

Unit 12: Undertake Manual Metal Arc Welding for Blacksmithing and Metalworking

Unit reference number: R/602/0704

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

● Aim and purpose

This unit aims to introduce learners to the skills and knowledge for manual metal arc welding for blacksmithing and metalworking, and how these can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or on to further/higher education.

● Unit introduction

Manual metal arc welding is an essential process within the blacksmithing and metalworking industries.

This unit focuses on the manual metal arc welding process. Learners will develop their competence in manual metal arc welding in a range of positions, and produce joints that are relatively complex and difficult to achieve. This unit also addresses process requirements, the range of available electrodes, distortion control and factors affecting weld quality.

Operator welfare and health and safety procedures are a fully integrated part of this unit.

Learning outcomes 1 and 2 explore the equipment and consumables required for manual metal arc welding activities, the methods used to set up and make welds safely and the operational variables that affect weld quality, including faults which may arise out of poor selection or control of variables.

For learning outcomes 3 and 4, learners need to produce fillet and butt welded joints (to the welding industry standard BS4872 or its equivalent) and evaluate their work against this standard. Learners will demonstrate and practise techniques in the manual metal arc welding workshop to produce repeatable, quality welded joints in steel in a range of positions.

● Learning outcomes

On completion of this unit a learner should:

- 1 Be able to prepare equipment and consumables for manual metal arc welding tasks
- 2 Understand the factors that influence the quality of manual metal arc welds
- 3 Be able to produce positional fillet welds using manual metal arc welding equipment
- 4 Be able to produce positional butt welds using manual metal arc welding equipment.

Unit content

1 Be able to prepare equipment and consumables for manual metal arc welding tasks

Equipment and consumables: types, characteristics and uses (rectifiers, electrode leads, return leads, electrode holders); mild steel electrode coatings eg rutile, cellulosic, basic, acid, combinations; power sources; maintenance requirements of equipment; costs; setting up and testing procedures; site environment management; personal protective equipment (PPE); risk assessment; risks associated with electricity, radiation and fume emission; relevant current legislation eg Health and Safety at Work Act 1974, Control of Substances Hazardous to Health (COSHH) Regulations 2002

2 Understand the factors that influence the quality of manual metal arc welds

Factors: variables (electrode types, current type, current setting, voltage, arc length, speed of travel, manipulation, welder competence); faults (slag traps, undercut, overlap, asymmetry, lack of fusion/penetration, porosity); distortion (pre-setting, strong backs, restraint and clamping, weld sequence, design); identification of faults and distortion; causes of variables, faults and distortion; consequences of variables, faults and distortion; methods of prevention

3 Be able to produce positional fillet welds using manual metal arc welding equipment

Production of fillet welds: types ('T', lap, closed corner); positions (flat, horizontal-vertical, vertical up and down); methods including preparation and equipment control and maintenance; equipment and consumables; welding standards (BS4872, EN287); safe working practices; PPE; risk assessment; relevant current legislation, eg Health and Safety at Work Act 1974, Control of Substances Hazardous to Health (COSHH) Regulations 2002

4 Be able to produce positional butt welds using manual metal arc welding equipment

Production of butt welds: types (square edge, single vee, double vee, open corner); positions (flat, horizontal-vertical, vertical up and down); methods including preparation and equipment control and maintenance; equipment and consumables; welding standards (BS4872, EN287); safe working practices; PPE; risk assessment; relevant current legislation eg Health and Safety at Work Act 1974, Control of Substances Hazardous to Health (COSHH) Regulations 2002

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
<p>P1 select and assemble manual metal arc welding equipment and consumables to meet a selected task [IE, RL, SM]</p>		
<p>P2 produce a risk assessment for the use of manual metal arc welding equipment in producing a specified welded joint [IE, RL, SM]</p>		
<p>P3 explain the variables that could influence the quality and cost of a manual metal arc weld produced in a given situation [IE, CT, RL, SM, EP]</p>		
<p>P4 set up manual metal arc welding equipment and produce 'T' fillet welded joints in the flat and horizontal/vertical position to meet the appropriate visual British Standard [RL, SM]</p>	<p>M1 apply fillet and butt welding techniques to produce manual metal arc welded joints to fully meet the appropriate British Standard</p>	<p>D1 evaluate a selected manual metal arc weld component/artefact, recognising faults/defects against the appropriate full British Standard, and make recommendations for improvement.</p>
<p>P5 set up manual metal arc welding equipment and produce 'T' fillet welded joints in the vertical position to meet the appropriate visual British Standard [RL, SM]</p>		

