ABC Awards

SEG Awards ABC Level 3 Certificate and Level 3 Diploma in Fabrication and Welding Practice

Qualification Guidance

Level 3 Certificate – 603/2258/5
Level 3 Diploma – 603/2259/7

About Us

At the Skills and Education SEG Awards (ABC)[1] we continually invest in high quality qualifications, assessments and services for our chosen sectors. As a UK leading sector specialist we continue to support employers and skills providers to enable individuals to achieve the skills and knowledge needed to raise professional standards across our sectors.

ABC has an on-line registration system to help customers register learners on its qualifications, units and exams. In addition it provides features to view exam results, invoices, mark sheets and other information about learners already registered.

The system is accessed via a web browser by connecting to our secure website using a username and password:
https://secure.ABCawards.co.uk/ors/secure_login.asp

Sources of Additional Information

The ABC Award's website www.ABCawards.co.uk provides access to a wide variety of information.

Copyright

Specification Code, Date and Issue Number

The specification code is C5701-03 (Certificate) and D5700-03 (Diploma). The date of this specification is June 2019. The Issue number is 2.2.

[1] ABC Awards is a brand of the Skills and Education Group Awards, a recognised awarding organisation and part of the Skills and Education Group. Any reference to ABC Awards, its registered address, company or charity number should be deemed to mean the Skills and Education Group Awards.

Contents

This is a live document and as such will be updated when required. It is the responsibility of the approved centre to ensure the most up-to-date version of the Qualification Guide is in use. Any amendments will be published on our website and centres are encouraged to check this site regularly.

Introduction

The new suite of ABC Awards qualifications in Fabrication and Welding Practice have been updated to include the latest fabrication and welding techniques, materials, processes and practices, and assessed in line with industry demands, which include updated rigorous practical assessments as well as online on-demand multiple-choice question (MCQ) assessments.

They have been developed in conjunction with academia and industry experts and will also complement the newly launched Apprenticeship Trailblazer Standards.[2]

The Level 3 Certificate and Diploma in Fabrication and Welding Practice are suitable for a wide range of learners, for example the self-employed, adults wishing to specialise by pursuing single units and young people who are new entrants to the industry. They link to the Level 1 Certificate and the Level 2 Award and Certificate in Fabrication and Welding Practice.

The overall aims of the qualifications across the 3 Levels are to:

- raise a learner's skill level and enhance their underpinning knowledge to promote progression from basic welding and fabrication skills to a more highly developed understanding of equipment functions and how materials behave when subjected to the welding process
- educate the learner in the observation of the correct and safe procedures that are paramount in the welding and fabrication industry.

Aims

The Level 3 Certificate and Diploma in Fabrication and Welding Practice aim to:

- provide an opportunity for existing employees to obtain relevant and up to date technical knowledge to meet the requirements of the application of practical skills
- provide an opportunity for acquiring practical skills in different processes and positions.

[2] Please see the Government apprenticeship standards website for further information gov.uk/government/collections/apprenticeship-standards

- provide an opportunity for progression onto further/higher levels of study.

Target Group

The Level 3 Certificate and Diploma in Fabrication and Welding Practice are designed for a wide range of learners such as:

- the self-employed
- adults wishing to pursue single units as a specialism
- adults wishing to update their personal skills and knowledge in fabrication and/or welding
- young people who are following an Apprenticeship programme.

ABC Awards expects approved centres to recruit with integrity on the basis of a learner's ability to contribute to and successfully complete all the requirements of a unit(s) or the full qualification.

Content Overview

The Level 3 Certificate qualification includes a mandatory externally assessed unit 'Materials, Science and Calculations for Fabrication and Welding Practice' plus a choice of another 3 units from 5 on MMA, MAGS, TAGS (all Vertical) welding, Plate and Sheet Metal Fabrication.

The Level 3 Diploma qualification builds on the Certificate from which learners must choose a further 3 units from a choice of 7 that include MMA, MAGS, TAGS (all Overhead) welding, Flux Cored MAGS welding and Pipe Welding, Advanced Plate and Advance Sheet Metal Fabrication. Learners must also complete another mandatory external assessment on either 'Welding Practice and Procedures' or 'Fabrication Practice and Procedures'.

Grading

The Level 3 Certificate in Fabrication and Welding Practice and Level 3 Diploma in Fabrication and Welding Practice, are pass or fail only overall. For both qualifications, the mandatory unit in Group A – Materials, Science and Calculations MCQ Exam, is pass/fail only and learners must achieve a minimum of 60% in order to pass. All other units are graded practical assessments, which can result in a fail, pass, merit or distinction.

The Level 3 Diploma has the Welding Practice and Procedures MCQ Exam or the Fabrication Practice and Procedures MCQ Exam, depending on the pathway taken, which are both pass/fail only.

The maximum achievable grade of the qualification is a pass.

Progression Opportunities

Learners who successfully complete the Level 3 Certificate in Fabrication and Welding Practice could complete additional units to gain the Level 3 Diploma in Fabrication and Welding Practice.

Learners could also continue their development by covering critical welds or by seeking to achieve approval under European Standards.

Centres should be aware that reasonable adjustments which may be permitted for assessment may in some instances limit a learner's progression into the sector. Centres must, therefore, inform learners of any limits their learning difficulty may impose on future progression.

Resource Requirements

Centres must provide access to sufficient equipment in the centre or workplace to ensure candidates have the opportunity to cover all of the practical activities.

For external assessments the examination should be conducted at the Centre where the course delivery has taken place and should be carried out in accordance with the examination requirements of ABC Awards.

Tutor/Assessor Requirements

We require those involved in the assessment process to be suitably experienced and / or qualified. In general terms, this usually means that the assessor is knowledgeable of the subject / occupational area to a level above that which they are assessing.

Assessors should also be trained and qualified to assess or be working towards appropriate qualifications.

Language

These specifications and associated assessment materials are in English only.

Qualification Summary

Qualification and Pathways Level 3 Certificate in Fabrication and Welding Practice Level 3 Diploma in Fabrication and Welding Practice	
Qualification Number	Level 3 Certificate – 603/2258/5 Level 3 Diploma – 603/2259/7
Regulated	The qualifications, identified above, are regulated by Ofqual.
Assessment	Internal assessment, internal and external moderation.
Grading	Pass
Operational Start Date	01/09/2017
Ofqual Review Date	01/09/2020
ABC Sector	Engineering
Ofqual SSA Sector	4.1 Engineering
Contact	See the ABC Awards website for Centre Support Officer responsible for these qualifications.

