

Unit 45: Land-based Engineering Operations – Perform Thermal Joining and Cutting Processes

Unit code: A/600/3427

QCF Level 2: BTEC First

Credit value: 10

Guided learning hours: 60

● Aim and purpose

The aim of this unit is to provide the learner with the knowledge and skills required for carrying out thermal joining and cutting processes within Land-based operations. This unit aims to introduce learners to the skills and knowledge in thermal joining and cutting processes and how these can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or onto further/higher education.

● Unit introduction

Land-based machinery and equipment is invariably built of metal components, often of heavy construction. The ability to cut and thermally join these is an important skill for any workshop operative. The size and complexity of the work carried out in the workshop facilities depends on the skill of the employees and the type of equipment and facilities available.

The majority of land-based businesses have some form of workshop associated with which are generally used for the maintenance and repair of land-based machinery and installations. They are important in helping businesses ensure their equipment and installations are available at the times that they are needed, reducing down time and costs.

This unit has been designed to cover the basic thermal joining and cutting process requirements within land-based workshops. Learners will learn how to use basic welding and cutting equipment commonly found in a land-based setting safely. The associated skills will be integrated with the development and use of basic maintenance and repair techniques.

Health and safety is integral and of paramount importance — not just while the learner or employee is working within the workshop. Learners will need to consider the safety of those working with, or coming into contact with, the equipment or installations being maintained and/or repaired.

● Learning outcomes

On completion of this unit a learner should:

- 1 Be able to perform thermal joining and cutting
- 2 Know how to perform thermal joining and cutting techniques.

Unit content

1 Be able to perform thermal joining and cutting

Techniques: oxy-acetylene; manual metal arc (MMA); metal inert gas (MIG); soldering and bronze welding (brazing)

Metals: ferrous and non-ferrous metals and their suitability

Equipment: joining equipment, personal protective equipment (PPE)

Preparation: cleaning; material removal (abrasives, filing, grinding); fire prevention, spatter control; light control; joint preparation (marking out, preparation, positioning of materials); clamping; tacking; bevelling; positioning

Joints: butt; lap; fillet

Techniques: positioning; clamping; tacking; single run; multi-run; using the downhand technique

Health and safety: health and safety; risk assessment; safe working practices; PPE; environmental risk assessment; fumes; dust; heat; light and heat radiation; sparks and spatter; relevant current legislation and codes of practice

2 Know how to perform thermal joining and cutting techniques

Techniques: oxy-acetylene; manual metal arc (MMA); metal inert gas (MIG); soldering and bronze welding (brazing)

Identification methods for ferrous and non-ferrous metals: filing; sawing; spark test; nick break; 'scrape'; heat

Preparation: cleaning; material removal (abrasives, filing, grinding); fire prevention; spatter control; light control; joint preparation (marking out, preparation, positioning of materials); clamping; tacking; bevelling; positioning

Safe selection, preparation and use of equipment: setting pressures; amperage; voltages; selecting electrode sizes; nozzle sizes; wire speed; selection of fluxes for bronze welding and soldering; the properties and purpose of flux; the methods for removal of welding slag; the range of techniques necessary to prepare material prior to downhand welding; how to control distortion, weld and heat effects

Detection and correct identification of faults and their causes in welded joints: visual inspection; non-destruction and destruction testing; fault-undercutting, slag traps, penetration, cracking and leak testing

Precautions required when engaging in a thermal joining and cutting process: fumes; explosions; fire; sharp edges; airborne debris; personal injury

Oxy-acetylene gas heating and cutting: nozzles; pressures and settings; changing and connecting gas cylinders; fire prevention and safety

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 identify welding and thermal joining equipment [IE]	M1 plan, prepare and carry out thermal joining tasks to a high standard	D1 evaluate a simple welded joint to meet given objectives.
P2 identify ferrous and non-ferrous materials and their suitability [IE]		
P3 prepare workplace, materials and equipment to carry out a thermal joining process [SM]		
P4 use the correct techniques to carry out thermal joining tasks [SM]		
P5 join ferrous or non-ferrous materials to the required quality and dimensions [SM]		
P6 identify faults in welded, bronze welded and soldered joints [SM]		
P7 inspect and maintain equipment and change consumables used in joining processes [SM]		
P8 safely set up and shut down equipment for oxy-acetylene gas heating, cutting and joining [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:
P9 describe how to identify ferrous and non-ferrous materials and their respective joining characteristics	M2 compare a range of joining techniques and their use with different materials	D2 select and justify the choice of basic welding equipment, materials and joining techniques to meet a given objective.
P10 describe material preparation and joining procedures		
P11 describe the techniques for joining ferrous and non-ferrous materials using gas and electric welding and soldering methods		
P12 describe how to select, prepare and set the relevant equipment to carry out welding and joining tasks	M3 explain the importance of correct selection, preparation and setting of equipment used in welding and joining tasks.	
P13 describe how to detect and correctly identify faults and their causes in welded joints [CT]		
P14 describe the precautions required when engaging in a thermal joining and cutting process		
P15 describe how to safely set up equipment and use the correct techniques for oxy-acetylene gas heating, cutting and joining. [CT, RL]		

