Unit 11: Undertake Oxy-acetylene Welding for Blacksmithing and Metalworking

Unit reference number: A/602/0678

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 associated with oxy-acetylene 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

Oxy-acetylene welding is an essential process within the blacksmithing and metalworking industries.

This unit focuses on the process of oxy-acetylene welding. Learners will develop their competence in oxy-acetylene welding in a range of positions and produce joints that are relatively complex and difficult to achieve. This unit also addresses the range of available filler wires, process requirements, distortion control and factors affecting weld quality. Operator welfare and health and safety procedures are fully integrated within this unit.

Learning outcomes 1 and 2 explore the equipment and consumables required for oxy-acetylene welding activities, the methods used for setting up and making 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 to the standard. Techniques will be demonstrated and practised in the 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 oxy-acetylene welding tasks

2 Understand the factors that influence the quality of oxy-acetylene welds

3 Be able to produce positional fillet welds using oxy-acetylene welding equipment

4 Be able to produce positional butt welds using oxy-acetylene welding equipment.

Unit content

1 Be able to prepare equipment and consumables for oxy-acetylene welding tasks

Equipment and consumables: types, characteristics and uses eg torches, gas, filler wire, flux; maintenance requirements of equipment; costs; setting up and testing procedures; site environment management; personal protective equipment (PPE); risk assessment; risks associated with explosive gases and fume emission; relevant current legislation eg health and safety at work legislation, control of substances hazardous to health regulations current requirements

2 Understand the factors that influence the quality of oxy-acetylene welds

Factors: variables (speed of travel, manipulation, welder competence); faults (undercut, overlap, asymmetry, lack of fusion/penetration); distortion (pre-setting, restraint and clamping, chills, 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 oxy-acetylene welding equipment

Production of fillet welds: types ('T', lap, closed corner); positions (flat, horizontal-vertical, vertical up); methods including preparation and equipment control; equipment and consumables; preparing job materials eg cleaning, edge preparation, cutting; relevant welding standards eg BS4872; safe working practices; PPE; risk assessment; relevant current legislation, eg health and safety at work legislation, control of substances hazardous to health regulations current requirements

4 Be able to produce positional butt welds using oxy-acetylene welding equipment

Production of butt welds: types (square edge, single vee, double vee, open corner); positions (flat, horizontal-vertical, vertical up); methods including preparation and equipment control; equipment and consumables; preparing job materials eg cleaning, edge preparation, cutting; relevant welding standards eg BS4872; safe working practices; PPE; risk assessment; relevant current legislation, eg health and safety at work legislation, control of substances hazardous to health regulations current requirements

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:**
P1 select and assemble oxy-acetylene welding equipment and consumables to meet a selected task [IE, RL, SM]		
P2 produce a risk assessment for the use of oxy-acetylene equipment in producing a specified welded joint [IE, RL, SM]		
P3 explain the variables that could influence the quality and cost of oxy-acetylene welding in a given situation [IE, CT, RL, SM, EP]		
P4 set up oxy-acetylene welding equipment and produce 'T' fillet welded joints in the flat and horizontal/vertical position to meet the appropriate visual British Standard [RL, SM]	**M1** apply fillet and butt welding techniques to produce oxy-acetylene welded joints to meet the appropriate British Standard	**D1** evaluate a selected welded component/artefact, recognising faults/defects against the appropriate full British Standard, making recommendations for improvement.
P5 set up oxy-acetylene welding equipment and produce 'T' fillet welded joints in the vertical position to meet the appropriate visual British Standard [RL, SM]		

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:**
P6	set up oxy-acetylene welding equipment and produce butt welded joints in flat position to meet the appropriate visual British Standard [RL, SM]	**M2**	describe the health and safety issues when using the oxy-acetylene welding process and methods of control and prevention	
P7	set up oxy-acetylene welding equipment and produce butt welded joints in the vertical position to meet the appropriate visual British Standard [RL, SM]	**M3**	describe possible weld faults when using the oxy-acetylene welding process and methods of control and prevention.	
P8	set up oxy-acetylene welding equipment and produce a braze welded fillet joint to a given specification. [RL, SM]			

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	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

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 so that naturally occurring evidence can be collected at the time. For example, learners may have the opportunity to produce fillet and butt welded joints using oxy-acetylene 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 Pearson 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 assessments for oxy-acetylene welding and the identification and evaluation of the variables, weld faults and distortion prevention related to oxy-acetylene welding. These learning outcomes are likely to be delivered through formal lectures, discussions, demonstrations, workshop practicals, site visits and independent learner research. Learners must be introduced to the welding 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 learner 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 by oxy-acetylene welding. Although the welding process will be delivered separately, learners are expected to gain competence and 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 essentially a practical unit and full access to welding and ancillary equipment is necessary.