Level 3 Certificate in Fabrication and Welding Practice

Rules of Combination:
Learners wishing to follow a **Welding Pathway** must pass a minimum of 4 units.
1 unit must be from Group A.
3 units must be from Group B.

Learners wishing to follow a **Fabrication and Welding** Pathway must pass a minimum of 4 units.
1 unit must be from Group A.
1 unit must be from Group B.
1 unit must be from Group C.
A 4th unit can come from Group B or C.

Units	Unit Number	Level	Credit Value	GLH
Mandatory – Group A				
1. Materials, Science and Calculations for Fabrication and Welding Practice	D/616/1291	3	8	80
Optional - Group B				
2. Manual Metal-Arc Welding – (Vertical) Low Carbon Steel, Stainless Steel or Aluminium	H/616/1292	3	7	60
3. Metal-Arc Gas Shielded Welding – (Vertical) Low Carbon Steel, Stainless Steel or Aluminium	K/616/1293	3	7	60
4. Tungsten-Arc Gas Shielded Welding – (Vertical) Low Carbon Steel, Stainless Steel or Aluminium	M/616/1294	3	7	60
Optional - Group C				
5. Fabrication Processes – Plate (3 mm and Above in Thickness)	T/616/1295	3	7	60
6. Fabrication Processes – Sheet Metal (Below 3 mm in Thickness)	A/616/1296	3	7	60

Level 3 Diploma in Fabrication and Welding Practice

Rules of Combination:
Learners wishing to follow a **Welding Pathway** must achieve a minimum of 7 units as follows:

- 1 unit from Group A
- 3 units from Group B
- 3 units from group D
- End-of-programme 40 question multiple-choice question (MCQ) examination on 'Welding Practice and Procedures'.

Learners wishing to follow a **Fabrication and Welding Pathway** must achieve a minimum of 7 units as follows:

- 1 unit from Group A
- 1 unit from Group B
- 1 unit from Group C
- 1 unit from either Group B or C (must be a different unit from one already selected above)
- 1 unit from Group D
- 1 unit from Group E
- 1 unit form either Group D or E (must be a different unit from one already selected above).
- End-of-programme 40 question multiple-choice question (MCQ) examination on 'Fabrication Practice and Procedures'.

Units	Unit Number	Level	Credit Value	GLH
Mandatory – Group A				
1. Materials, Science and Calculations for Fabrication and Welding Practice	D/616/1291	3	8	80
Optional – Group B				
2. Manual Metal-Arc Welding – (Vertical) Low Carbon Steel, Stainless Steel or Aluminium	H/616/1292	3	7	60
3. Metal-Arc Gas Shielded Welding – (Vertical) Low Carbon Steel, Stainless Steel or Aluminium	K/616/1293	3	7	60
4. Tungsten-Arc Gas Shielded Welding – (Vertical) Low Carbon Steel, Stainless Steel or Aluminium	M/616/1294	3	7	60

Optional - Group C				
5. Fabrication Processes – Plate (3 mm and Above in Thickness)	T/616/1295	3	7	60
6. Fabrication Processes – Sheet Metal (below 3 mm in Thickness)	A/616/1296	3	7	60
Optional - Group D				
7. Manual Metal-Arc Welding – (Overhead) Low Carbon Steel, Stainless Steel or Aluminium	F/616/1297	3	7	60
8. Metal-Arc Gas Shielded Welding – (Overhead) Low Carbon Steel, Stainless Steel, Aluminium	J/616/1298	3	7	60
9. Tungsten-Arc Gas Shielded Welding – (Overhead) Low Carbon Steel, Stainless Steel, Aluminium	L/616/1299	3	7	60
10. Thick Plate Welding using Flux Cored Metal-Arc Gas Shielded Welding	T/616/1300	3	7	60
11. Pipe Welding using Manual Metal-Arc Welding, Metal-Arc Gas Shielded Welding or Tungsten-Arc Gas Shielded Welding	A/616/1301	3	7	60
Optional - Group E				
12. Advanced Fabrication Processes – Plate (3 mm and Above in Thickness)	F/616/1302	3	7	60
13. Advanced Fabrication Processes – Sheet Metal (Below 3 mm in Thickness)	J/616/1303	3	7	60
End-of-Programme MCQ				
End-of-programme MCQ examination: 'Welding Practice and Procedures' or 'Fabrication Practice and Procedures'	NA	3	NA	NA

If learners achieve credits from units of the same title (or linked titles) at more than one level, they cannot count credits achieved from both units towards the credit target of a qualification.

Qualification Purpose	B. Prepare for further learning or training and/or develop knowledge and/or skills in a subject area. B2. Develop knowledge and/or skills in a subject area.							
Entry Requirements	There are no formal pre-requisites for entry onto this scheme. Each centre is required to notify the awarding body of its policies on access and equality of opportunity. Within the parameters of these policies, a centre is expected to recruit with integrity on the basis of a learner's ability to contribute to and successfully complete the qualification.							
Age Range	Pre 16		16 - 18	✓	18+	✓	19+	✓
Recommended GLH	Level 3 Certificate – 230 Level 3 Diploma – 440							
Recommended TQT	Level 3 Certificate – 290 Level 3 Diploma – 500							
Credit Value	Level 3 Certificate – 29 Level 3 Diploma – 50							
Learning Aims Reference	See Learning Aim Reference Service (LARS) website: https://data.gov.uk/dataset/learning-aim-reference-service							
Type of Funding Available	See Learning Aim Reference Service (LARS) website							
Qualification Fee / Unit Fee	See ABC website for current fees and charges.							
Additional Information	See ABC website for resources available for this qualification.							

Unit Details

1. Materials, Science and Calculations for Fabrication and Welding Practice

Unit Reference	D/616/1291
Level	3
Credit Value	8
Guided Learning Hours	80
Unit Summary	This is a mandatory unit which will be assessed by a 40 question on-line multi-choice question (MCQ) assessment. Learners will gain an understanding of various topics associated with the related aspects of welding and fabrication. The main areas or key focus points are materials, science, calculations and quality control of welding and fabrication operations. There is no practical requirement for this unit, however, observation of demonstrations concerning various aspects of the assessment criteria carried out in the workshop or laboratory is to be encouraged.

