ADHERENCE TO QUALITY SYSTEM WHILE FABRICATING PIPING COMPONENTS FOR POWER PLANTS

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INTRODUCTION

Power plant components cover a large number of items. In any thermal power plant, piping plays an important role as the means for transporting and distributing steam at high pressure and temperature as well as water and air. Certain chemicals and pulverised fuels are also transported through pipes.

A piping system normally consists of pipes, valves expansion bellows, reducers, tees, elbows, bends, stainless etc. this piping system is supported by hangers and is provided with insulation.

Quality System Requirements

For fabrication of power piping, the quality of the piping systems mainly depends on the following :

✱ Engineering
✱ Materials
✱ Workmanship
✱ In-Process Control
✱ Inspection'
✱ Quality Records

Engineering

Various stages involved in piping projects are :

✱ Schematic Engineering
✱ Layout Engineering
✱ Material Procurement
✱ Manufacturing and Inspection
✱ Despatch
✱ Erection
✱ Commissioning

Schematic Engineering is the first stage where the overall process requirement of the plant is conceived. In this stage all pipe sizes are calculated and finalised based on the design pressure, design temperature, stipulated velocity limits and allowable pressure drop.

Layout Engineering will be carried out after the schematic engineering, taking into account proper placement of boiler auxiliaries location. Then the required piping interconnection between the equipment is done at site. The path which is followed by a pipe line to interconnect its end points is termed as "Pipe Routing". While doing pipe routing load transfer of self weight of pipes to supporting structures is made by providing proper hangers and supports, Stress induced due to temperature variation are also taken care during layout engineering.

Materials

Power Plant piping encounters a wide range of parameters i.e. temp 40 - 540°C or 0 - 315 ata. Hence the material selected should be capable of withstanding these parameters.

The procurement of material shall be based on relevant codes/standards and also should meet the statutory regulations as applicable. Within India the applicable statutory authority is the Chief Inspectors of Boiler and the governing regulations is the "Indian Boiler Regulations 1950".

ASME, ASTM, API, DIN are the international codes which gives material requirements (Chemical, Mechanical, Creep Strength etc.)

Material (Pipes, Tubes, Plates, Barstocks) shall be procured from the approved vendors as per the "Appendix-G" (Well known steel makers recognised under regulation 4(C) of IBR-1950.

Materials (Fittings, Castings & Forgings) shall be procured from the approved vendors as per the "Appendix-K" (Well known foundries and forgers) recognised by Central Boiler Board.

The materials shall be inspected and certified by the competent authorities recognised by Central Boiler Board for the region within India and as per "Appendix-C" (List of Inspecting Authorities recognised as competent under Regulation 2g of IBR-1950 for other than Indian region.

Approved vendors shall meet the following quality requirements

- Incoming material verification for adherence to the specified quality requirements.
- Non-destructive examination facilities.
- Chemical and Mechanical test labs.
- In-Process control.
- Final inspection by the vendor/ purchaser
- Customer/statutory Inspection Clearance & Process.

Periodical quality audits shall be carried out to ensure the above said points and properly documented

Product identification & Traceability

Pipes, tubes, plates, castings, forgings & bar stocks shall bear the following details to put in use at power plants as per codes/ standards/statutory Regulation IBR-1950.

Size ; Specification; Heat number (Melt Number); Colour code & Inspecting Authorities Inspection Seal Mark.

Raw material test certificates shall be made available for correlation & the above details shall be duly certified by the Inspecting Authorities.

Workmanship

Stage covered in fabrication will be

- Raw material receipts.
- Cut-to-sizes as per cutting plan.
- Fit-up according to manufacturer drawing.
- Welding as per code/statutory requirements.
- Heat treatment (if required) as per code/statutory requirements
- Final Inspection.
- Surface preparation & protection
- Handling & Packing.
- Despatch clearance to site by customers.

To carryout the above in an orderly methods, Quality Control Procedures and Quality Plans shall be prepared in line with code/statutory requirements and shall be approved by customer indicating the stage & extent of their inspection such as verification, witness & hold point wherever applicable.

Welding

Welding shall be carried out only by the qualified welders and as per approved Welding Procedure Specification (WPS) and shall be supported by Procedure qualification Record (PQR).

WPS shall be in line with ASME Section IX or equivalent codes/ standards. Care shall be taken that WPS shall meet the IBR-1950 requirements.

For demonstrating the quality of the Weldments, procedure qualification tests shall be carried out based on Cl.5.3.2.

Non-destructive and destructive tests shall be carried out as per ASME Section IX or equivalent codes.

For carrying out welding in the Class-1 Piping and Class-II Piping (Ref : As per IBR CL360 (d)), a welder shall qualify in a test as per IBR-1950 Chapter XIII.

Welders qualified as per IBR-1950 will be issued a certificate indicating their qualification for carrying out welding (Carbon steel or Alloy steel, Plate or Pipe, Position of welding & process etc.) and the validity period. Generally the validity period is two years.

Welders qualified as per ASME Section IX or equivalent codes shall be issued with an identify card to monitor the performance of welder at regular interval.

To have better control over the welder's performance Welder Log Book shall be maintained and periodically reviewed.

NDE Personnel Qualification

To carry out NDE like LPI, MPI, RT & UT the persons shall be qualified as Level 1 (for carrying out) Level II (for supervising) & Level III (for procedural formation) by ASNT (American Society for Non-Destructive Testing) or by ISNT (Indian Society for Non-Destructive Testing).

Prior to carry out NDE, relevant procedures shall be prepared as per the guidelines indicated in ASTM.

Testing parameters, findings and results shall be documented and certified by the NDE incharge.

In-Process Control

Visual examination shall be carried out to avoid material mixup and ensure perfect fitup, defect free material, orientation of branches & stubs etc.

During fit up (or trial assembly) the dimensions as per drawing shall be ensured.

Inter-stage NDE shall be carried out and shall be recorded wherever required.

Heat treatment shall be carried out and HT charts shall be made wherever required.

Heat treatment shall be carried out in accordance with code (ANSI B311)/statutory (IBR-1950) requirements and the following parameters shall be taken care.

Type of heat treatment (e.g. Stress Relieving).

Method of carrying out (e.g. Furnace/Localised heating Coil Method)

Calibrated recorder.

Rate of heating (e.g. 110°C/Hours from 400°C)

Soaking temperature (e.g. 610°± 10°)

Soacking time (e.g. 2.5 mts/mm thick/a minimum 30 mts.)

Rate of cooling e.g. 110°C/Hours up to 400°C)

Final Inspection

Visual examination shall be carried out to check the surface free from defect, spatters etc., and to ensure proper identification etc.

Dimensional check shall be carried out as per the relevant drawing and shall be recorded in the "History Card".

Hydraulic tests wherever applicable shall be carried out in the presence of External Inspector and the results shall be documented.

IBR Inspection

IBR Inspection will be applicable for class I Pipe lines as per Rg 360(d)

Class I - Pipelines for service conditions in which any one of the following limits is exceeded :

Design Temperature : 218°C (425°C)
Design Pressure : 17.6Kg/cm^2(250 lbs/sq in)
Feed Water : 24.6Kg/Cm^2(350 lbs/sq in)

Class II - Pipelines for service conditions in which none of the foregoing is exceeded.

Quality Records

The following statutory records shall be prepared and submitted by the fabricators (manufacturer) to Inspecting Authority (Chief Inspector of Boilers) for approval as per IBR-1950.

"Certificate of steam pipes"

"Certificate of Manufacture and Test" in Form III A.

"Certificate for Tubes"

"Certificate of Manufacture and Test" in Form III B.

"Certificate for Fittings"

Certificate of Manufacture and Test" in Form III C.