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
<p>P6 set up manual metal arc welding equipment and produce butt welded joints in the flat position to meet the appropriate visual British Standard [RL, SM]</p>	<p>M2 describe the health and safety issues when using the manual metal arc welding process and methods of control and prevention</p>	
<p>P7 set up manual metal arc welding equipment and produce butt welded joints in the vertical position to meet the appropriate visual British Standard. [RL, SM]</p>	<p>M3 describe possible weld faults when using the manual metal arc welding process and methods of control and prevention.</p>	

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers	RL – reflective learners TW – team workers	SM – self-managers EP – effective participators
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Essential guidance for tutors

Delivery

Delivery of this unit will involve practical assessments, written assessment, visits to suitable collections and will link to work experience placements.

Tutors delivering this unit have opportunities to use as wide a range of techniques as possible. Lectures, discussions, seminar presentations, site visits, supervised welding practicals, research using the internet and/or library resources and the use of personal and/or industrial experience would all be suitable. Delivery should stimulate, motivate, educate and enthuse learners.

Work placements should be monitored regularly in order to ensure the quality of the learning experience. It would be beneficial if learners and supervisors were made aware of the requirements of this unit before any work-related activities are undertaken so that naturally occurring evidence can be collected at the time. For example, learners may have the opportunity to produce fillet and butt welds using manual metal arc welding equipment and they should ask for observation records and/or witness statements to be provided as evidence of this. Guidance on the use of observation records and witness statements is provided on the Edexcel website.

Whichever delivery methods are used, it is essential that tutors stress the importance of operator welfare, sound environmental management and the need to manage the resource using legal methods.

Health and safety issues relating to working with welding materials must be stressed and reinforced regularly, and risk assessments must be undertaken before any practical activities. Adequate PPE must be provided and used following the production of suitable risk assessments.

Tutors should consider integrating the delivery, private study and assessment for this unit with other relevant units and assessment instruments learners are taking as part of their programme of study.

Learning outcomes 1 and 2 look at the selection of components and consumables, performing risk assessment for manual metal arc welding and the identification and evaluation of the variables, weld faults and distortion prevention related to manual metal arc welding. These learning outcomes are likely to be delivered through formal lectures, discussion, demonstrations, workshop practicals, site visits and independent learner research. Learners must be introduced to the techniques and associated equipment appropriate to each welding skill being practised. Welding and cutting should be in mild steel, in a range of thicknesses and configurations, in order for learners' experience to be as broad as possible. Other metals will be considered where possible.

Learning outcomes 3 and 4 cover the production of positional fillet and butt welds using manual metal arc welding. Although the welding process will be delivered as a separate entity, learners are expected to gain competence and an awareness of how skills can be transferred to other processes and techniques. Similarities and distinctions between the welding processes will be emphasised when considering joining tasks. This is an essentially practical unit and learners need full access to welding and ancillary equipment.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan gives **an indication of the volume of learning it would take the average learner** to achieve the learning outcomes. It is **indicative and is one way of achieving the credit value**.

Learning time should address all learning (including assessment) relevant to the learning outcomes, regardless of where, when and how the learning has taken place.

Topic and suggested assignments/activities and/assessment
Introduction and overview of the unit.
Assignment 1: Health and Safety Issues, Risk Assessment and Assembly of Manual Metal Arc Welding Equipment (P1, P2, M2 part)
Tutor introduces the assignment.
Theory session: health and safety and risk assessments related to manual metal arc welding.
Theory session and practice: assembly of manual metal arc welding equipment.
Assignment 2: Quality and Cost in Manual Metal Arc Welding (P3, M2 part, M3, D1)
Tutor introduces the assignment brief.
Theory session and practice: discuss the variables influencing quality in manual metal arc welding.
Theory session: costing related to manual metal arc welding equipment.
Assignment 3: Producing Manual Metal Arc Welded Butts and Fillets in Position (P4, P5, P6, P7, M1)
Tutor introduces the assignment brief.
Demonstrate manual metal arc welding fillet joints in the flat position.
Practical application of manual metal arc welding fillet joints in the flat position.
Demonstrate manual metal arc welding butt joints in the flat position.
Practical application of manual metal arc welding butt joints in the flat position.
Demonstrate manual metal arc welding fillet joints in the vertical position.
Practical application of manual metal arc welding fillet joints in the vertical position.
Demonstrate manual metal arc welding fillet joints in the vertical position.
Practical application of manual metal arc welding fillet joints in the vertical position.
Unit review.