Learning Outcomes The learner will:	Assessment Criteria The learner can:
1. Identify a range of materials used in engineering	1.1. Identify the characteristics of materials used in engineering, to include: • ferrous metals • non–ferrous metals • thermoplastics • thermosetting plastics • ceramics • composites 1.2. Identify an engineering application for each material listed in 1.1 1.3. Identify the approximate carbon percentage of: • low carbon steel • medium carbon steel • high carbon steel 1.4. Identify common alloying elements added to steel 1.5. Describe the changes to the mechanical properties of steels by the addition of alloying elements 1.6. Identify typical compositions of common engineering materials, to include • stainless steel • brass • bronze • duralumin
2. Know about the crystalline structure of weld deposits in steels	2.1. Identify the different types of crystalline structure found in both single pass and multi pass weld deposits found in welded joints in steels, to include: • parent material • weld deposit • heat affected zone (HAZ) 2.2. Identify the stages of recrystallisation and grain growth in steel

3. Know about heat treatments and the effects of heat on materials	3.1. Identify the heat treatment process of materials, to include: • annealing • normalising • hardening • tempering • stress relieving 3.2. Describe how the properties of a material can be changed by the application of a heat treatment process 3.3. Describe the effects of hot and cold working on the mechanical properties of steels 3.4. Identify the purpose of using pre and post heating on welded joints in steels 3.5. Describe the effects of welding and cooling rates on the structure and mechanical properties of welded joints
4. Know about the mechanical testing of materials and the properties of materials	4.1. Identify methods of mechanically testing materials, to include: • tensile testing • hardness testing (Brinell, Vickers and Rockwell) • charpy/izod testing • fatigue testing 4.2. Define the terms associated with the properties of materials, to include: • work hardening • weldability of materials • hardenability • cold working 4.3. Identify the effects when different types of forces are applied to a material, to include: • tensile force • compressive force • shear force • torsion

5. Understand the structure and state of matter	5.1. Recognise the three states of matter 5.2. Identify the basic structure of matter, to include: • atoms • molecules • elements • compounds • mixtures 5.3. Be able to give examples of elements, compounds and mixtures
6. Understand the units used in the SI system	6.1. Recognise the SI units for engineering applications, to include: • force • energy • heat • time • length • area • volume • mass • electrical current • gas pressure
7. Understand the electrical principles and conditions of welding processes	7.1. Define: • open circuit voltage (OCV) • arc voltage • welding current 7.2. Identify the effects of increasing/decreasing the arc length when MMA welding on the: • welding current • arc voltage 7.3. Identify the characteristics of a welding power source, to include flat and drooping types 7.4. Identify welding processes that use flat or drooping characteristic type power sources 7.5. Explain the terms associated with welding power sources, to include: • duty cycles • single and three phase systems • tapped reactor • moving core reactor

8. Be able to use calculations relating to fabrication and welding activities	8.1. Calculate volume and surface areas applicable to fabricated and welded assemblies 8.2. Calculate the cost of welding, to include: • purchase of equipment • cost of consumables • purchase of materials • cost of labour 8.3. Calculate total length of welding required for a fabricated assembly 8.4. Calculate unknown angles and side lengths in right angled triangles using trigonometry 8.5. Calculate unknown side lengths in right angled triangles using the Pythagoras theory 8.6. Calculate the length of flat section required to produce a cylinder of a given diameter using the mean or neutral line 8.7. Calculate bending allowances when producing bends/folds in material

9. Know about the problems associated with the manufacture of fabricated and welded assemblies	9.1. Identify different types of distortion that can occur in welded assemblies, to include: • longitudinal • transverse • angular 9.2. Identify methods used for the control of distortion in welded assemblies 9.3. Describe the importance of selecting and using the correct joint preparation for a given joint type 9.4. Describe typical welding defects specific to the welding processes listed: • MMA welding • MAGS welding • TAGS welding 9.5. Identify the problems associated with the conditions found in a completed welded joint, to include: • residual stress • corrosion • shock loading • distortion
10. Know the importance of quality assurance in fabrication and welding activities	10.1. Describe the application and procedures to be followed when carrying out non-destructive testing (NDT) of welded joints, to include: • dye penetrant testing • magnetic particle testing • ultrasonic flaw detection • radiography 10.2. Identify the limitations of using the NDT methods listed in 10.1 10.3. Identify the importance of carrying out quality control checks on welding consumables 10.4. Identify the application and use of quality control documentation, to include: • welding procedure specification (WPS) • Inspection report for welding • certificates of conformity (consumables)

Supporting Unit Information

Materials, Science and Calculations for Fabrication and Welding Practice – D/616/1291 – Level 3

Indicative Content

Note: Indicative content provides an indication of the scope for the Learning Outcomes and Assessment Criteria. It is intended as a resource to help guide the delivery and assessment of the unit. Indicative content is NOT a statement of material which must be covered and evidenced for assessment.

Learning Outcome 1. Identify a range of materials used in engineering

1.1 Identify the characteristics of materials used in engineering – Ferrous metals, non-ferrous metals, thermoplastics, thermosetting plastics, ceramics and composites.

1.2 Identify an engineering application for ferrous metals, non-ferrous metals, thermoplastics, thermosetting plastics, ceramics and composites.

1.3 Identify the approximate carbon percentage of low carbon steel, approximately 0.05% to 0.25% carbon content with up to 0.4% manganese content. Medium carbon steel approximately 0.29% to 0.54% carbon content with 0.60 to 1.65% manganese content and high carbon steel, approximately 0.55% to 0.95% carbon content with 0.30 to 0.90% manganese content.

1.4 Identify common alloying elements added to steel – manganese, nickel, chromium, molybdenum, vanadium, silicon, and boron.

1.5 Describe the changes to the mechanical properties of steels by the addition of alloying elements of manganese, nickel, chromium, molybdenum, vanadium, silicon, and boron.