For preparing the above the following supporting documents are to be compiled.

IBR approved manufacturing drawings.

Material Test Certificates.

Raw Material Inspection Reports (RIR)

History Cards.

NDE Reports, Heat Treatment Records (Wherever applicable).

Final Inspection Report (FIR)

Copy of challan in support of inspection fee paid.

Approved certificates as mentioned in 8.1.0 are necessary for the fabricated components to be allowed for use at the erection site by the respective State Competent Authority (C.I.B) as per IBR-1950.

In the case of piping not coming under IBR purview, relevant details of fabrication shall be compiled in the form of data book and shall be submitted to the customer.

Surface Preparation & Protection

After the completion of final inspection the following operation shall be carried out :

Surface (inside & outside) shall be thoroughly cleaned by wire brushing/power tool cleaning/ chemical treatment/Blust cleaning or by any other specified methods.

The surface coatings shall be carried out as specified/recommended by the paint manufacturer.

Primer coat shall be applied within six hours of completion of mechanical cleaning/blast cleaning.

Further coatings shall be applied, allowing specified drying time between coats.

Colour shades of paints shall be in line with BIS : 5/BS 381C.

The quality of the paints shall be as per BIS:2074 (Red Oxide Zing Chrome Paints for Primer), BIS:2932 (Synthetic Enamel Paints for top coats) BIS:102(Red Lead Primer for special purposes) or as specified by the customer.

The coating thickness (in Dry Film Thickness DFT) shall be ensured by using non-magnetic coating thickness gauge.

The quality of paint coated (to ensure the absence of pin-holes) surfaces shall be ensured by using "Holiday-Detector"

Proper punching and stencilling of the job details shall be ensured and cleanly indicated on the fabricated job prior to shipment.

Handling and Packing

After completion of surface protection (Painting) care shall be made for proper handling to prevent damages during transit.

All openings shall be properly closed by using plastic/metallic end caps and properly secured.

Prior to closing of the opening sufficient amount of 'Silicagel' or VCI pellets (Vapor Corrosion Inhibitor) shall be kept inside to prevent surface contimation.

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You are requested to make good use of it and offer practical proposals for improvement.

We also request you to kindly donate books of Welding Science and Technology to our Library for the benefit of one and all and for the promotion of welding technology in general.

Trust, you will heed to our request and give wholehearted supports to our venture.

Thanking you

Yours faithfully

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MIG/MAG WELDING

MIG Welding, like all welding processes has developed its own particular terms (jargon). A knowledge of the meanings of the following terms will help you achieve a further understanding of the process.

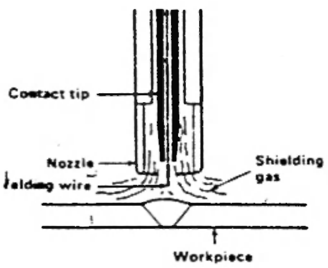
Characteristics of Welding power sources

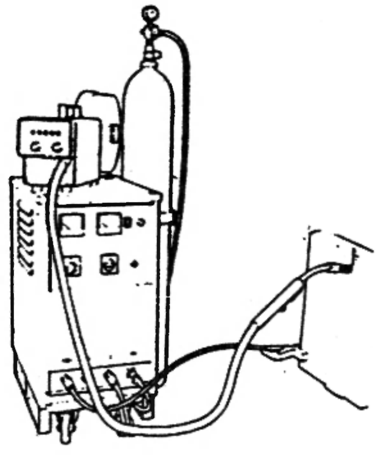
Constant current

Constant current power sources are mainly used for manual arc welding. As the name implies the power source maintains the selected current setting despite variations in arc voltage caused by the operator's hand movements. This constant current characteristic is most desirable to maintain a constant burn off rate of the electrode and hence produce weld beads of regular shape.(Burn off rate is directly proportional to current).

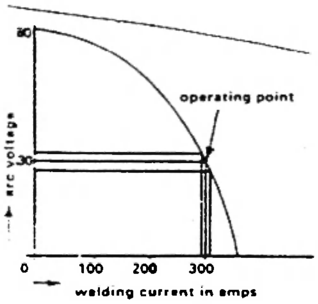
To summarise - The inevitable movements of the welder's hand. Which cause large arc voltage variations, have little effect on the current and therefore a constant burn off rate is obtained.

The typical drooping characteristic of a manual arc machine show that a change in arc volts up or down has very little effect on the output current.





Typical MIG installation

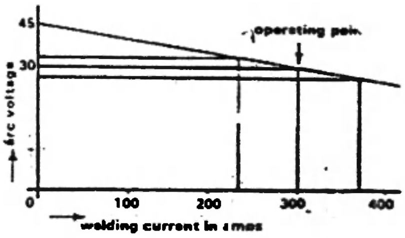


Volt - ampere curve of a typical constant current power source

Constant potential

Constant potential power sources are used mainly for MIG welding. They maintain a preselected arc voltage within close limits. This means for a very small change in arc voltage (arc length), there is a large adjustment in current. A charge in current brings about a change in burn off rate. To Summarise-a constant bead width will result despite variations in arc length, because the electrode wire is being fed into the weld pool at a constant rate and the arc voltage remains virtually constant, thus the arc is self adjusting.

The typical slope characteristic of a MIG power source shows that a change in arc volts up or down has a large effect on the output current.



Volt - ampere curve of a typical constant current power source

Transformer/Rectifier

All power sources used for MIG and MAG welding with solid mild steel wires have a direct current (DC) output. This is in contrast with most manual welding machines for use with stick electrodes, which are normally the straight transformer type supplying alternating current(AC). In a MIG power source, the transformer reduces mains voltage to a working level and the bridge rectifier converts the reduced AC voltage into DC voltage for the welding power. In MIG welding, the circuit is connected so the work is at negative potential to the electrode wire which is connected to the positive pole. This is known as direct current reverse polarity.

Voltage selection

Open circuit voltage (OCV) is the voltage across the power source. output terminals before an arc is struck. With the manual arc process. OCV ranges from 50 to 80 volts (AC), but with MIG, typical OCV's range from 15 to 50 volts (DC).

A suitable OCV is selected by a switch or switches on the power source. On most machines these switches, in effect, select a number of windings on the primary side of the transformer. The selection of a suitable OCV also determines the maximum current which the machine is capable of delivering within the duty cycle of that machine. The current is controlled by the wire feed speed when welding.

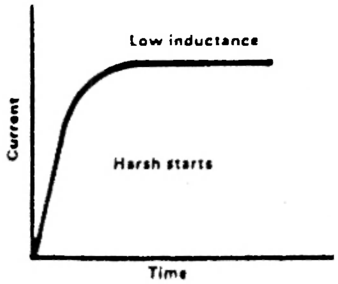
Inductance

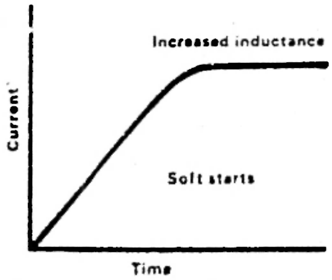
In any electrical circuit, a rise in current above the rated current of that circuit results in the wire over-heating and eventually melting at its thinnost point. To avoid damage, a fuse is placed in the circuit at a convenient position, Inspecting a blown fuse can indicate to a certain extent how big the overload has been. If the wire in the fuse has only just parted with a small globule and metal on one strand, it indicates a slow, gradual overload of the circuit. If, however, the wire has 'blown' violently and pieces of molten fuse wire are spread about the fuse holder, the cause of the overload was certainly a serious short circuit.

