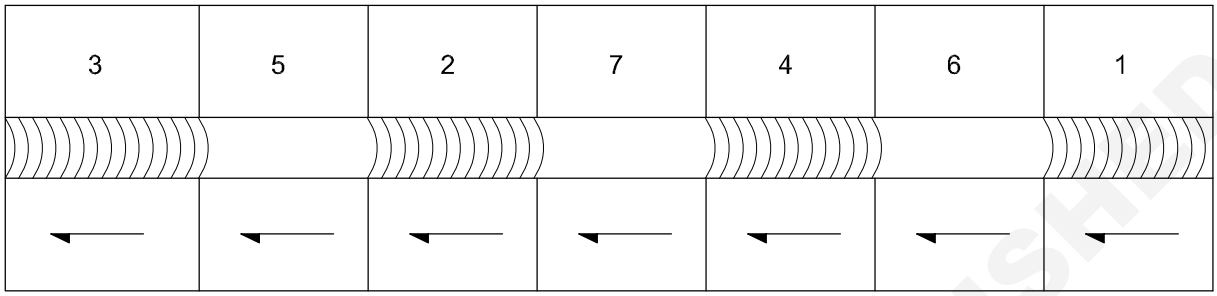
Fig 1



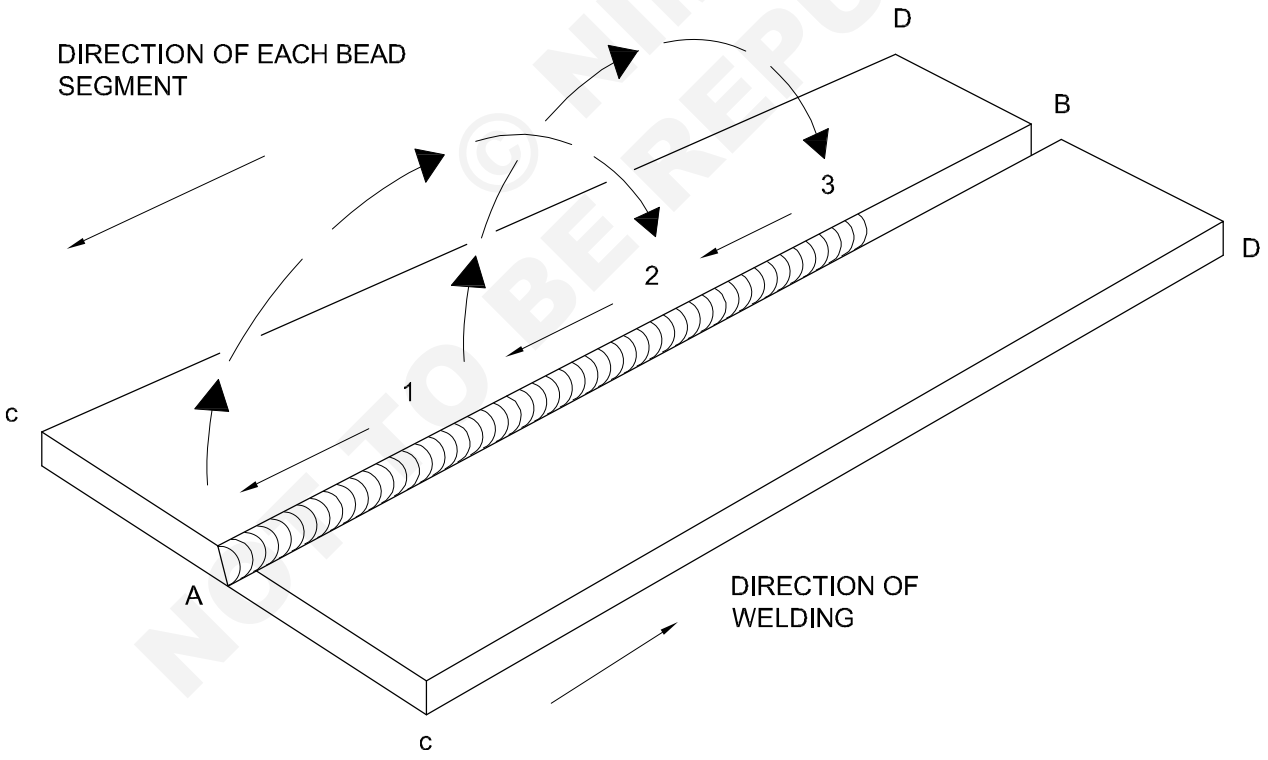
Adapting Skip welding & back step welding method for controlling distortion

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

- **practice skip welding and Back step welding**
- **method of controlling distortion**



SKIP WELDING TECHNIQUE



BACK STEP WELDING METHOD

WS20N1782H1

Job sequence

- Distortion in a weld result from the expansion and contraction of a weld metal.
- To control distortion. We are using skip welding method and back step method.