PLTS: This summary references where applicable in the pass criteria, in the square brackets, the elements of the personal, learning and thinking skills. 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

All centres must comply with the requirements of relevant, current legislation and codes of practice eg the *Prevention of Accidents to Children in Agriculture Regulations 1998*; and associated approved codes of practice. Learners must be made aware of, and have access to, relevant health and safety legislation and know the importance of the use of risk assessments appropriate to each situation. Appropriate risk assessments must precede all practical machinery activities and learners must work in a safe manner at all times when using equipment or working with machinery. Learners must be supervised at all times and tutors must not ask learners to undertake tasks that are beyond their physical capabilities.

Tutors have the opportunity to use as wide a range of delivery techniques as possible. It is likely that delivery will have a strong practical bias, with supervised workshop sessions. Lectures, discussions, seminar presentations, site visits, internet and library-based research and the use of personal and/or industrial experience would also be suitable delivery methods.

Where used to support delivery of this unit, 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 take part in welding activities and they should be encouraged to ask for observation records and/or witness statements to be provided as evidence. Guidance on the use of observation records and witness statements is provided on the Edexcel website.

Learners will develop their knowledge about the safe use of basic welding and cutting equipment in the maintenance of land-based machinery and installations. Tutors are required to cover the four methods listed in the unit content but it is accepted that learners may not become proficient in all of these during the learning time available. Tutors can concentrate practical delivery on one of the systems and, if time and learner development allow, move on to the other methods. Learners should be given the background theory and practical demonstrations of all the systems. Visiting expert speakers could add to the relevance of the subject for learners. For example, a mechanic working with land-based machinery could talk about their work and the welding systems they use to maintain and repair appropriate machinery and installations.

Tutors should consider integrating the delivery, private study and assessment relating to this unit with any other relevant units and assessment instruments learner's may also be taking as part of their programme of study.

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 review of unit; testing of previous knowledge.

Theory session: health and safety; hazards and precautions.

Topic and suggested assignments/activities and/assessment

Assignment 1: Thermal Joining Techniques (P9, P10, P11, M2)

Tutor introduces the assignment brief.

Theory session: ferrous and non-ferrous metals: properties, joining characteristics and identification.

Theory and demonstration: material preparation and joining techniques.

Assessment completion.

Assignment 2: Preparation for Thermal Joining (P12, P13, P14, P15, M3, D2)

Tutor introduces the assignment brief.

Theory and demonstration: selecting, preparing and setting up equipment, workshop precautions.

Practical sessions: selecting, preparing and setting up equipment.

Assessment completion.

Assignment 3: Thermal Joining (P1, P2, P3, P4, P5, P6, P7, P8, M1, D1)

Tutor introduces the assignment brief.

Theory and demonstration- gas welding.

Workshop practicals: oxy-acetylene welding.

Theory and demonstration: oxy-acetylene heating and cutting.

Workshop practicals oxy-acetylene cutting.

Theory and demonstration session- manual metal arc welding.

Workshop practicals: manual metal arc welding.

Theory and demonstration session: metal inert gas welding.

Workshop practicals: metal inert gas welding.

Theory and demonstration: soldering and bronze welding.

Workshop practicals: soldering and bronze welding.

Theory and practical: fault identification.

Assignment completion and practical observation.

Unit review.

Assessment

P1 requires learners to identify welding and thermal joining equipment and 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 worklogs or other relevant learner notes. If assessed during a work placement, witness statements should be provided by a suitable representative and verified by the tutor.

Alternatively, evidence could take the form of a pictorial presentation with notes (possibly using appropriate software or an overhead projector), an annotated poster or a written assignment.

For P2, learners are required to identify ferrous and non-ferrous materials and their suitability for welding and joining. The tutor should provide examples of common ferrous and non-ferrous metals used in the construction of machinery and equipment. P2 could be assessed directly by the tutor during practical activities using verbal questioning techniques. Alternatively, it could be assessed in a classroom-based situation using pre selected examples of relevant material.

For P3, learners need to prepare the workplace, materials and equipment to carry out a thermal joining process. P3 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 worklogs or other relevant learner notes. If assessed during a work placement, witness statements should be provided by a suitable representative and verified by the tutor.