Consider MIG welding in action. Before the wire strikes the workpiece and completes the circuit, there is no flow of current and the voltage is at maximum value(OCV). When the wire strikes the workpiece, a 'dead short' is created. This short circuit causes the current to rise very rapidly and burn off the wire violently, showering the surrounding area with molten globules of metal(spatter).

This very rapid rise in short circuit current has to be slowed down, making the burn off smoother with only one large globule forming on the end of the wire, drastically reducing the amount of spatter (as in the fuse which is slowly overloaded).

To control the rate of rise of the short circuit current, an inductor (electric choke) is fitted in series with the welding power cable. This inductor slows down (chokes) the rate of rise of short circuit current and ensures smooth arc conditions.





It is now evident that inductance is a function of time and current, since it controls the time taken for the current to reach the pre-set value. Hence an increase in inductance results in less frequent short circuiting. Fewer short circuit implies that the arc is present for a longer period of time increased `arc on' time means increased heat input. Therefore, on thick plate, where more heat is required to ensure good fusion, more inductance would optimise welding conditions. Less inductance decreases 'arc on' time and consequently a cooler arc, which enables thin materials to be welded with ease.

Summary

Inductance has the following effects :

- Reduces spatter
- Allows control of heat input (when variable inductance fitted to unit).

- ✱ Has no effect when spray arc welding beacuse once there is no change in current, the inductance coil becomes inoperative. A certain amount of inductance with spray transfer will provide softer starts (the initial short circuit).

Burn back control

When the torch trigger is released, welding ceases. More specifically, the welding current contactor 'drops out' (opens), the wire feed motor stops and the gas supply solenoid valve shuts. If all this happened simultaneously, the electrode end would freeze and stick to the workpiece. This could be overcome by quickly pulling the torch away as welding ceases, but this is not desirable because gas coverage is lost over the solidifying weld.

Wire freezing is prevented by using a burn back control. This control delays the drop out of the welding current contactor and effectively maintains the arc for a fraction of a second after the wire feed motor has stopped. The wire stops feeding and `burns back' a fraction from the weld pool and prevents it from freezing to the workpiece.

Excessive burn back time causes the wire to stick to the contact tip, hence an adjustable timer is used to control burn back of the various wire sizes used at varying welding currents.

Wire feed unit

The wire feed unit consists of a hub for mounting the spool of consumable electrode wire and motor driven feed rolls to push the wire through to the torch and into the weld pool at a constant pre-set value. The unit also controls the supply of gas to the weld and the spot timing function (if fitted).

The wire feed unit can be either integral with the power source case, or as with most higher capacity machines, a separate unit with interconnecting cables.

Most wire feed systems consist of 2 feed rolls. One a driven roll with a groove machined into its circumference; the other a pressure roll that applies physical pressure to the wire. When the driven roller rotates, it effects wire feeding.

Welding torches (guns)

The welding torch with its cable, delivers the welding wire to the workpiece. Power is transmitted to the torch contact via the torch connection block and torch cable. Welding is commenced by depressing the torch trigger, which energises three separate functions :

- ✱ The mains contactor is 'pulled in' (closed) and welding current becomes available.
- ✱ The wire feed motor starts up and feeds wire at the pre-set, constant speed through the torch conduit. As the wire passes through the contact tip, welding current is tranferred to it.
- ✱ The gas solenoid valve opens and allows shielding gas to flow. Because of the heat generated in the weld pool and the heat generated through electrical resistance at the contact tip, torches have to be efficiently cooled.

Torches can be air cooled or water cooled, depending on the duty cycle, current and shielding gas used. There are three basic types of MIG wire feeding systems, each requiring different torches.

Push system

By far the most popular method, the wire feed unit pushes the electrode wire along the torch conduit, through the torch and contact tip and to the weld pool. Push systems are generally robust, lightweight and very functional (also the least expensive method). The system works very well with hard wires (steel stainless steel etc.) with cables up to 4.5 metres in length.

Pull-system

A very versatile system with the main advantage being manouvreability. The motor and feed system are built into the handle of the gun which allows welding up to 16.5 metres from the power source.

The drawbacks of this system are : High cost of consumable wire on small spools and high initial cost of equipment and weight of torch and wire, but, in many applications, these are outweighed by its versatility. (Though mainly used for aluminium work, mild steel and stainless steel wires can be used as well.)

Push/pull system

As the name implies, both push and pull motors are employed. One in the torch handle which pulls the wire through the torch and one in the control cabinet which pushes the wire into the conduit. This allows long distance feeding of hard and soft wires up to 9 metres from control cabinet and still offers the economy of 15 kg. spools of wire.

A versatile system, particularly suited to aluminium but readily used for hard wires as well.

Modes of metal transfer

The mode, or type of metal transfer depends upon the current, arc voltage, electrode diameter and the type of shielding gas used. In general, there are four modes of transfer.The figures in Table 1 are for argoshield 20 shielding gas. Using another Argon/CO_2 mixture or CO_2 would change the figures considerably.

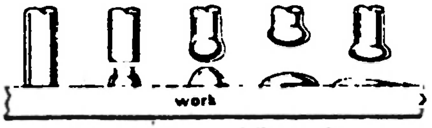
Table 1

Transfer type	Arc Volts	Current (Amps)	Applications
Dip transfer	13-23	60-210	Light gauge material, all positions
Spray transfer	24-40	200 and over	High deposition rates on heavier plate sections-flat and H.V.positions only.
Globular transfer	20-26	200-280	Higher deposition rates than dip transfer with lower heat input than spray transfer.
Pulsed arc (Background)	16-26 38J - 50V	60-220	For good results on light guage materials including mild and stainless steels, aluminium, etc.

Dip transfer (or short circuiting arc)

In the dip transfer range, low current and voltage settings are used to produce a short circuiting arc.

When welding commences, an arc is struck and a weld pool is formed. The tip of the electrode wire dips into the pool and causes a short circuit. This results in a rapid temperature rise in the wire (caused by the short circuit current following through to the workpirce) and the end of the electrode wire is melted off. An arc is immediately formed between the tip of the wire and the weld pool. This arc maintains the electrical circuit and produces sufficient heat to keep the weld pool fluid.



Schematic diagram of dip transfer

The electrode wire continues to feed and the tip once gain dips into the pool. This sequence of events is repeated at a frequency of up to 200 times per second, until the weld switch is released.

This method of transfer is suitable for positional welding and has the advantage that the heat input to the workpiece is kept to a minimum. This limits distortion and enables thin sheet material to be welded.

Dip transfer occurs with both Argon gas mixtures and CO_2 shielding gases. Suitable wire diameters are 0.6 mm to 1.2 mm.

Spray transfer

In the spray transfer mode, higher voltage and current values are used than for dip transfer.

An arc is formed when the tip of the electrode wire strikes the work piece. The increased voltage and current available cuases the wire to melt off before touching the workpiece, once the arc has been eatablished. This extra energy causes the molten metal to cross the gap to the workpiece in spray form. The size of each droplet is about the same as the wire diameter. Current flows continuously because of the high voltage maintaining a longer arc and short circuiting cannot take place.

High weld metal deposition rates are possible and weld appearance and reliability are good. Positional welding is not normally possible, due to the higher heat input making the weld pool very fluid. Spray transfer is best achieved with Argon/CO_2 shielding gases, suitable solid wire diameters are from 0.8 mm up to 1.6mm.