Skip welding method:

- Laying of short weld length at equally space along the seam of weld.
- The direction of deposit for each electrode is same by doing this method. The expansion & contraction are control by this method.
- If reduce locked up stresses and warping due to more uniform distribution of heat.

Back step welding method:

- The general progression of welding may be from left to right but deposition is from right to left. The direction of welding as shown in fig.
- The welded plates are expand to a lesser degree with each bead because of the locking effect of each weld. Hence the distortion is control.

Skill sequence

Adapting Skip welding & back step welding for controlling distortion

Objectives: At the end of this lesson you shall be able to
- **practice skip welding and Back step welding**
- **method of controlling distortion**

Skip welding: Fig 1

Intermittent beads of the weld balance the heat expansion and contractions. This quality control the distortion of welded plates. The following figure. Indicate the skip welding and uses in the gusset plates welding.

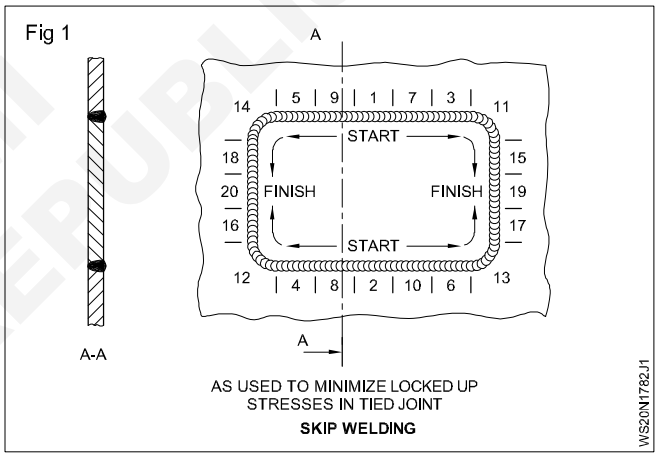
Back step welding:

Alternate beads of welding balance the heat expansion and contraction in the back step welding.

This types of welding is not normally used, in the long welding process.

Hence it's use for this sheet & for simple components.

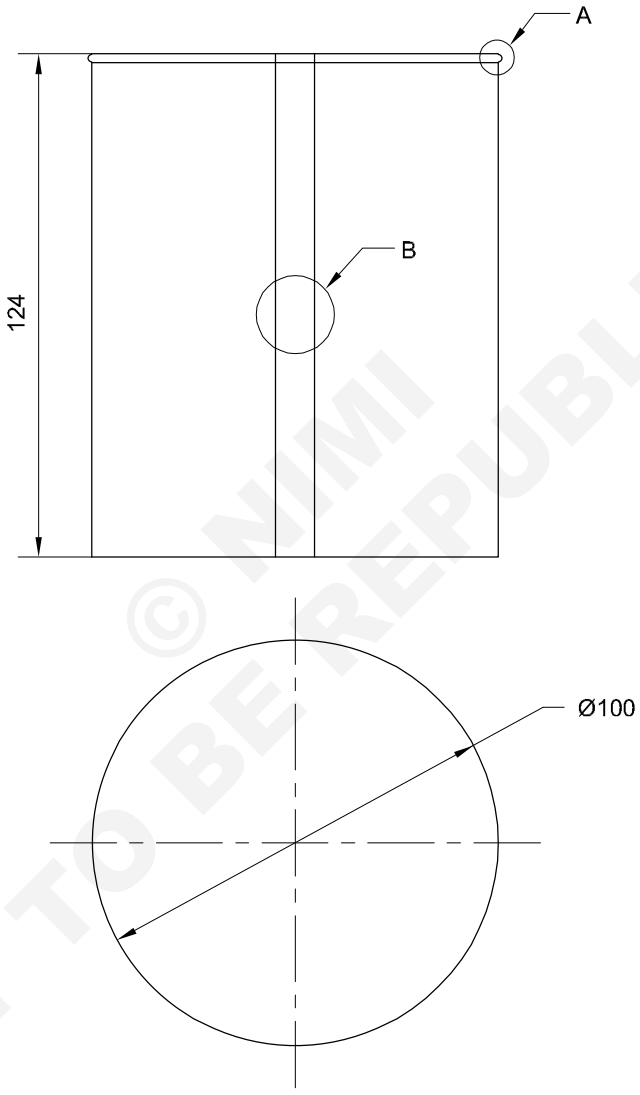
Fig 1



Fabrication of pipe/cone on M.S Sheet by SMAW

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

- **cut M.S sheet at given sizes**
- **making cylindrical pattern using round mandrel stack**
- **deposition in straight line bead on SMAW process**
- **cleaning and finding destects**