1.6 Identify typical compositions of common engineering materials – stainless steel: containing carbon, chromium, nickel and/or manganese. Brass: containing copper and zinc. Bronze: containing primarily copper, commonly with about 12% tin and often with the addition of other metals (such as aluminium, manganese, nickel or zinc). Duralumin: containing 95% aluminium, 4% copper, 0.5% magnesium and 0.5% manganese.

Learning Outcome 2. Know about the crystalline structure of weld deposits in steels

2.1 Identify the different types of crystalline structure found in both single pass and multi pass weld deposits found in welded joints in steels – parent material, weld deposit and heat affected zone – reference to equiaxe grain sizes in the HAZ, in the centre of the weld and columnar grains around the edge of the weld. Refer to the application of welds and the refinement of grains.

2.2 Identify the stages of recrystallisation and grain growth in steel following the application of heat when welding.

Learning Outcome 3. Know about heat treatments and the effects of heat on materials

3.1 Identify the heat treatment process of materials including annealing, normalising, hardening, tempering and stress relieving including critical temperatures and soaking times for low carbon and austenitic stainless steel.

3.2 Describe how the properties of a material can be changed by the application of a heat treatment process.

3.3 Describe the effects of hot and cold working on the mechanical properties of steels with reference to the shape and size of the grains when worked – ductility, malleability, hardness, toughness, brittleness etc.

3.4 Identify the purpose of using pre and post heating on welded joints in steels with regards to grain structures and mechanical properties of materials.

3.5 Describe the effects of welding and cooling rates on the structure and mechanical properties of welded joints.

Learning Outcome 4. Know about the mechanical testing of materials and the properties of materials

4.1 Identify methods of mechanically testing materials – tensile testing, hardness testing (Brinell, Rockwell, Vickers), Charpy/Izod testing for toughness and fatigue testing. Provide the learners with the opportunity to perform and/or observe examples of tensile test graphs. Indicate on the graphs, elastic limit, and limit of proportionality, yield point, ultimate tensile strength (true and engineering strength) and fracture point. As appropriate use calculations to enhance descriptions of the behaviour of a materials subject to a tensile force in terms of stress, strain and elasticity, yield strength, tensile strength, percentage elongation, percentage

reduction in area, stiffness (without proof of Young's modulus), proof stress. Define Hooke's Law.

4.2 Define the terms associated with the properties of materials.
Work hardening (the use of mechanical methods to increase the hardness value of the material being worked).
Weldability (a material's ability to be satisfactorily welded, without the need for), mass (), electrical current (ampere) and gas pressure (bar)additional precautions such as pre-heating, type of gas shield etc, by a variety of welding processes).
Hardenability (the depth to which a material can be hardened on cooling and cold working).
Cold working (the working of a material in the cold condition such as hammering, forming, bending and rolling).

4.3 Identify the effects when different types of forces are applied to a material – tensile force, compressive force, shear force and torsion.

Learning Outcome 5. Understand the structure and states of matter

5.1 Recognise the three states of matter – solids, liquids and gases

5.2 Identify the basic structure of matter – atoms, molecules, elements, compounds and mixtures.

5.3 Be able to give examples of elements, compounds and mixtures.

Learning Outcome 6. Understand the units used in the SI system

6.1 Recognise the SI units for engineering applications – force (Newton), energy (Joule), heat (Joule), time (seconds), length (metre), area (square metre), volume (cubic metre), mass (kilogramme), electrical current (ampere) and gas pressure (pascal).

Learning Outcome 7. Understand the electrical principles and conditions of welding processes

7.1 Define open circuit voltage (OCV) as the voltage reading taken when the arc welding circuit is open, arc voltage as the voltage reading taken when the arc has been struck and welding current as the reading taken whilst welding in amperes.

7.2 Identify the effects of increasing/decreasing the arc length when MMA welding on the welding current and voltage.

7.3 Identify the characteristics of a welding power source to include flat (MAGS welding) and drooping types (MMA / TAGS welding).

7.4 Identify welding processes that use flat (MAGS welding) and drooping characteristic (MMA / TAGS welding) type power sources.
7.5 Explain the terms associated with welding power sources – duty cycles, single and three phase systems including colour coding of plugs and sockets, tapped reactor and moving core reactor.

Learning Outcome 8. Be able to use calculations relating to fabrication and welding activities

8.1 Calculate volume and surface areas applicable to fabricated and welded assemblies.
8.2 Calculate the cost of welding – purchase of equipment, cost of consumables, purchase of materials and cost of labour.
8.3 Calculate total length of welding required for a fabricated assembly
8.4 Calculate unknown angles and side lengths in right angled triangles using trigonometry.
8.5 Calculate unknown side lengths in right angled triangles using the Pythagoras theory.
8.6 Calculate the length of flat section required to produce a cylinder of a given diameter using the mean or neutral line.
8.7 Calculate bending allowances when producing bends/folds in material taking into account spring back properties of materials.

Learning Outcome 9. Know about the problems associated with the manufacture of fabricated and welded assemblies.

9.1 Identify different types of distortion that can occur in welded assemblies – longitudinal, transverse and angular distortion.
9.2 Identify methods used for the control of distortion in welded assemblies such as weld sequences (skip, back step), pre and post heat treatment, pre-setting of the plates.
9.3 Describe the importance of selecting and using the correct joint preparation for a given joint type – butt and fillet welds.
9.4 Describe typical welding defects specific to the welding processes – MMA welding (slag inclusions), MAGS welding (cold lap), TAGS welding (Tungsten inclusions), lack of penetration, excessive penetration, lack of fusion, surface and internal porosity, undercutting, cracking etc.
9.5 Identify the problems associated with the conditions found in a completed welded joint – residual stress, corrosion, shock loading and distortion.

Learning Outcome 10. Know the importance of quality assurance in fabrication and welding activities

10.1 Describe the application and procedures to be followed when carrying out non-destructive testing (NDT) of welded joints – dye penetrant testing, magnetic particle testing, Ultrasonic flaw detection and radiography. Hazards when using penetrant flaw detection - chemicals on the skin (de-fatting effect), inhalation of chemicals, chemicals in eyes, using ultra violet lighting. Magnetic particle flaw detection - burns from "prods", inks/chemicals on skin, and in eyes, fumes from background lacquer solution, using ultra violet lighting.