Globular transfer

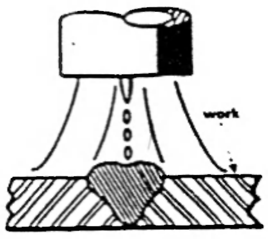
This is an intermediate range between dip transfer and spray transfer. It is neither true dip transfer not true spray transfer, and as the name implies, the transfer takes place in the form of irregular shaped globules. These molten globules of metal fall to the weld pool under the action of gravity rather than arc force as with spray transfer. Unlike Argon/CO$_2$ shielding gases CO$_2$ will not produce a true spray transfer. Globular transfer is the nearest that can be achieved. Although satisfactory for varying applications, globular transfer produces excessive spatter and an untidy looking weld when compared with welds made using spray transfer and Argoshield shielding gases.

Globular transfer can be used to advantage if a lower heat input than spray transfer is required, but in general is not desired because of the higher spatter levels. Globular transfer can take place using all sizes of electrode wires.

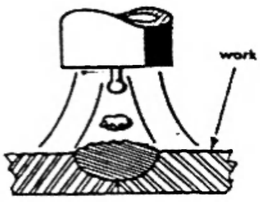
Pulsed transfer (Pulsed-arc welding)

This process requires more sophisticated and expensive equipment to be employed, whereas with the three methods previously described basic MIG power sources and wire feed units perform satisfactorily.

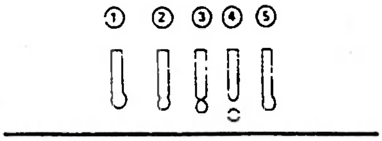
Pulsed arc welding is a controlled method of spray transfer welding. In spray transfer, droplets of metal are projected from the wire tip across the arc gap to the weld pool at a constant current. In dip transfer, metal is transferred to the weld pool somewhat irregularly during the periods of short circuiting. Pulses arc welding enables the transfer of droplets to be controlled by projecting them across the arc gap at a regular frequency, using pulses of current in the spray transfer range supplied from a special power source.



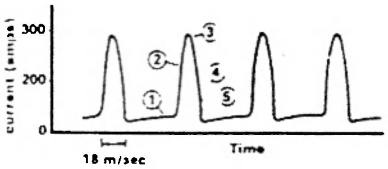
Schematic diagram of spray transfer



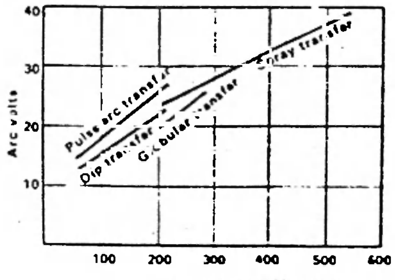
Schematic diagram of globular transfer



Pulsed arc droplets



Controlled pulse frequency



Shows graphically the volt amp relationship between the four modes of metal transfer

Transfer of metal from the wire tip to the weld pool occurs only at the period of pulse, or peak current. During the intervals between pulses, a 'background' current maintains an ionized medium (arc) between the wire tip and the weld pool to keep the wire tip molten, but no metal is transferred.

Control of transfer means that the weld metal is projected across the gap at high current - but the mean total welding current remains relatively low. The operator has independent control of the pulse height and the background current. This allows full control of both the heat input and the amount of metal deposited.

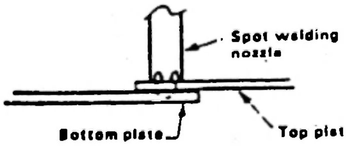
Pulsed - arc transfer can be used on mild and low alloy steels, stainless steel, aluminium and its alloys with excellent results on light to medium plate sections.

MIG spot welding

MIG spot welding is the means of achieving a fusion spot weld between two plates, by applying the torch to only one side of a lap joint. If dissimilar plate thicknesses are to be joined, the thinnest should be on top. Spot welds can be produced in the horizontal or vertical planes. Equipment required for one sided consumable MIG spot welds is basically a MIG plant with the spot timing function fitted and a spot nozzle. The spot nozzle is fitted to the torch and pressed to the workpiece. On presing the trigger the welding sequence begins and the spot timer is actuated, the wire is fed in to the weld puddle for a pre-set period of time then is automatically switched off.

MIG plug welding - where the top plate thickness exceeds the output availability from the machine. Drill or punch a small hole in the top plate, lower the torch and spot nozzle over the hole and perform the normal spot welding function.

The spot nozzle has gaps around the outlet orifice. These are designed to let shielding gas flow over the weld area and allow welding fumes to escape from the weld area.



Current density/deposition rate

The rate of metal transfer is proportional to the current and more specifically to the current density.

Table 2

Wire Size (mm)	Cross sect area mm^2	Current (amps)	Current density (Amps/mm^2)	Deposition rate (Kg/Hr)from deposition rate Table 8.
1.0	0.636	$\frac{200}{0.636}$	314.46	3.2
1.2	1.130	$\frac{200}{1.130}$	176.99	2.8

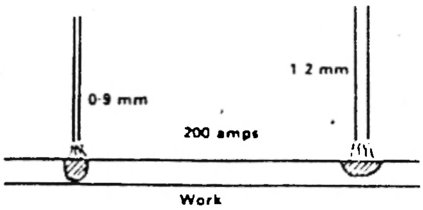
Current density is defined as the current per cross sectional area of the electrode wire and is normally expressed as amperes per mm^2. At a given current there is much higher current density with 1.0 mm diameter wire than with 1.2 mm diameter wire.

$$\text{Current density}\ \frac{\text{Amperage}}{\text{Cross sectional area}}$$

From Table 2 it can be seen that using a thinner wire(thus obtaining a higher current density) at the same amperage, increases the metal deposition rate.

A similar increase may be obtained by using the same wire size but increasing the current. It is clear from the definition of current density that doing this should produce the same end result but there are limitations on how much the current can be increased. It is possible to increase it to such an extent that the wire vapourises and practically no transfer takes place. Machine capacity and duty cycles also determine the upper limit of current. High currents produce vary fluid weld pools which make out of position work very difficult.

Higher current density (or smaller diameter wire) also gives deeper penetration.



Penetration comparison—same current

Duty cycle

To avoid overheating of the electrical components in a power source, it is given an output rating over a certain time period. If this rating is continually exceeded, overheating occurs and serious electrical failure is imminent. The typical duty cycle time on MIG plants and power sources is 5 minutes, i.e. a duty cycle of 60% at 200 amps indicates that the power source can be used at 200 amps for 3 minutes in every 5 minute period and then off for 2 minutes. Similarly a duty cycle of 100% at 180 amps means the machine can be used continuously at 180 amps.

Wire feed speed

This is controlled by the motor speed which is adjusted by a potentiometer mounted on the wire feed unit : current drawn is directly proportional to wire feed speed for a given wire size and type.

Stubbing

This welding condition can be caused by excess wire feed or alternatively, poor current pick up. The machine settings are easily adjusted to remedy stubbing but if the problem persists, poor current pick up is the most likely cause, which occurs in the bore of the contact tip. If the tip is badly worn or pitted, it should be replaced with a new one of the correct size for the wire being used.

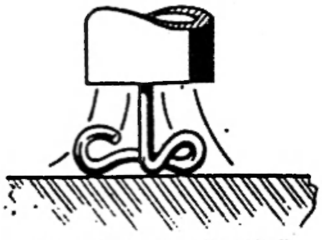
Mains contactor

This is a unit located in the power source and its function is to make and break the mains supply into the power transformer when welding is either commenced, or finished. It is controlled by the torch switch and makes a clacking noise when the torch is actuated.

Stickout length

This term describes distance from the contact tip in the torch to the workpiece,(also known as electrode extension) or the length of wire protruding from the contact tip to the workpiece.

The operator should set his conditions to give him the heat input required for the job in hand. If he wishes to 'cool' the weld pool down a little for bad fit up or out of position work, increase the 'stickout' length, and the extra electrical resistance on the longer length of wiew will allow a 'cooler', less fluid deposit.