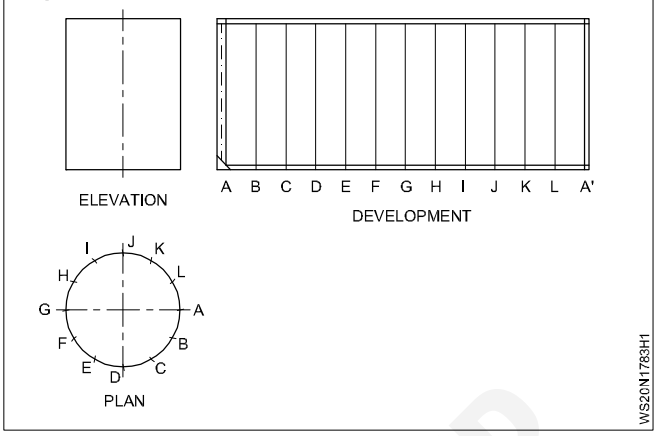


1	ISSH 350 x 125 x 0.6		G.I SHEET			1.7.83
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:2					DEVIATIONS ±1	TIME :
					CODE NO. WS20N1783E1	

Job sequence

- Develop and layout the pattern for the cylinder (Fig 1) with all allowances for joining and hemming on plain paper by parallel line method.
- Check the pattern for its correctness.
- Ensure the correct size of the material.
- Cut the pattern and paste it on the given sheet metal with gum.
- Cut the pattern with notches using 12" straight snips.
- Deburr the edges using a smooth flat file 150mm long.
- Fold the edges of the sheet metal pattern using a hatchet stake and a mallet in the form of hooks for making the lock grooved joint. (Ref Skill Sequence)
- Set the cylindrical job in welding table
- Set the steel cylindrical flat position on the welding table.
- S with on the SMAW welding machine and adjust the current setting according to the thickness of the metal.
- Weld with uniform speed and using short ARC length M.S electrode of dia 2.5 mm.
- Clean the job and inspect the defects.

Fig 1



- Form the sheet metal pattern to cylindrical shape using a round mandrel stake and a mallet. (Ref. Skill Sequence)
- Hook the folded edges and make the lock grooved joint using a hand groover. (Ref. Skill Sequence)
- Make single hemming on one end of the cylinder using a hatchet stake and Tinman's anvil. (Ref. Skill Sequence)
- Drees the cylinder to regular round shape using a round mandrel stake and a mallet.
- Check the roundness of the inside diameter of the cylinder using a gauge.

Skill sequence

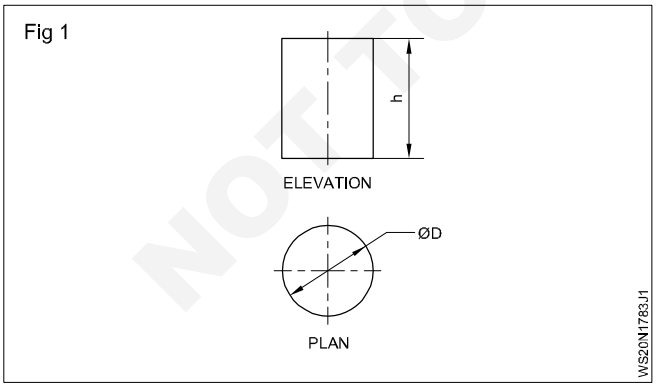
Parallel line development

Objectives: This shall help you to

- **develop and layout a pattern for a cylinder by parallel line development method.**

Draw the front elevation and the plan of the cylinder on a paper.(Fig 1)

Fig 1



Divide the periphery of the circle into 12 equal parts and check each division.(Fig 2)

Extend the lines to a length slightly more than the circumference of the circle (pd) 4"12 D plus the allowances for the locked grooved joint.(Fig 3)

Draw a line 00' perpendicular to the parallel line through the left end. (Fig 4)