10.2 Identify the limitations of using dye penetrant testing, magnetic particle testing, Ultrasonic flaw detection and radiography.

10.3 Identify the importance of carrying out quality control checks on welding consumables.

10.4 Identify the application and use of quality control documentation – welding procedure specification (WPS), gives detailed information on the requirements for the welder to produce a weld that is fit for purpose.
Inspection report for welding involves the examination of welded joints by visual examination and assessing the results found against a standard. Certificate of conformity used for consumable production.

Teaching Strategies and Learning Activities

Centres should adopt a delivery approach which supports the development of their particular learners. The aims and aspirations of all learners, including those with identified specific needs, including learning difficulties/disabilities, should be considered and appropriate support mechanisms put in place.

This unit provides material, scientific and mathematical background whilst enhancing (both in breadth and depth) the knowledge base of any of the other units contributing to the ABC Level 3 qualifications. This needs to be delivered in the context of Fabrication and Welding practice.

Health and safety aspects of fabrication and welding practice should be reinforced within all practical units.

Learning should be delivered through a combination of learner-centred classroom sessions, workshop practice and individual guided learning. The emphasis is on practical learning opportunities and individual action plans. The prospective learning group is likely to require a good deal of tutor support in achieving the planned outcomes.

It is suggested that a simulated working atmosphere/environment should be adopted. In addition, learners should be provided with real work experiences wherever possible and visits to places of interest and co-operation with local engineering establishments are strongly recommended.

Delivery may be enhanced by:

- liaising with employers with reference to delivery, work experience and/or resources
- visits to appropriate places of interest
- the provision of information and guidance to learners on the availability and type of employment the qualification may lead to and on the progression routes available for further education and training.

Methods of Assessment

This unit is mandatory for all learners undertaking the Level 3 Certificate/Diploma.

This unit is assessed by a 40 question externally set MCQ (multiple choice question) exam to be completed in one and a half hours.

In order to achieve a pass grade, a minimum mark of 60% will be required (24 correct questions out of 40). The grade recorded will be pass/fail only.

The format of the questions will be standard multi-choice type, i.e. one question with four possible answers, only one of which is correct.

Evidence of Achievement

The examination covers the learning outcomes of this unit according to the following split:

Learning Outcome		Number of questions from each Learning Outcome
LO 1	Identify a range of materials used in engineering	6
LO 2	Know about the crystalline structure of weld deposits in steels	2
LO 3	Know about heat treatments and the effects of heat on materials	5
LO 4	Know about the mechanical testing of materials and the properties of materials	3
LO 5	Understand the structure and state of matter	3
LO 6	Understand the units used in the SI system	1
LO 7	Understand the electrical principles and conditions of welding processes	5
LO 8	Be able to use calculations relating to fabrication and welding activities	6
LO 9	Know about the problems associated with the manufacture of fabricated and welded assemblies	5
LO 10	Know the importance of quality assurance in fabrication and welding activities	4
	Total	**40**

The examination should be conducted at the Centre where the course delivery has taken place and should be carried out in accordance with the examination requirements of ABC Awards.

It is required that an independent invigilator should oversee the examination and that course tutors/assessors should not have access to the examination room before, during or after the examination.

ABC Awards reserve the right to attend examinations to undertake an audit of the centre's procedures relating to compliance with these invigilation instructions.

Additional Information

Additional guidance for delivering and assessing ABC Awards qualifications and information about Internal Quality Assurance is available on the ABC Awards web site.

2. Manual Metal-Arc Welding – (Vertical) Low Carbon Steel, Stainless Steel or Aluminium

Unit Reference	H/616/1292
Level	3
Credit Value	7
Guided Learning Hours	60
Unit Summary	This unit covering manual metal-arc (MMA) welding is designed to further the skills of the learner who has satisfactorily completed and achieved a level 2 qualification in fabrication and welding practice. Learners will further develop skills in the theory of safe working practice and the theoretical aspects of technology associated with this particular welding process. For this qualification all welding is to be carried out in the vertical welding position (PF/PG) covering a range of welded joints. Both the fillet weld and butt joint will be tested to ensure that they are structurally sound.

Learning Outcomes The learner will:	**Assessment Criteria The learner can:**
1. Understand health and safety legislation and follow safe working practices	1.1. Identify the responsibilities of both the employer and the employee when complying with the Health and Safety at Work Act 1974 1.2. Identify the use of current legislation, to include: • COSHH (Control of Substances Hazardous to Health) • PUWER (Provision and Use of Work Equipment) • RIDDOR (Reporting of Injuries, Diseases, and Dangerous Occurrences Regulations)

	1.3. Identify the use of a risk assessment procedure 1.4. Identify safe working practices when using the MMA welding process, to include working: • in a confined space • at an height above 2 metres • with containers that have held chemicals or flammable liquids • in damp or wet conditions • on site conditions
2. Be able to identify and use, in a safe manner, equipment used for MMA welding activities	2.1. Describe the function of the equipment used in MMA welding, to include: • transformer • generator • rectifier • invertors • welding lead cable • welding return cable • secondary earth and connector • electrode holder • cable clamp • low voltage safety devices (LVSD) 2.2. Identify suitable maintenance checks that would be required on the items listed in 2.1 2.3. State the procedures to be followed for the safe storage of welding equipment when the welding activity has been completed
3. Be able to identify consumables used when using the MMA welding process	3.1. Identify a range of electrodes that are used for the MMA welding process, to include: • general purpose • low hydrogen (basic) • positional 3.2. State the function of the flux coating on electrodes 3.3. Describe the effects of incorrect storage of electrodes 3.4. State the effect of using damaged electrodes when carrying out welding activities