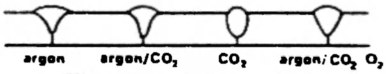


Schematic diagram of "stubbing"

Generally, when operating in the short arc mode, a stickout length of 6 mm will be satisfactory. With spray transfer and the greater radiated heat, the stickout should be increased to approximately 16mm. During welding, any large variations in stickout length will show as an inconsistent weld deposit. Too much stickout will reduce the effectiveness of the gas cover.

Shielding gases

The Argon & CO_2 GAS mixtures contains mixtures which are designed to suit particular applications such as light or heavy fabrications, and to control spatter levels, weld contour, depth of penetration, etc.



Effects of gases on weld bead shape

Welding procedures

Work preparation

Generally, the surface should be thoroughly dry and free from rust, scale, grease, paint or any other foreign matter. For work of highest quality, the surface should be ground, shot blasted of flame cleaned.

Joint preparation

On heavy sections a much reduced angle (or width) of preparation can be tolerated, due to the deeper penetration properties of the MIG process. With short arc transfer, gaps can be tolerated particularly in the vertical position. However, the higher current and deeper penetration characteristies spray transfer makes it much less tolerant to poor fit up.

The back of a root run is slag free, thus rendering back chipping or gouging generally unnecessary, Backing strips can be used in the accepted manner where the reverse side is inaccessible.

When using spray arc, it is rec-

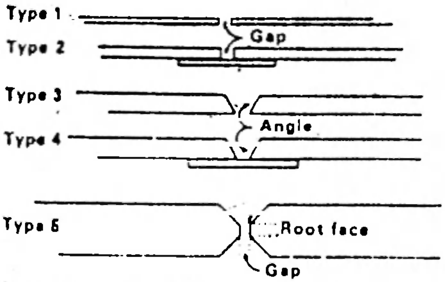


Plate preparation, different types of butt joints

Table 3 Guide to plate preparations

Plate thickness (mm)	Weld Position	Joint type (See Fig.17)	Gap (mm)	Included angle	Rec.wire size(mm)
0.5 to 1.6		1	Nil	-	0.6
2.0		1	0.8	-	0.6
3.0		1	1.6	-	0.8
5	Flat	3	Nil	60°	0.8
5	Vertical	3	1.6	60°	0.8
6.0	Flat	3	Nil	60°	0.9
6.0*	Vertical	3	1.2	60°	1.0
6.0	Flat	2	0.8	90°	1.0
10	Flat	3	0.8	60°	1.0
10	Vertical	3	1.2	60°	1.0
10	Flat	4	1.6	40°	1.0
13 and up	Vertical	3 or 5	1.6	60°	1.2
13	Flat	1	0.8	-	1.2
13 and up	Flat	4	1.6	30°	1.2
16	Flat	1	1.6	-	1.2
20 and up	Flat	4 or 5	2.4	50°	1.6

* Root face 3.2 mm.

ommended that if double V butt joint preparation is used, the root face be sufficiently heavy to avoid blowing through.

Estimating tables for MIG welding

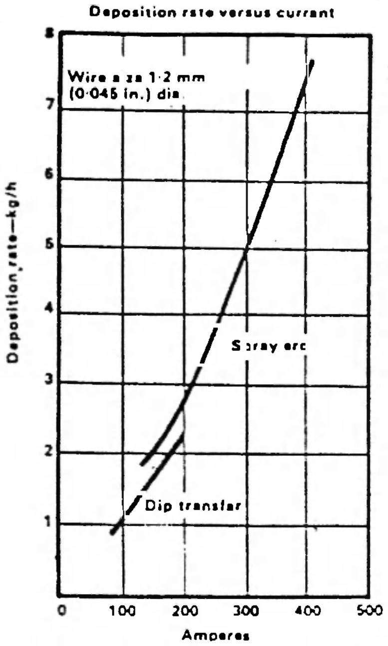
The following tables have been carefully compiled from actual welding performance tests, and the information they contain should prove very useful in costing and determining actual conditions for a particular job. When referring to these tables, the following points should be kept in mind :

Argon/CO_2 flow rate -14 liters/minute, no heater required. CO_2 (carbon dioxide) flow rate - 16-18 litres/min. with heater fitted.

Stickout-for dip transfer approx. 6mm and pray transfer approx 16 mm (Variations in stickout length change welding conditions and affect the quality of the weld deposit, but do not affect the deposition rate).

Direct current reverse polarity was used in all cases.

Travel speeds given for multiple pass joints are for all passes in the joint.



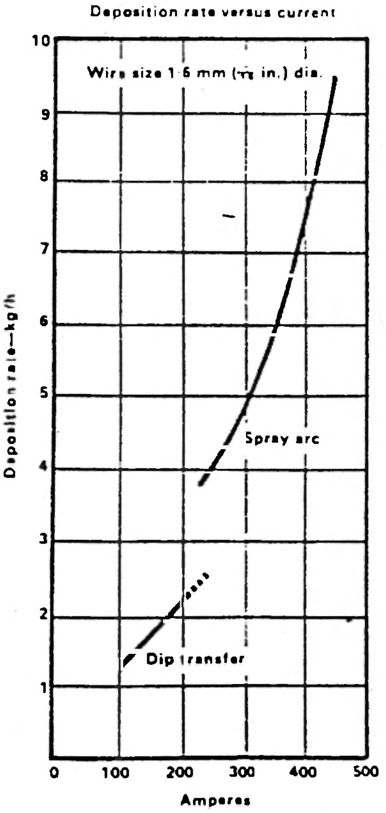


Table 4 length per kilogram of welding wire

(Diam.) mm	(Length) metres
0.8	126
0.9	93
1.2	56
1.6	30

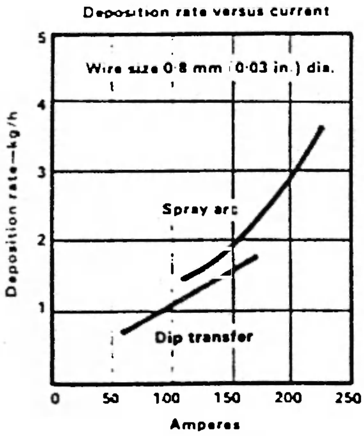


Table 5 Weight of welding wire per metre

(Diam.) mm	(Weight) kg
0.8	0.0038
0.9	0.0050
1.0	0.0060
1.2	0.0088

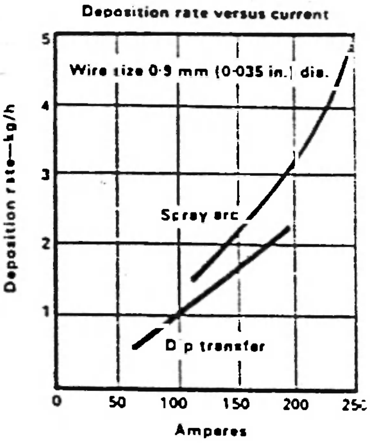


Table 6 fillet welds - weld metal weight per metre

(Fillet size) mm	Weight * (kg)/metre
3.0	0.0395
5.0	0.088
6.0	0.133
8.0	0.238
9	0.337
11	0.45
13	0.633
14	0.783
16	0.99
19	1.42
22	1.93
25	2.32

* Guide only

Techniques

Spray Transfer

Flat position (butt)

Because of the high heat input and high welding speeds possible when using spray arc, it is important to maintain adequate gas coverage to the solidifying weld area trailing the torch. Forehand welding (most right handed welders move left to right with the torch inclined towards the body) is preferable and weaving is permitted, allowing an even further spread of shielding gas.