Fig 2

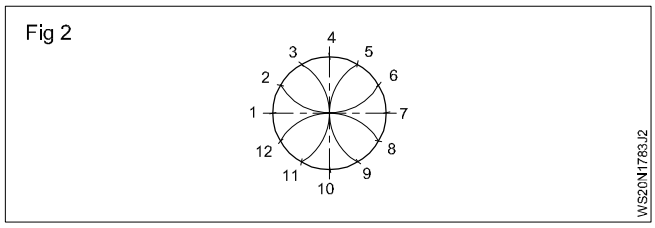


Fig 3

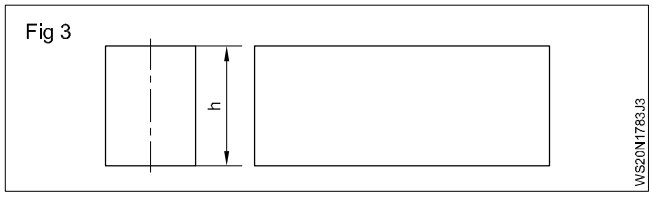
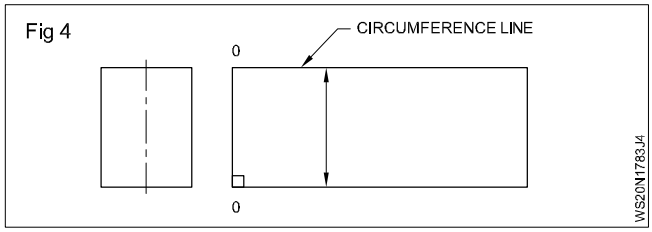
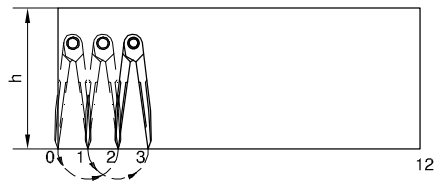


Fig 4



Transfer equal distances 0,1,2,3,4 upto 12 of the plan on the circumferential line without disturbing the equal lengths with compass.(Fig 5)

Fig 5



Draw a perpendicular at the end of the twelth point of layout to the base line. (Fig 6)

Draw parallel lines to line 00' at points 1,2,3,4 upto 12 (Fig 6)

Mark the lines at 4mm distance on the top and bottom of the pattern for hemming at the top edge and joining at the bottom edge. (Fig 7)

Fig 6

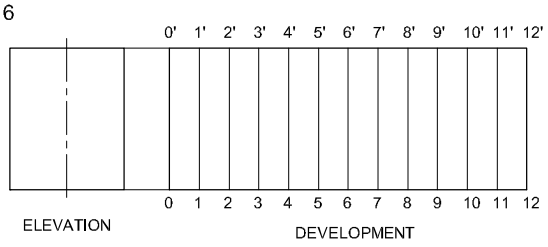
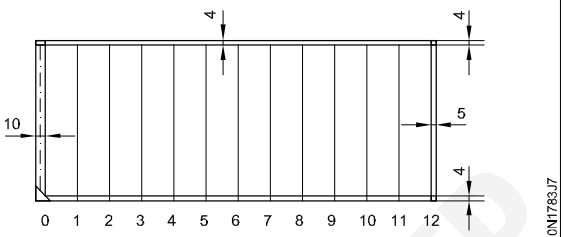


Fig 7



Draw the lines parallel to 00' and 12 12' at a distance of 4 mm and 8 mm on both sides respectively for seaming. (Fig 7) Now the pattern is completed.

Forming hand process

Objectives: This shall help you to

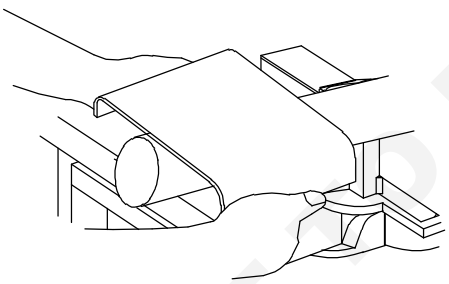
- **form a plain sheet to cylindrical shape by hand process.**

Ensure for the correct size and shape of the pattern. (Work piece)

Fix the mandrel stake on the bench plate.

Set and bend the work piece ends parallel to the axial line of the mandrel (Fig 1)

Fig 1



Gradually rotate and form the entire work piece to cylindrical shape by hand. (Fig 2)

Check the formed cylinder for the roundness of the external diameter using an external gauge. See Fig 2 of skill sequence of checking the roundness.