4. Understand the welding parameters used when carrying out MMA welding in the vertical welding (PF/PG) position	4.1. Identify and select the welding parameters to be used when welding materials in the vertical welding position (PF/PG), to include: • welding current • OCV (open circuit voltage) • electrode slope and tilt angles • arc length • speed of travel • electrode polarity
5. Know about material preparation and the setting up of MMA welding equipment	5.1. Identify suitable welding preparations for the type of joint and material thickness being welded 5.2. Identify terms associated with welding preparations, to include: • included angle • angle of bevel • root face dimension • root gap dimension 5.3. Describe the application of distortion control techniques, to include: • pre-setting • restraint • joint geometry 5.4. Be able to follow instructions given on a WPS (Welding Procedure Sheet)
6. Be able to complete welds in the vertical welding position (PF/PG) using the MMA welding process	6.1. Identify appropriate safety checks on the welding equipment prior to use 6.2. Select suitable welding parameters to enable the listed joints to be welded by the MMA welding process on low carbon steel or stainless steel or aluminium • tee fillet (PF) • butt (PF) • open outside corner (PF or PG) • lap joint (PF or PG)
7. Know how to carry out visual inspection and destructive tests on completed welds	7.1. Carry out visual inspection of completed welds 7.2. Prepare and carry out nick break tests on the completed fillet welds 7.3. Prepare and carry out destructive tests on completed butt welds, to include:

	• face bend • root bend • fracture test 7.4. Record the results of the weld examination as detailed in 7.1, 7.2 and 7.3
8. Know about defects found in welds produced by the MMA welding process	8.1. Identify and describe typical defects found in MMA welded joints, to include: • cracks • inclusions (slag) • undercut • arc craters • porosity • lack of penetration 8.2. Identify possible causes of the defects listed in 8.1

Supporting Unit Information

Manual Metal-Arc Welding – (Vertical) Low Carbon Steel, Stainless Steel – H/616/1292 – Level 3

Indicative Content

Note: Indicative content provides an indication of the scope for the Learning Outcomes and Assessment Criteria. It is intended as a resource to help guide the delivery and assessment of the unit. Indicative content is NOT a statement of material which must be covered and evidenced for assessment.

Learning Outcome 1. Understand health and safety legislation and follow safe working practices

1.1 Identify the responsibilities of both the employer and employee when complying with the Health and Safety at Work Act.

1.2 Identify the use of current legislation – Control of Substances Hazardous to Health (COSHH), Provision and Use of Work Equipment (PUWER), Reporting of Injuries, Diseases, and Dangerous Occurrences Regulations (RIDDOR).

1.3 Identify the use of a risk assessment procedure.

1.4 Identify safe working practices – MMA welding on containers holding chemicals and inflammable substances, confined spaces, at a height above 2 metres, flammable liquids, in damp or wet conditions and on site conditions .

Learning Outcome 2. Be able to identify and use, in a safe manner, equipment used for MMA welding activities

2.1 Describe the function of equipment used in MMA welding – transformer, generator, rectifier, invertors providing power for welding. Welding lead cable, welding return cable, secondary earth and connector for a complete and safe welding circuit, electrode holder, cable clamp and low voltage safety devices.

2.2 Identify suitable maintenance checks that would be required with the equipment in 2.1 – reference to visual checks on cable condition and diameter, secure connections, insulation on the electrode holder, being able to hold electrodes and the duty cycle of MMA power sources (A.C/D.C).

2.3 State the procedures to be followed for the safe storage of welding equipment when the welding activity has been completed – avoidance of slip, trip and fall hazards.

Learning Outcome 3. Be able to identify consumables used when using the MMA welding process

3.1 Identify a range of electrodes that are used for the MMA welding process - welding electrodes to current BS, EN and/or ISO standards, weld positions, general purpose, low hydrogen (basic) and positional electrodes.

3.2 State the function of the flux coating on electrodes- gives off gases as it decomposes to prevent weld contamination, introduces deoxidizers to purify the weld, causes weld-protecting slag to form, improves the arc stability, and provides alloying elements to improve the weld quality.

3.3 Describe the effects of incorrect storage of electrodes - increased moisture content, corrosion of core wire, covering damage.

3.4 State the effect of using damaged electrodes when carrying out welding activities – reference to weld quality and defects such as porosity, stray arcing, spatter and slag inclusions.

Learning Outcome 4. Understand the welding parameters used when carrying out MMA welding in the vertical welding position (PF/PG)

4.1 Identify and select the welding parameters to be used when welding materials in the vertical welding position (PF/PG) – welding current type (AC or DC) and size (amperes), open circuit voltage (OCV), electrode slope and tilt angles, arc length, speed of travel and electrode polarity necessary to produce a defect free welded joint.

Learning Outcome 5. Know about material preparation and the setting up of MMA welding equipment

5.1 Identify suitable welding preparations for the type of joint and material thickness being welded to achieve butt and fillet welds in the vertical-up/vertical-down position.

5.2 Identify terms associated with welding preparations – included angle, angle of bevel, root face and root gap dimensions

5.3 Describe the application of distortion control techniques – pre-setting, restraint, weld sequence, chills, pre and post heating and joint geometry.

5.4 Be able to follow instructions given on a welding procedure sheet (WPS) – such as welding current, voltage, joint preparation, weld position, electrode diameter and type etc.

Learning Outcome 6. Be able to complete welds in the vertical welding position (PF/PG) using the MMA welding process

6.1 Identify appropriate safety checks on the welding equipment prior to use – visual checks on cable condition/diameter, connections, insulation on the welding electrode holder.

6.2 Select suitable welding parameters to enable the listed joints to be welded by the MMA welding process on low carbon steel or stainless steel – tee fillet (PF), butt (PF), open outside corner (PF or PG), lap joint (PF or PG).

Learning Outcome 7. Know how to carry out visual inspection and destructive tests on completed welds

7.1 Carry out visual inspection of completed welds.

7.2 Prepare and carry out nick break tests on the completed fillet welds

7.3 Prepare and carry out destructive tests on completed butt welds – face bend, root bend and fracture test.

7.4 Record the results of the welding examination as detailed in 7.1, 7.2 and 7.3.

Learning Outcome 8. Know about defects found in welds produced by the MMA welding process

8.1 Identify and describe typical defects found in MMA welding joints – cracks, slag inclusions, undercut, arc craters, porosity and lack of penetration.

8.2 Identify possible causes of the defects cracks, slag inclusions, undercut, arc craters, porosity and lack of penetration – material contamination, electrode slope and tilt angles, speed of travel, incorrect parameters, incorrect edge preparation, poor welding technique, incorrect consumable type, incorrect electrode diameter and arc length.