Horizontal/vertical fillet

Forehand welding is desirable for good gas cover and optimum weld shape. Typical spray arc MIG welding conditions are found in Tables 11 - 13.

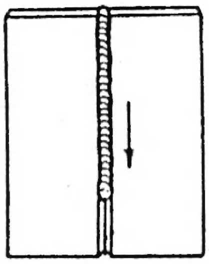
Dip transfer

Vertical down

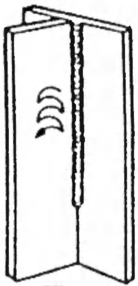
Adequate gas cover is important-stick out length should be kept constant for an even weld contour. By controlling stickout, poor 'fit up' can be tolerated by depositing a much cooler weld, Vertical down is not recommended for heavier sections because of the risk of cold lapping and lack of fusion particularly in the root run.

Vertical Up

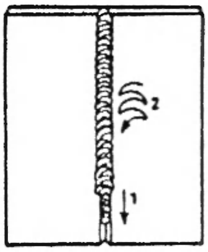
Generally gives a convex weld contour and it is suggested that a slight weaving technique be used, even on smaller passes, This weaving produces a weld of good appearance.



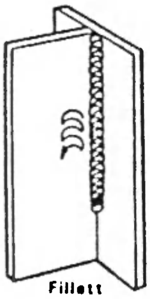
Up to 3·2 mm thick—butt



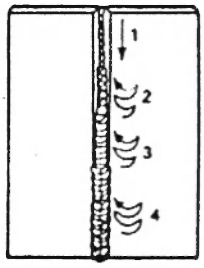
Fillett



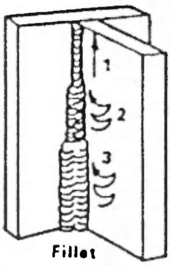
6·4 mm thick—Butt



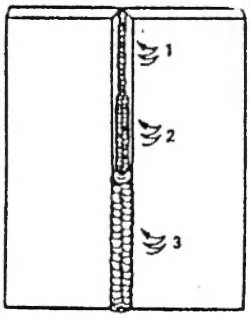
Fillett



Over 10 mm thick—Butt

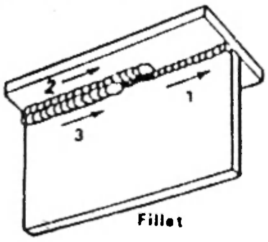


Fillet



Butt

Vertical down and up with dip transfer



Overhead welding with dip transfer

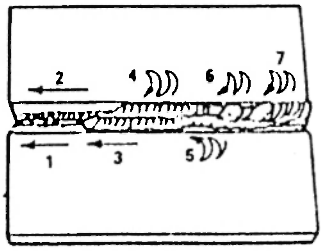
Larger fillets require a triangular movement, with slight pauses at either side to eliminate under cutting and to deposit enough metal at the edges to avoid a convex bead shape. illustrated are various joint configurations using dip transfer.

Overhead (thicker sections)

A circular movement can be used to flatten the weld face and lessen the risk of a convex weld.

Horizontal butt joint

Use forehand technique for good gas cover and use weaving as shown. Typical dip transfer MIG welding conditions are found in Tables 8, 9 and 10.



Butt
Horizontal butt welding with dip transfer

Table 7 Deposition rates

Table 8 to 13 relate to welds performed by the semi automatic MIG process using Argon/CO_2 shielding gas.

Table 8 Dip transfer - 0.8 mm wire and Argon/CO_2 shielding gas

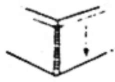
Plate thickness	Root gap	Current	Voltage	Wire feed speed	Travel speed
0.6 mm	Nil	40	14	1.5 m/mm	320 mm/min.
0.8 mm	Nil	60	15	3.75 m/min	600 mm/min
1.0 mm	Nil	90	16	5.25 m/min	580 mm/min
1.6 mm	1.0 mm	130	16	6.75 m/min	430 mm/min
2.0 mm	1-0 mm	155	17	8.25 m/min	470 mm/min
0.6 mm	-	60	14	1.5 m/min	320 mm/min
0.8 mm	-	40	15	3.75 m/min	530 mm/min
1.0 mm	-	90	16	5.25 m/min	450 mm/min
1.6 mm	-	130	16	6.75 m/min	520 mm/min
2.0 mm	-	155	17	8.25 m/min	540 min/mm
1.6 mm	-	155	17	0.825 m/min	600 mm/min
2.0 mm	-	155	17	0.825 m/min	560 mm/min
3.0 mm	-	155	17	0.825 m/min	390 mm/min

Table 9 Dip transfer - 1.0 mm wire and Argon/CO_2 shielding gas

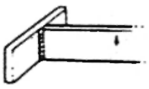
Material thickness	Fillet size	No.of passes	Current	Voltage	Wire feed Speed	Travel Speed
6 mm	6 mm	1	90	17	4.3 m/min	100 mm/min
10 mm	10mm	1	175	19	9.25 m/mon	88 mm/min
12 mm	12 mm	1	175	19	9.25 m/min	68 mm/min.
16 mm	16 mm	2	175	19	9.25 m/min	35 mm/min
20 mm	20 mm	4	175	19	9.25 m/min	17 mm/min
3.0 mm		1	160	18	7 m/min	500 mm/min
5.0 mm		1	160	18	7 m/min	350 mm/min
6.0 mm		1	160	18	7 m/min	230 mm/min
1.2 mm	Nil	1	100	17	5.25 m/min	550 mm/min
1.6 mm	1.0 mm	1	100	17	5.25 m/min	410 mm/min
2.0 mm	1.6 mm	1	100	17	5.25 m/min	390 mm/min
3.0 mm	2.0 mm	1	100	17	5.25 m/min	280 mm/min
1.2 mm	-	1	100	17	5.25 m/min	410 mm/min
1.6 mm	-	1	160	18	7 m/min	550 mm/min
2.0 mm	-	1	160	18	7 m/min	480 mm/min
3.0 mm	-	1	160	18	7 m/min	350 mm/min

Butt weld
vertical down

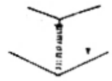
Lap joint



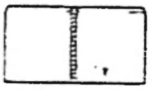
Outside corner
vertical down



Fillet weld
vertical up

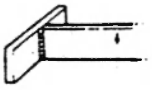


Outside corner
vertical down

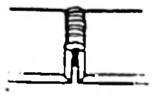


Butt weld
vertical down
(full penetration)

Lap weld



Fillet welds
vertical up



Vertical butt
1st pass vertical down
2nd pass vertical up

Table 10 Dip transfer - 1.2 mm wire and Argon/CO_2 shielding gas

Fillet size	Number of passes	Current	Voltage	Wire feed	Travel speed
10 mm	1	175	18	3.8 m/min	84 mm/min
12 mm	1	175	18	3.8 m/min	48 mm/min
16 mm	2	175	18	3.8 m/min	32 mm/min
20 mm	4	175	18		19 mm/min

Plate thick	Included angle	Root gap	Root face	Current	Voltage	Wire feed	Travel speed
* 6 mm	60°	2.5 mm	Nil	175	18	3.8 m/min	120 mm/min
12 mm	60°	2.5 mm	Nil	175	18	3.8 m/min	30 mm/min
20 mm	60°	2.5 mm	Nil	175	18	3.8 m/min	13 mm/min
						3.8 m/min	

* Both passes vertical down

Table 11 Spray transfer-0.8 mm wire and Argon/CO_2 shielding gas

Plate thickness	Fillet size	Current	Voltage	Wire feed speed	Travel speed
2.0 mm	5 mm	175	25	12.9 m/min	660 mm/min
3.0 mm	6 mm	175	25	12.9 m/min	470 mm/min
5 mm	6 mm	180	26	13.45 m/min	430 mm/min
	Root gap				
1.6 mm	Nil	165	25	12 m/min	780 mm/min
2.0 mm	Nil	165	25	12 m/min	760 mm/min
3.0 mm	1.0 mm	165	25	12 m/min	530 mm/min