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 learners** 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 Oxy-Acetylene Welding Equipment (P1, P2, M2 part) Tutor introduces the assignment.
Theory session: health and safety and risk assessments related to oxy-acetylene welding.
Theory session and practice: assembly of oxy-acetylene welding equipment.
Assignment 2: Quality and Cost in Oxy-Acetylene Welding (P3, M2 part, D1) Tutor introduces the assignment.
Theory session and practice: discuss the variables influencing quality in oxy-acetylene welding.
Theory session: costings related to oxy-acetylene welding equipment.
Assignment 3: Producing Oxy-Acetylene Welded Butts and Fillets in Position (P4, P5, P6, P7, M1) Tutor introduces the assignment brief.
Demonstrate oxy-acetylene welding fillet joints in the flat position.
Practical application of oxy-acetylene welding fillet joints in the flat position.
Demonstrate oxy-acetylene welding butt joints in the flat position.
Practical application of oxy-acetylene welding butt joints in the flat position.
Demonstrate oxy-acetylene welding fillet joints in the vertical position.
Practical application of oxy-acetylene welding fillet joints in the vertical position.
Demonstrate oxy-acetylene welding butt joints in the vertical position.
Practical application of oxy-acetylene welding butt joints in the vertical position.
Assignment 4: Producing Brazed Joints (P8) Tutor introduces the assignment brief.
Demonstrate brazing of a range of joints.
Practical application of brazing techniques.
Unit review.

Assessment

The grading criteria related to learning outcomes 3 and 4 are intended to mirror gaining welder approval to the industrial welding standard BS4872. In other words, 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 the relevant british standard BS4872 or its equivalent, reflecting the most common type of weld assessment, namely visual inspection. The merit criteria require welds which satisfy the standard fully to meet the BS4872 destructive criteria as well.

For P1, learners must select and assemble oxy-acetylene welding equipment and consumables to meet 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 oxy-acetylene welding equipment in position. Tutors should identify the situations for using the oxy-acetylene welding equipment or agree them 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 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 an oxy-acetylene 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 a basic knowledge of the costs of oxy-acetylene welding equipment and its application to various tasks. Some emphasis must be placed on the relative cost of the oxy-acetylene welding process compared with other welding processes.

P4 and P5 require learners to set up oxy-acetylene welding equipment and produce selected fillet welded joints in the flat and horizontal/vertical (P4) and vertical (P5) position to BS4872 visual standards. 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 format as for P1.

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

P8 requires learners to set up oxy-acetylene welding equipment and produce selected fillet welded joints by means of brazing to BS4872 visual standards. Evidence could be in the same format as for P1, P4 and P5.

For M1, learners must apply fillet and butt welding techniques to produce oxy-acetylene 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 format as for P1 and P4—P8.

For M2, learners are required to describe the major health and safety issues relating to oxy-acetylene welding and make recommendations to limit these. This evidence may support and enhance the risk assessment produced in P2.

For M3, learners must describe the possible effects of faults in oxy-acetylene welded 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 fairness of assessment, the size and complexity of the tasks should be the same for all learners. Learners are expected to provide evidence for at least three different types of welded joints produced using oxy-acetylene 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 full BS4872 criteria or its equivalent and make recommendations for improvement. Tutors should identify the component/artefact to be evaluated or agree it through discussion with learners. The component/artefact may have been supplied, or 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 fairness of assessment, the size and complexity of the task should be as similar as possible for all learners. Evidence could be through the production of evaluation sheets. Recommendations for improvement must be feasible and appropriate. Where appropriate, improvements to making quality should be demonstrated within the components/artefacts produced.

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 Pearson 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 Oxy-acetylene Welding Equipment	You have been placed in charge of health and safety in an oxy-acetylene welding workshop. You are to demonstrate how to assemble oxy-acetylene 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), D1	Quality and Cost in Oxy-acetylene Welding	You have been placed in charge of quality and effectiveness in an oxy-acetylene welding workshop. You are to describe the variables affecting the quality and cost of welding, and to evaluate its use in a particular welded fabrication.	Written work.
P4, P5, P6, P7, and M1	Producing Oxy-Acetylene Welded Butts and Fillets in Position	An artefact is to be fabricated by oxy-acetylene 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.
P8	Producing Brazed Joints	An artefact is to be fabricated by oxy-acetylene brazing. You are to produce it by means of brazing fillet joints in the flat position.	Observation and assessment of practical work.

Links to other BTEC units

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

Level 2	Level 3
	Undertake Workshop Practice for Blacksmithing and Metalworking
	Understanding and Using Forging Techniques for Blacksmithing and Metalworking
	Undertake Introductory Welding for Blacksmithing and Metalworking
	Undertake Blacksmithing Processes
	Undertake Manual Metal Arc Welding for Blacksmithing and Metalworking

Essential resources

Learners will need supervised access to sufficiently resourced forge workshops appropriate to their 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.

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

Health and safety considerations and effective learning require that sufficient facilities be provided 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 practical skills and underpinning knowledge associated with successful oxy-acetylene 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.

Delivery of personal, learning and thinking skills (PLTS)

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	identifying equipment, and variables in its use
Creative thinkers	producing a risk assessment identifying and explaining variables
Reflective learners	setting up oxy-acetylene equipment and employing welding and brazing techniques
Self-managers	setting up oxy-acetylene equipment and employing welding and brazing techniques.