P4 requires learners to use the correct techniques to carry out a minimum of three thermal joining tasks. Safe working techniques and the use of personal protective equipment (PPE) must form part of this. Assessment and evidence could take the same form as for P3.

P5 requires learners to join ferrous or non-ferrous material to meet the required quality and dimensions. Learners will be expected to use at least four types of welding system. Tutors should identify the given objectives, which may include basic quality tolerances. Three types of join should be produced, each by four different techniques, all to an acceptable standard. Safe working techniques and the use of personal protective equipment (PPE) must form part of this. Assessment and evidence of this could take the same form as for P3.

In P6 learners are required to identify faults in thermal joints including welded, soldered and bronze welds. This could be carried out using the joints produced in P5 or using examples provided by the tutor to ensure coverage of thermal joining faults. Assessment and evidence of this could take the same form as for P1.

P7 requires learners to inspect and maintain equipment and replace consumables as necessary. P7 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 worklogs or other relevant learner notes. If assessed during a work placement, witness statements should be provided by a suitable representative and verified by the tutor.

P8 requires learners to set up and shut down equipment for oxy-acetylene gas heating, cutting and joining safely. Safeing work techniques and the use of personal protective equipment (PPE) must form part of this. Assessment and evidence of this could take the same form as for P3.

P9 requires learners to describe how to identify ferrous and non-ferrous material and their respective joining characteristics. This could be combined with the assessment for P2. P9 could be assessed directly by the tutor during practical activities, or through completion of a written or verbal assignment. Evidence for this could be provided in the same form as for P1.

For P10, learners are required to describe material preparation and joining procedures prior to tasks being carried out. Assessment could be carried out at the same time as P3, or it could be linked to P9. P10 could be assessed directly by the tutor during practical activities, or through completion of a written or verbal assignment. Evidences could be in the same form as for P1.

P11 requires learners to describe the techniques for joining ferrous and non-ferrous materials using gas and electric welding and soldering techniques. Assessment could be carried out at the same time as P4, or in a written or verbal report linked to P10. Assessment and evidence for this could be provided in the same form as for P1.

P12 requires learners to describe how to select, prepare and set the relevant equipment to carry out welding and joining tasks. Assessment could be carried out at the same time as P3 and evidence provided in the same manner, or through a written or verbal report, poster, leaflet or presentation.

P13 requires learners to describe how to detect and identify faults and their causes correctly in welded joints. Assessment may be linked to P6, or in the same format as for P12.

For P14, learners must describe the precautions required when engaging in a thermal joining and cutting process. Assessment could be carried out at the same time as P3, or as a separate assignment with evidence in the same form as for P12.

P15 requires learners to describe how to set up equipment and use the correct techniques for oxy-acetylene gas heating, cutting and joining safely. This could be assessed in conjunction with P8. Assessment and evidence for this could be provided in the same form as for P1.

For M1, learners must plan, prepare and carry out thermal joining tasks to a high standard. Assessment could be directly linked to the relevant pass criteria, with learners demonstrating their ability to plan the tasks and prepare and carry out thermal joining to a high standard. A minimum of three joining tasks should be included, with assessment taking the same form as for P3.

M2 requires learners to compare a range of joining techniques and their use with different materials. Assessment could be in the same form as for P1.

For M3, learners are required to explain the importance of correct selection, preparation and setting of equipment. This is likely to be linked to evidence presented for P12, P13, P14 and P15 and presented in the same format.

For D1, learners are required to evaluate a simple welded joint to meet given objectives. This may be a joint produced from their own work, or one provided by the tutor. D1 could be assessed during practical activities or within the workplace. Alternatively, assessment could be carried out using a pre selected example of a completed welded joint. Suitable evidence from guided activities would be observation records completed by learners and the tutor, and accompanied by appropriate worklogs or other relevant learner notes. If assessed during a work placement, witness statements should be provided by a suitable representative and verified by the tutor.

For D2, learners need to select and justify their choice of basic welding equipment, materials and joining techniques to meet a given objective. Evidence may be a written or report, completed case study or presentation.

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, P3, P4, P5, P6, P7, P8, M1, D1	Thermal Joining	You are a trainee fitter in an agricultural workshop. You are required to produce three different types of weld using four different techniques to a standard acceptable by the workshop manager. As part of your training you are also required to identify faults in welded and soldered joints, and to evaluate your own work against the objectives set.	Practical Assessment.
P9, P10, P11, M2	Thermal Joining Techniques	Your manager is very pleased with your work, and has asked you to prepare a poster for display in the workshop. This should include how to identify different materials, material preparation and a comparison of the range of joining techniques.	Annotated poster.
P12, P13, P14, P15, M3, D2	Preparation for Thermal Joining	Having now completed your training, you are helping to support a new trainee. Prepare some guidance notes that include how to set up for welding and oxy-acetylene gas cutting, the precautions to take, and how to detect and identify faults in welded joints.	Written guidance notes.