Set the work piece parallel to the axial line of the stake. If not the edges will not match with each other as shown in Fig 3.

Fig 2

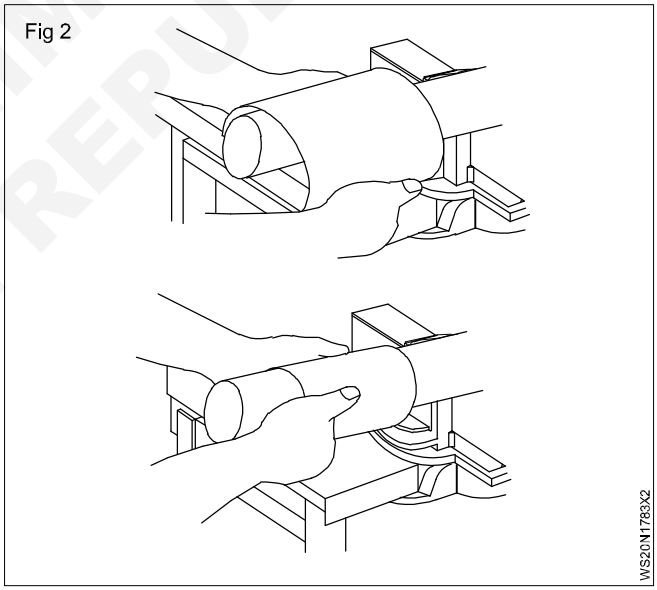
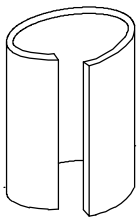
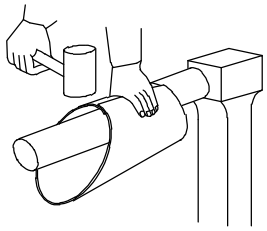


Fig 3



Close down the hooks by light blows using mallet this is the grooved seam.Fig 4

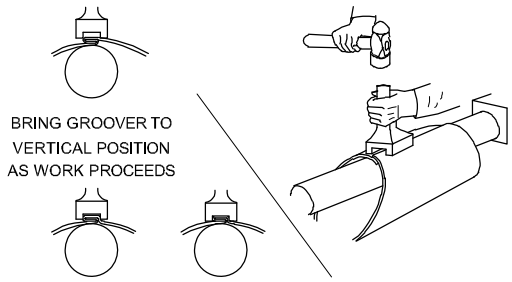
Fig 4



WS20N1783X4

Lock the grooved seam with a hand groover and a hammer as shown in (Fig 5)

Fig 5



WS20N1783X5

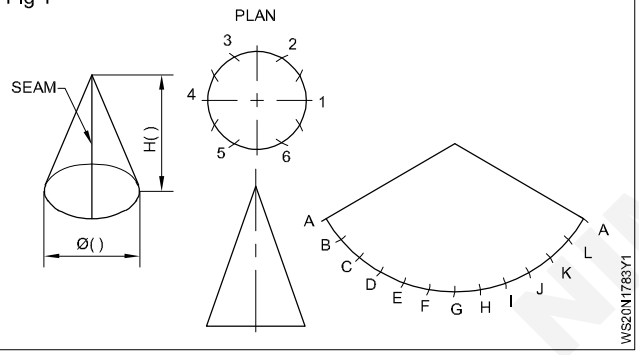
Dress the formed cylinder to a regular round shape using a round mandrel stake and a wooden mallet.

Development for a circular cone

Objectives: This shall help you to

- **develop a circular cone by the radial line development** (Fig 1)

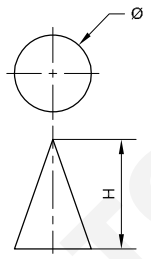
Fig 1



WS20N1783Y1

Circular cone: Draw the front elevation and the plan. (Fig 2)

Fig 2



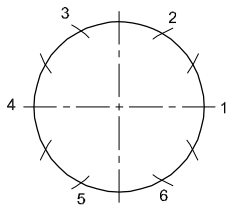
WS20N1783Y2

While drawing the plan, the neutral plane (outer diameter plate thickness) of the base circle is taken as the diameter.