Table 12 Spray transfer-1.0 mm wire and Argon/CO_2 shielding gas

Plate thickness	Fillet size	Current	Voltage	Wire feed speed	Travel speed
3.0 mm	4 mm	210	27	12.9 m/min	740 mm/min
5.0 mm	5 mm	210	27	12.9 m/min	560 mm/min
6.0 mm	6 mm	210	27	12.9 m/min	490 mm/min
	Root gap				
2.0 mm	Nil	230	26	13.45 m/min	930 mm/min
3.0 mm	Nil	230	26	13.45 m/min	630 mm/min

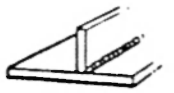
Table 13 Spray transfer-1.2 mm wire and Argon/CO_2 shielding gas

Plate thickness	Fillet size	No.of passes	Current	Voltage	Wire feed Speed	Travel speed
6 mm	6 mm	1	320	32	10.5 m/min	480 mm/min
10 mm	10 mm	2	320	32	10.5 m/min	165 mm/min
12 mm	12 mm	4	320	32	10.5 m/min	110 mm/min

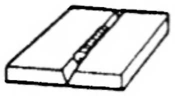
Plate thickness	Included angle	Root face	No. of passes	Current	Voltage	Were feed Speed	Travel speed
6 mm	60°	3 mm	1	320	32	10.5 m/min	250 mm/min
10 mm	60°	3 mm	4	320	32	10.5 m/min	140 mm/min
12 mm	60°	3 mm	12*	320	32	10.5 m/min	50 mm/min

* Stringerbeads

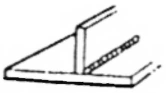
Table 14 - 17 relate to welds performed with fully automated mechanised torches using CO_2 shielding gas, but the results also apply to semi-automatic welding.
Dip transfer welding conditions. For thin guage mild steel using 0.8 mm wire and CO_2.



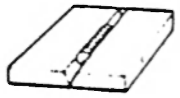
Horizontel verticel fillet



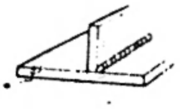
Flet butt welds



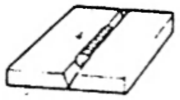
Horizontel verticel fillet



Flet butt



Horizontel . verticel fillet



Flet butt stringer beads

Table 14 Vertival down (mechanised)

Sheet thickness mm	Weld type	Weld current amp	Arc voltage	Welding speed mm/min	Wire feed speed m/min
0.9	Fillet	85	19		3.8
	Butt	75	18	510	3.3
	Lap	75	18		3.3
	Corner	75	18		3.3
1.2	Fillet	100	19	480	5
	Butt	100	19	450	5
	Lap	100	19	480	5
	Corner	100	19	480	5
1.6	Fillet	120	19	450	6
	Butt	120	19	510	6
	Lap	120	19	510	6
	Corner	120	19	560	6
2	Fillet	130	19½	450	7
	Butt	130	19½	450	7
2.5	Filler	130	20	450	8
	Butt	130	20	450	8

Horizontal/vertical position (mechanised)

Sheet thickness mm	Weld type	Weld current amp	Arc voltage	Welding speed mm/min	Wire feed speed m/min
1.6	Fillet	120	19	510	6
	Lap	100	19	560	5
	Butt	120	20	710	6
1.2	Fillet	100	19½	610	5
	Lap	100	19	710	5
	Butt	100	19	635	5
0.8	Fillet	90	18½	610	4.4
	Lap	90	18½	760	4.3
	Butt	90	19	760	4.3

Table 15 Welding conditions downhand butt welds mechanised (CO_2 shielding gas)

Plate thickness mm	Wire size mm	amp	Volts	Were feed speed m/min	Weld Speed mm/min	Stick out mm	No.of passes	Joint preparation	Root face mm	Root gap mm	kg/h
0.9	0.8	120	19	6.6	890	6.0	1	SEOB	-	-	1.36
1.6	0.8	120	19	6.6	630	6.0	1	SEOB	-	0.8	1.36
1.6	1.2	150	20	4.3	890	6.0	1	SEOB	-	1.6	2.0
3.0	0.8	130	21	7.6	510	6.0	1	SEOB	-	1.2	1.5
3.0	1.2	150	21	4.3	630	6.0	1	SEOB	-	1.6	20
6.4	1.2	320	33	13	380	22	1	+SSV.40°	-	3.2	7.0
6.4	1.6	390	36	8.6	610	22	1	+SEOB	-	3.2	7.3
6.4	1.6	400	32	7.4	1110	19	1	SEOB	-	0.8	7.3
10	1.2	310	33	12.7	320	25	1	+ SSV.40°	-	3.2	7.0
10	1.6	400	35	10.3	400	25	1	+SSV.40°	-	3.2	9.5
10	1.6	420	32	7.1	1220	13	2	SECB	-	-	7.3
12	1.2	300	33	12.7	165	28	1	+ssv.40	-	2.4	7.0
12	1 6	390	36	10.2	230	28	1	+ ssv.40	-	3.2	9.5
12	1.6	490	32	8.9	1220	13	2	SEOB	-	0.8	7.9
20	1.2	310	33	12.7	320	25	2	DSV.60°	3.0	-	7.0
20	1.6	430	38	10.7	440	22	2	DSV.40°	6.0	-	10.2
25	1.2	300	33	12.7	190	28	2	DSV.60°	1.6	-	7.0
25	1.6	400	36	10.2	230	25	2	DSV.60°	6.0	-	9.5

* Dip transfer
SECB Square Edged close butt
SEOB Square edged open butt

\+ with backing strip
SSV Single side vee
DSV Double side vee

: Spray transfer

Table 16 Welding conditions vertical position mechanised (CO_2 shielding gas)

Plate thickness mm	Weld current amp	Were feed speed m/min	Arc voltage volts	wire diameter mm	Welding speed mm/min	Type of we;d	Remarks
3.0	50	4.7	20	0.2	320	3.2 mm external corner weld	Single straight pass, vertical down Good appearance with excellent penetration
3.0	110	5.7	20	0.8	510	3.2 mm external corner Weld	Single straight pass, vertical down Good appearance, penetration not as even at higher speed.
3.0	80	4.7	19	0.8	235	3.2 mm external corner weld	Single straight pass, vertical up. Good appearance, even penetration.
3.0	140	7.0	20	0.8	280	4.8 mm Fillet	Single straight pass, vertical down. Good flat appearance, good root penetration.
3.0	160	7.7	20	0.8	320	4.8 mm Fillet	Single straight pass vertical down , good appearance, deeper root penetration
3.0	80	1.7	19	0.8	115	4.8 mm Fillet	Single pass, vertical up. Weld shape too convex for good appearance Fusion satisfactory.
3.0	145	5.9	18	0.9	265	4.8 mm Fillet	Single pass, vertical down Good appearance. Good root penetration
3.0	90	3.4	18	0.9	195	4.8 mm Fillet	Single pass, vertical up. Convex Bead Good root penetration Better side fusion than immediately above.
6.0	130	5.2	18	0.9	115	6.4 mm Fillet	Single pass weave, vertical up. Good appearance.
10	130	5.2	18	0.9	65	9.5 mm Fillet	Single triangular weave, vertical up. Good appearance
12	140	3.3	19	1.2	51	1.3 mm Fillet	Single triangular weave vertical up. Good appearance.