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
LEO9 Core land-based engineering principles – Thermal joining processes	Land-based Engineering Operations – Perform Thermal Joining Processes

Essential resources

Learners will need supervised access to workshop facilities containing a sufficiently diverse range of materials and equipment to meet the unit requirements. Health and safety considerations and effective learning require that there are sufficient facilities allow for one welding station per learner. Learners should also have access to sufficient library and internet facilities to enable research into techniques, materials, equipment and work examples. This unit requires vocationally-specific craft knowledge and appropriately qualified tutors to deliver it.

Employer engagement and vocational contexts

It is essential that this unit be delivered in an applied and vocational context. Work-based experience will also be important. The unit will be enhanced by contact with employers. Centres are encouraged to develop links with local businesses, manufacturers, machinery dealers and workshops, who can support the breadth and application of this unit. Employers can provide real-work practical exercises, and guest speakers and experts to support the learning experience.

Indicative reading for learners

Textbooks

Finch R – *Welder's Handbook: A Guide to Plasma Cutting, Oxyacetylene, ARC, MIG and TIG Welding, Revised Edition* (HP Books, 2007) ISBN 1557885133

Flood C – *Fabrication Welding and Metal Joining Processes* (Butterworth-Heinemann, 1981) ISBN 0408004487

Gibson S and Smith A – *Basic Welding* (Thomson Learning, 1993) ISBN 0333578538

Gourd L – *Principles of Welding Technology, 3rd Edition* (Butterworth-Heinemann, 1995) ISBN 0340613998

Griffin I, Roden E and Briggs C – *Basic Oxyacetylene Welding, 4th Edition* (Delmar, 1984) ISBN 0827321376

Griffin I, Roden E and Briggs C – *Basic Arc Welding, 4th Edition* (Delmar, 1984) ISBN 0827321317

Health and Safety Executive – *Health and Safety in Arc Welding* (HSE Books, 2000) ISBN 0717618137

HSE – *Essentials of Health and Safety at Work* (HSE Books, 2006) ISBN 0717661794

Kenyon W – *Basic Welding and Fabrication, 2nd Edition* (Longman, 1987) ISBN 0582005361

Pearce A – *Farm and Workshop Welding, 2nd revised Edition* (Old Pond Publishing Ltd, 2007) ISBN 1905523300

Pritchard D – *Soldering, Brazing & Welding: A Manual of Techniques* (The Crowood Press, 2001) ISBN 1861263910

Farnsworth S – *Welding for Dummies* (John Wiley and Sons, 2010) ISBN 0470455969

Websites

www.baba.org.uk

www.bagma.com

www.gowelding.com

www.howstuffworks.com

www.hse.gov.uk

www.roymech.co.uk

www.twi.co.uk

British Artist Blacksmiths Association

British Agricultural and Garden Machinery Association

Go Welding

HowStuffWorks

Health and Safety Executive

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 welding and thermal joining equipment identifying ferrous and non-ferrous materials and their suitability
Creative thinkers	describing how to detect and identify faults and their causes correctly in welded joints
Reflective learners	identifying faults in welded, bronze welded and soldered joints
Self-managers	preparing workplace, materials and equipment to carryout a thermal joining process using the correct techniques to carry out thermal joining tasks joining ferrous or non-ferrous materials to the required quality and dimensions inspecting and maintaining equipment and changing consumables used in joining setting up and shutting down equipment for oxy-acetylene gas heating, cutting and joining safely.

Although PLTS opportunities are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	describing how to identify ferrous and non-ferrous materials describing how to select, prepare and setup the relevant equipment to carryout welding and joining tasks.

● Functional Skills — Level 2

Skill	When learners are ...
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: <ul style="list-style-type: none"> • text and tables • images • numbers • records 	
Bring together information to suit content and purpose	producing a report comparing a range of joining techniques
Present information in ways that are fit for purpose and audience	giving presentation to peers
Evaluate the selection and use of ICT tools and facilities used to present information	
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	
Draw conclusions and provide mathematical justifications	
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	describing how to identify ferrous and non-ferrous materials describing how to select, prepare and set the relevant equipment to carryout welding and joining tasks describing the precautions required when engaging in a thermal joining and cutting process
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	producing a report comparing a range of joining techniques.