Assessment

The grading criteria associated with learning outcomes 3 and 4 are intended to mirror gaining welder approval to the industrial welding standard BS4872. Learners are assessed under the same conditions as a welder in industry seeking this qualification. The pass criteria are achieved by producing welds which satisfy the visual criteria of BS4872 reflecting the most common type of weld assessment, namely visual inspection. The merit criteria require, in addition, welds which fully satisfy the standard to meet the BS4872 destructive criteria.

For P1, learners must select and assemble manual metal arc welding equipment and consumables to carry out a selected task. Tutors should identify the task or agree it through discussion with learners. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners.

P1 could be assessed directly by the tutor during practical activities. If this format is used then suitable evidence from guided activities would be observation records completed by learners and the tutor and accompanied by appropriate work logs or other relevant learner notes. If assessed during a placement, witness statements should be provided by a suitable representative and verified by the tutor.

For P2, learners must carry out a risk assessment for the use of manual metal arc welding equipment in position. Tutors should identify the situation for using manual metal arc welding equipment or agree it through discussion with learners. The situations may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the range of the assessment should be the same for all learners. Evidence should be in a format that is recognised within the industry and by the Health and Safety Executive.

For P3, learners must explain the variables that could influence the quality of a manual metal arc weld produced in a given situation. Tutors should identify the situation or agree it through discussion with learners. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners. Evidence could be in the same form as for P1. Alternatively, evidence could be a pictorial presentation with notes (possibly using appropriate software or an overhead projector), an annotated poster or a written assignment.

Learners must also demonstrate basic knowledge of the costs of manual metal arc welding equipment and how it is applied to various tasks. Some emphasis must also be placed on the relative cost of this welding process compared with other welding processes.

P4 and P5 require learners to set up manual metal arc welding equipment and produce selected fillet welded joints in the flat and horizontal/vertical (P4) and vertical (P5) position to BS4872 visual standard. Learners are expected to produce each of the fillet joints in each of the positions listed in the unit content. Evidence could be in the same form as for P1.

For P6 and P7, learners must set up manual metal arc welding equipment and produce selected butt welded joints in the flat (P6) and vertical (P7) positions to BS4872 visual standard. Learners are expected to produce butt joints in each of the positions listed in the unit content. Evidence could be in the same form as for P1.

For M1, learners must apply fillet and butt welding techniques to produce manual metal arc welded joints to fully meet the criteria of the BS4872 standard. Learners are expected to produce each of the fillet and butt joints in the positions listed in the unit content. Evidence could be in the same form as for P1 and P4, P5, P6, P7 and P8.

For M2, learners are required to describe the major health and safety issues that can arise when manual metal arc welding, and make recommendations to limit them. This evidence may support and enhance the risk assessment produced for P2.

For M3, learners will describe the possible effects of faults in manual metal arc joints, their causes and methods of prevention. Tutors should identify the welded joints or agree them through discussion with learners. The welded joints may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners. Learners are expected to provide evidence of at least three different types of welded joints produced using manual metal arc welding equipment. Evidence could be in the same form as for P3.

For the distinction grade learners must evaluate a selected welded component/artefact, recognising faults and/or defects against the full BS4872 criteria, or equivalent, and recommend improvements. Tutors should identify the component/artefact to be evaluated or agree it through discussion with learners. The component/artefact may have been supplied, or it may have been produced by the learner and used to provide evidence for other grading criteria. The component/artefact will possess a range of fillet and butt joints and, to ensure assessment is fair, the size and complexity of the task should be as similar as possible for all learners. Evidence could be provided through the production of evaluation sheets. Recommendations for improvement must be feasible and appropriate.

Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M2 (part)	Health and Safety Issues, Risk Assessment and Assembly of Manual Metal Arc Welding Equipment	You have been placed in charge of health and safety in a manual metal arc welding workshop. You are to demonstrate how to assemble manual metal arc equipment in readiness for producing a specified butt weld. You will also describe the health and safety issues you would need to induct your workforce in, and produce an example risk assessment to use as an illustration.	Observation and assessment of practical work. Written work.
P3, M2 (part), M3, D1	Quality and Cost in Manual Metal Arc Welding	You have been placed in charge of quality and effectiveness in a manual metal arc welding workshop. You need to describe the variables affecting the quality and cost of welding, and evaluate its use in a particular welded fabrication.	Written work.
P4, P5, P6, P7, M1	Producing Manual Metal Arc Welded Butts and Fillets in Position	An artefact is to be fabricated using manual metal arc welding. You are to produce it by performing butt and fillet joints, each in the flat and vertical positions.	Observation and assessment of practical work.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC land-based sector suite. This unit has particular links with:

Level 2	Level 3
Application of Welding Processes	Undertake Workshop Practice for Blacksmithing and Metalworking
Fabrication Techniques and Sheet Metal Work	Understanding and Using Forging Techniques for Blacksmithing and Metalworking
	Undertake Blacksmithing Processes
	Undertake Oxy-acetylene Welding for Blacksmithing and Metalworking
	Undertake Metal Arc Gas Shielded Welding for Blacksmithing and Metalworking
	Understanding and Using Fabrication Skills for Blacksmithing and Metalworking
	Understanding and Using Fabrication Techniques for Blacksmithing and Metalworking

This unit also has links with Level 3 National Occupational Standards in Fabrication and Welding, and Farriery.

Essential resources

Learners will need supervised access to sufficiently resourced forge workshops appropriate to their learners' specialist pathways. These should offer a comprehensive range of welding and cutting equipment, and ancillary equipment such as guillotine, cropper, band saw and general and welding hand tools. Weld test facilities are an essential requirement for establishing quality in any welding unit and should comprise an etching provision and bend/break testing equipment, each with suitable health and safety provision in place.

Learners should have access to a sufficiently diverse range of stock sizes/sections to explore this unit fully.

Health and safety considerations and effective learning require that there are sufficient facilities to allow for one welding station per learner. Health and safety information and support should be provided.

Tutors delivering this unit should have vocationally specific craft knowledge.

Employer engagement and vocational contexts

This unit focuses on developing the practical skills and underpinning knowledge associated with successful manual metal arc welding. Tutors are encouraged to make links with local blacksmiths and fabrication and engineering companies. A visit to a successful welding and fabrication company is particularly advised so that learners can appreciate the conversion process within an industrial context.

Indicative reading for learners

Textbooks

Davies A – *The Science and Practice of Welding: Welding Science and Technology Volume 1 10th Edition* (Cambridge University Press, 1993) ISBN 9780521435659

Davies A – *The Science and Practice of Welding: The Practice of Welding Volume 2 10th Edition* (Cambridge University Press, 1993) ISBN 9780521435666

Flood C – *Fabrication Welding and Metal Joining Processes* (Butterworth-Heinemann, 1981) ISBN 9780408004480

Gibson S and Smith A – *Basic Welding* (Thomson Learning, 1993) ISBN 9780333578537

Gourd L – *Principles of Welding Technology 3rd Edition* (Butterworth-Heinemann, 1995) ISBN 9780340613993

Griffin I Roden E and Briggs C – *Basic Arc Welding 4th Edition* (Delmar, 1984) ISBN 9780827321311

Kenyon W – *Basic Welding and Fabrication* (Longman, 1987) ISBN 9780582005365

Pritchard D – *Soldering, Brazing and Welding: A Manual of Techniques* (The Crowood Press, 2001) ISBN 9781861263919

Journals

Artist Blacksmith

Forge

The Worshipful Company of Blacksmiths newsletter

Welding and Metal Fabrication

Websites

en.wikipedia.org/wiki/Welding

www.baba.org.uk

www.gowelding.com

www.hse.gov.uk

www.megco.uk/meg/weldglos.htm

www.roymech.co.uk/Useful_Tables/Manufacturing/Welding.html

www.twi.co.uk/j32k/index.xtp

Welding

The British Artist Blacksmiths Association

Gowelding

Health and Safety Executive

Materials Engineering Group

Welding processes

The Welding Institute

Delivery of personal, learning and thinking skills (PLTS)

The following table identifies the PLTS opportunities that have been included within the assessment criteria of this unit:

Skill	When learners are ...
Independent enquirers	identifying equipment, and variations in its use
Creative thinkers	producing a risk assessment identifying and explaining variables
Reflective learners	setting up manual metal arc equipment and using welding techniques
Self-managers	setting up manual metal arc equipment and using welding techniques.