Teaching Strategies and Learning Activities

Centres should adopt a delivery approach which supports the development of their particular learners. The aims and aspirations of all learners, including those with identified specific needs, including learning

difficulties/disabilities, should be considered and appropriate support mechanisms put in place.

This unit provides material, scientific and mathematical background whilst enhancing (both in breadth and depth) the knowledge base of any of the other units contributing to the ABC Level 3 qualifications. This needs to be delivered in the context of Fabrication and Welding practice.

Health and safety aspects of fabrication and welding practice should be reinforced within all practical units.

Learning should be delivered through a combination of learner-centred classroom sessions, workshop practice and individual guided learning. The emphasis is on practical learning opportunities and individual action plans. The prospective learning group is likely to require a good deal of tutor support in achieving the planned outcomes.

It is suggested that a simulated working atmosphere/environment should be adopted. In addition, learners should be provided with real work experiences wherever possible and visits to places of interest and co-operation with local engineering establishments are strongly recommended.

Delivery may be enhanced by:

- liaising with employers with reference to delivery, work experience and/or resources
- visits to appropriate places of interest
- the provision of information and guidance to learners on the availability and type of employment the qualification may lead to and on the progression routes available for further education and training.

Methods of Assessment

This unit will be internally assessed, internally and externally moderated.

Evidence of Achievement

ABC Awards has produced an assessment pack for this unit which is available to approved centres from the ABC Awards website.

This assessment pack contains details of the requirements of the practical tasks and examinations in the ABC Level 3 Certificate and Diploma in Fabrication and Welding Practice. Prior to commencing the qualification(s), the learner, assessor and appointed Internal Quality Assurer should familiarise themselves with the contents of this pack and what is to be expected in order to achieve.

Additional Information

Additional guidance for delivering and assessing ABC Awards qualifications and information about Internal Quality Assurance is available on the ABC Awards web site.

3. Metal-Arc Gas Shielded Welding – (Vertical) Low Carbon Steel, Stainless Steel or Aluminium

Unit Reference	K/616/1293
Level	3
Credit Value	7
Guided Learning Hours	60
Unit Summary	This unit covering metal-arc gas shielded (MAGS) welding is designed to further the skills of the learner who has satisfactorily completed and achieved a level 2 qualifications in fabrication and welding practice. Learners will further develop skills in the theory of safe working practice and the theoretical aspects of technology associated with this particular welding process. For this qualification all welding is to be carried out in the vertical welding position (PF/PG) covering a range of welded joints. Both the fillet weld and butt joint will be tested to ensure that they are structurally sound.

Learning Outcomes The learner will:	**Assessment Criteria The learner can:**
1. Understand health and safety legislation and follow safe working practices	1.1. Identify the responsibilities of both the employer and the employee when complying with the Health and Safety at Work Act 1974 1.2. Identify the use of current legislation, to include: • COSHH (Control of Substances Hazardous to Health) • PUWER (Provision and Use of Work Equipment) • RIDDOR (Reporting of Injuries, Diseases, and Dangerous Occurrences Regulations)

	1.3. Identify the use of a risk assessment procedure 1.4. Identify safe working practices when using the MAGS welding process, to include working: • in a confined space • at an height above 2 metres • with containers that have held chemicals or flammable liquids • in damp or wet conditions
2. Be able to identify and use, in a safe manner, equipment used for MAGS welding activities	2.1. Describe the function of the equipment used in the MAGS welding process, to include: • rectifier • welding lead cable and clamp • welding return cable and clamp • secondary earth and connector • torch • contact tip • shroud/nozzle • wire feed mechanism • gas supply, regulator and flow meter 2.2. Identify suitable maintenance checks that would be required on the items listed in 2.1 2.3. State the procedures to be followed for the safe storage of welding equipment when the welding activity has been completed
3. Be able to identify consumables used when using the MAGS welding process	3.1. Identify a range of electrode wires that are used for the MAGS welding process, to include: • non-coated • copper coated 3.2. Describe the effects of incorrect storage of electrode wires 3.3. Recognise the effect of using damaged electrode wires when carrying out welding activities 3.4. Identify the shielding gas/es used in MAGS welding 3.5. Identify the function of the shielding gas used in MAGS welding

4. Understand the welding parameters used when carrying MAGS welding in the vertical welding (PF/PG) position	4.1. Recognise the different modes of metal transfer used in MAGS welding 4.2. Identify and select the welding parameters to be used when welding materials greater than 6 mm in thickness in the vertical welding position (PF/PG). • mode of metal transfer • welding current • arc voltage • torch slope and tilt angles • shielding gas flow rate • wire speed • speed of travel
5. Know about material preparation and the setting up of MAGS welding equipment	5.1. Identify suitable welding preparations for the type of joint and material thickness being welded 5.2. Identify terms associated with welding preparations, to include: • included angle • angle of bevel • root face dimension • root gap dimension 5.3. Describe the application of distortion control techniques, to include: • pre-setting • restraint • joint geometry 5.4. Be able to follow instructions given on a WPS (Welding Procedure Sheet)
6. Be able to complete welds in the vertical welding position (PF/PG) using the MAGS welding process	6.1. Identify appropriate safety checks on the welding equipment prior to use 6.2. Select suitable welding parameters to enable the listed joints to be welded by the MAGS welding process on low carbon steel or stainless steel or aluminium • tee fillet (PF) • butt (PF) • open outside corner (PF or PG) • lap joint (PF or PG)
7. Know how to carry out visual inspection and	7.1. Carry out visual inspection of completed welds

destructive tests on completed welds	7.2. Prepare and carry out nick break tests on completed fillet welds 7.3. Prepare and carry out destructive tests on completed butt welds, to include: • face bend • root bend • fracture test 7.4. Record the results of the weld examination as detailed in 7.1, 7.2 and 7.3
8. Know about defects found in welds produced by the MAGS welding process	8.1. Identify and describe typical defects found in the MAGS welding process joints, to include: • cracks • inclusions • undercut • lack of fusion • arc craters • porosity • lack of penetration 8.2. Identify possible causes of the defects listed in 8.1

Supporting Unit Information

Metal-Arc Gas Shielded Welding – (Vertical) Low Carbon Steel, Stainless Steel or Aluminium – K/616/1293 – Level 3

Indicative Content

Note: Indicative content provides an indication of the scope for the Learning Outcomes and Assessment Criteria. It is intended as a resource to help guide the delivery and assessment of the unit. Indicative content is NOT a statement of material which must be covered and evidenced for assessment.