Table 17 Welding conditions downhand fillet weld mechanised (CO_2 shielding gas)

Leg length mm	Wire size mm	Amp	Volts	Weld feed speed m/min	Weld speed mm/min	Stick-out mm	No.of passes	Deposition rate kg/h
3.0*	0.8	100	19	5.9	300	10	1	1.36
3.0*	1.2	155	20	3.6	400		1	2.04
5.0*	0.8	100	19	5.9	190	10	1	1.36
5.0*	1.2	155	21	3.6	300		1	2.04
6.0 +	1.2	320	35	11.2	510	20	1	5.9
6.0 +	1.6	420	37	7.1	590		1	6.1
10 +	1.2	310	35	11.4	250	20	1	6.1
10 +	1.6	420	37	7.1	300	16	1	6.1
12 +	1.2	310	35	11.4	160	20	1	6.1
12 +	1.6	420	37	8.9	190		1	7.5
20 +	1.2	310	35	11.4	260	22	3	6.1
20 +	1.6	420	37	9.1	110		1	7.9

* Dip transfer + Spray arc transfer

Safety

Eye protection

Arc intensity with the MIG process is much higher than that associated with manual arc welding. When MIG welding, it is desirable to use a filter lens one shade darker than is normally used for manual arc welding.

The helmet and filter should be of reputable manufacture and conform to the relevant code requirements. Cracked or poor fitting filters should be replaced immediately and the clear safety lens should be replaced if excess spatter restricts vision.

It is also an advantage for the operator to wear anti-flash glasses and thus avoid any stray reflected weld flashes that may occur.

Table 26 Recommended protective filters for arc welding

Description of process	Approximate Range of Welding current amperes	Filter(s) recommended Shade No.
Resistance welding		Safety spectacles or eye shield
Submerged arc welding		
Electroslag welding *	-	2(5)
Arc welding-covered electrodes	UP to 100	8
Tungsten inert gas (TIG)	Up to 75	10
Covered electrodes	100 - 200	10
TIG	75-100	10
Metal inert gas (MIG)-Dip transfer	Up to 150	10
Covered electrodes	200-300	11
TIG	100-200	11
MiG/CO_2	150-250	11
Cored Wires CO_2	Up to 300	11
Covered electrodes	300-400	12
TIG	200-250	12
MIG (aluminium and stainless steel)	Up to 250	12
MIG/CO_2	250-300	12
Cored wires CO_2	300-400	12
Air-arc gounging	Up to 400	12
Covered electrodes	Over 400	13
TIG	250-350	13
MiG (aluminium and stainless steel)	250-350	13
MiG/CO_2	300-400	13
Cored wires CO_2	400-500	13
Cored wires Argoshield	300-400	13
TIG	Over 350	14
MIG	Over 400	14
Cored wires with CO_2	Over 500	14
Plasma arc cutting and spraying	-	15

* Shade 5 filter (gas welding) recommended when watching molten pool in electroslag welding.

NOTE : The shade numbers in this table are the minimum recomended for the operation specified.

Body protection

This same arc intensity requires the operator to completely cover his body. Failure to do this is to risk painful 'ray burn' (ultra violet radiation from the arc). Gloves, jacket and spats made of leather give protection from rays and spatter.

Woollen materials, being less combustible are more durable than cottons or synthetics.

Ventilation

Work areas should be large and open so that welding fumed can dissipate quickly. Exhaust fans and air supply apparatus must be used when operating in confined spaces.

Degreasing agents

Trichlorethylene (TCE) must not be used in its liquid form however it is perfectly acceptable to use it within a properly designed vapour bath, provided that time is allowed for components to dry fully before welding. Carbon Tetrachloride (CTC) and White Spirit must not be used to prepare weld joints.

A welding station must not be sited near to degreasing equipment.

Electrical

The work area should be kept dry-dampness could provide a path for current to the operator's body, resulting in electric shock. It is good workshop practice to use rubber mats or wooden slats on the floor.

Maintenance or repair

Before any maintenance or repair work is carried out on the welding machine, switch the mains supply off and withdraw the mains fuses (or open the circuit breaker if fitted)

Only a licensed eiectreician should carry out work inside the power source.

Safety summary

- ✱ Filter lens-darker shade (shade 10-12)
- ✱ Woolen clothing-preferable.
- ✱ Complete body covering essential
- ✱ Adequate ventilation-important.
- ✱ Confined space-clean dry air supply
- ✱ Do not use Trichiorethylene (T.C.E.) or Carbon Tetrachloride (C.T.C.) solvents.
- ✱ Electrical repairs by a qualified electrician.

Rectifying weld faults and machine faults

Fault	Possible Cause	Remedy
Undercutting	Speed too slow for current Torch angle too low. Voltage too high	Increase speed. Raise torch angle. reduce voltage.
Lack of penetration	Current too low. Inconsistent current pickup. Stickout too great. Joint preparation too narrow. Gap too small.	Increase current. Renew contact tip. Shorten stickout. Widen preparation. Open gap.
Lack of fusion. Spatter (excessive)	Voltage too low Voltage too high. Voltage too low Incorrect shielding gas. Insufficient inductance. Blocked gas nozzle	Increase voltage. Reduce voltage. Increase voltage. Check selection. Increase inductance (if possible). Clean nozzle regularly and spray with Spattagard.
Irregular weld shape	Current too high for voltage. Excessive stickout. Wire wander. Incorrect shielding gas. Travel speed too slow. Excessive gas flow.	Reduce current. Contact tip closer to work. Replace contact tip. Check contact tip. Check selection. Increase speed. Set to 14 l/min.
Weld cracking	Dirty work piece, i.e. grease, paint, scale, rust. Weld beads too small weld too deep. Highly restrained weld. Excessive voltage.	Clean and degrease prior to welding. Slow speed down. Reduce current. Voltage and increase speed. Revise setting up procedure. Decrease voltage.

Porosity.	Insufficient shielding gas. Dirty work piece. Arc voltage too high. Air entrainment into gas shielding system. Excessive gas flow rates. Spatter on gas nozzle. Wrong wire analysis.	Set to 14 l/min. (Argoshield) (more if in windy position). Clean work throughly. Reduce voltage. Check gas connections. Set to 14 l/min. Clean nozzle and regularly spray with Spattagard Check selection.
Mains power on but no welding power.	Fault in control circuit of torch. Control fuse blown.	Check torch control plugged in, repair switch lead in torch handle. Replace fuse.
No mains power at machine.	Power supply switch open. Primary fuse blown. Open circuit breaker. Loose or breaken connection in primary circuit.	Close switch. Replace fuse, Reset breaker. Repair connection.
Mains power on, no wire feed but contractor operates when trigger is actuated (clacking sound in power source). Wire feeds but arc will not strike.	Feed motor circuit breaker open, or fuse blown. Wire stuck in guide, liner or contact tip. Poor or no contact between work piece and earth clamp.	Reset breaker. Replace fuse. Clean or replace faulty item. Clean earth clamp and ensure good contact with work piece.
'Cold' weld puddle.	Incorrect machine settings. Incorrect shielding gas. Bad connection. Faulty diode	Increase heat input. Replace gas. Check and tighten connection. Test and replace faulty diodes (see instruction Manual).
'Jerky' wire feeding causing uneven welding conditions.	Worn, dirty contact tip. Worn wire guides. Worn, kinked or dirty conduit liner. Wire spool runs stiffly.	Replace contact tip. Clean or replace wire guides. Clean or replace liner. Adjust break (see instruction Manual)

N.B. Most wire feeding problems are caused by faulty contact tips and conduit liners. If feeding problems are experienced, check these two items first and replace if necessary.