The neutral plane size is negligible, if the plate thickness is less than 0.5mm

Divide accurately the circumference of the plan into 12 equal parts. (Fig 3)

Fig 3



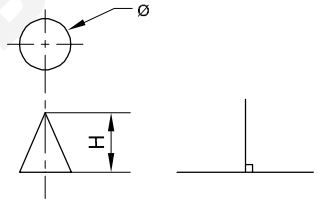
WS20N1783Y3

With the radius of the circle, first divide the circumference into 6 equal parts.

Then divide each part into two.

Draw a perpendicular line on the material. (Fig 4)

Fig 4



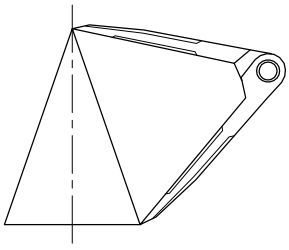
WS20N1783Y4

Draw the base line at about 5 mm from the end of the material.

Draw a perpendicular line to the Centre of the material blank space.

Transfer the length of the edge line (slant height) to the compass. (Fig 5)

Fig 5



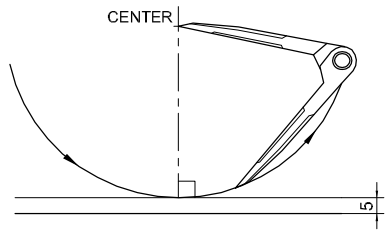
WS20N1783Y5

Transfer it accurately.

Draw an arc with the Centre at a point on the perpendicular line (Fig 6) and the slant height as the radius.

Check the opening of the compass with each equally divided points, to minimize errors.

Fig 6



Open the compass points to one of the 12 equally divided parts of the circumferential length.

Open the compass by checking each equally divided point to minimize errors.

Scribe 12 opening points of the compass on the arc.

Scribe six points on both the right and left sides of the perpendicular respectively. (Fig 7)

Use the compass points alternately while scribing points, without removing the compass from the arc at a time.

Connect the right and left ends of the arc to the Centre. (Fig 8)

Place the development template on the iron sheet and the mark the same and cut the mark line using angle grinder.

Fig 7

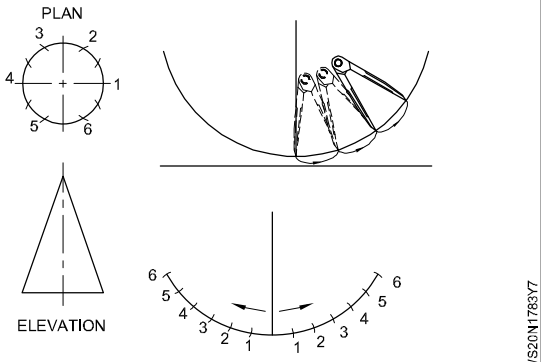
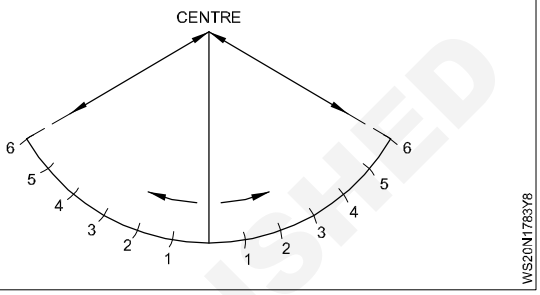


Fig 8



Edges of the iron sheet joint together and weld joint using arc welding dent on the sheet fit end by wonder hammer.

Weld test specimen - preparation as per standard Inspection & Testing

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

- **test the specimen using welding testing gauge.**
- **finding the defects of welding**
- **test the specimen using NDT methods visual & magnetic particle testing.**

Job sequence

1 Clean the test specimen free from weld slag,oil etc using wire brush and other cleaning material.

2 Test the weld bead using fillet gauges

3 Measure flatness, convexity,concavity ect using gauge

4 Check electrode for size,type etc during welding

5 Watch root pass for susceptibity to cracking

NDT Test- magnetic particle testing

1 Clean the specimen

2 Fix the magnetic particle test kit on the specimen

3 Spray iron powder on the specimen

4 When switch on magnetic field passes through the specimen.

5 Usually magnetic field travel straight line through the specimen

6 If any crack or defects found in the specimen the field travel bend on the defected region

7 This results found on the surface of specimen by heaped iron particle on the defect region

8 After cleaning again testing the area if needs reweld on the particular region.

6 Check for craters that need to be filled

7 Check weld against code and standard after welding

8 Check size with gauges and prints after welding

9 Check for cracks against standards

10 Look for overlap and undercut

11 Determine of spatter in at acceptable levels.

Fig 1