Learning Outcome 1. Understand health and safety legislation and follow safe working practices

1.1 Identify the responsibilities of both the employer and employee when complying with the Health and Safety at Work Act.

1.2 Identify the use of current legislation – Control of Substances Hazardous to Health (COSHH), Provision and Use of Work Equipment (PUWER), Reporting of Injuries, Diseases, and Dangerous Occurrences Regulations (RIDDOR).

1.3 Identify the use of a risk assessment procedure.

1.4 Identify safe working practices – MAGS welding on containers holding chemicals and inflammable substances, confined spaces, at a height above 2 metres, flammable liquids, in damp or wet conditions and on site conditions.

Learning Outcome 2. Be able to identify and use, in a safe manner, equipment used for MAGS welding activities

2.1 Describe the function of equipment used in MAGS welding – rectifier, providing power for welding. Welding lead cable, welding return cable, secondary earth and connector for a complete and safe welding circuit, welding torch, contact tip, shroud/nozzle, wire feed mechanism, gas supply, regulator and flow meter.

2.2 Identify suitable maintenance checks that would be required with the equipment in 2.1 – reference to visual checks on cable condition and diameter, secure connections, insulation on the welding torch and the duty cycle of MAGS welding power source (D.C).

2.3 State the procedures to be followed for the safe storage of welding equipment when the welding activity has been completed – avoidance of slip, trip and fall hazards.

Learning Outcome 3. Be able to identify consumables used when using the MAGS welding process

3.1 Identify a range of electrode wires that are used for the MAGS welding process – non-coated and coated electrode wires to current BS, EN and/or ISO standards.

3.2 Describe the effects of incorrect storage of electrode wires - corrosion of the electrode wire.

3.3 Recognise the effect of using damaged electrode wires when carrying out welding activities – reference to weld quality and defects such as porosity and spatter.

3.4 Identify the shielding gas/es used in MAGS welding – pure argon and helium used for some non-ferrous metals. Semi-inert shielding gases, or active shield gases, include carbon dioxide, oxygen, nitrogen, and hydrogen.

3.5 Identify the function of the shielding gas used in MAGS welding - purpose of the shielding gas is to prevent exposure of the molten weld pool to oxygen, nitrogen and hydrogen contained in the air atmosphere. The reaction of these elements with the weld pool can create a variety of problems, including porosity (holes within the weld bead) and excessive spatter.

Learning Outcome 4. Understand the welding parameters used when carrying out MAGS welding in the vertical welding position (PF/PG)

4.1 Recognise the different modes of metal transfer used in MAGS welding – dip, spray, pulsed.

4.2 Identify and select the welding parameters to be used when welding materials greater than 6mm in thickness in the vertical welding position (PF/PG) – mode of metal transfer, welding current, arc voltage, torch slope and tilt angles, shielding gas flow rate, wire speed, speed of travel and electrode polarity necessary to produce a defect free welded joint.

Learning Outcome 5. Know about material preparation and the setting up of MAGS welding equipment

5.1 Identify suitable welding preparations for the type of joint and material thickness being welded to achieve butt and fillet welds in the vertical-up/vertical-down position.

5.2 Identify terms associated with welding preparations – included angle, angle of bevel, root face and root gap dimensions.

5.3 Describe the application of distortion control techniques – pre-setting, restraint, weld sequence, chills, pre and post heating and joint geometry.
5.4 Be able to follow instructions given on a welding procedure sheet (WPS) – such as welding current, voltage, joint preparation, weld position, electrode wire diameter and type etc.

Learning Outcome 6. Be able to complete welds in the vertical welding position (PF/PG) using the MAGS welding process

6.1 Identify appropriate safety checks on the welding equipment prior to use – visual checks on cable condition/diameter, connections, insulation on the welding torch.
6.2 Select suitable welding parameters to enable the listed joints to be welded by the MAGS welding process on low carbon steel or stainless steel – tee fillet (PF), butt (PF), open outside corner (PF or PG), lap joint (PF or PG).

Learning Outcome 7. Know how to carry out visual inspection and destructive tests on completed welds

7.1 Carry out visual inspection of completed welds.
7.2 Prepare and carry out nick break tests on the completed fillet welds.
7.3 Prepare and carry out destructive tests on completed butt welds – face bend, root bend and fracture test.
7.4 Record the results of the welding examination as detailed in 7.1, 7.2 and 7.3.

Learning Outcome 8. Know about defects found in welds produced by the MAGS welding process

8.1 Identify and describe typical defects found in MAGS welded joints – cracks, slag inclusions, undercut, lack of fusion, arc craters, porosity and lack of penetration.
8.2 Identify possible causes of the defects cracks, undercut, arc craters, porosity, lack of fusion and lack of penetration – material contamination, welding torch slope and tilt angles, speed of travel, incorrect parameters, incorrect edge preparation, poor welding technique, incorrect consumable type and incorrect wire electrode diameter.

Teaching Strategies and Learning Activities

Centres should adopt a delivery approach which supports the development of their particular learners. The aims and aspirations of all learners, including those with identified specific needs, including learning difficulties/disabilities, should be considered and appropriate support mechanisms put in place.

This unit provides material, scientific and mathematical background whilst enhancing (both in breadth and depth) the knowledge base of any of the other units contributing to the ABC Level 3 qualifications. This needs to be delivered in the context of Fabrication and Welding practice.

Health and safety aspects of fabrication and welding practice should be reinforced within all practical units.

Learning should be delivered through a combination of learner-centred classroom sessions, workshop practice and individual guided learning. The emphasis is on practical learning opportunities and individual action plans. The prospective learning group is likely to require a good deal of tutor support in achieving the planned outcomes.

It is suggested that a simulated working atmosphere/environment should be adopted. In addition, learners should be provided with real work experiences wherever possible and visits to places of interest and co-operation with local engineering establishments are strongly recommended.

Delivery may be enhanced by:

- liaising with employers with reference to delivery, work experience and/or resources
- visits to appropriate places of interest
- the provision of information and guidance to learners on the availability and type of employment the qualification may lead to and on the progression routes available for further education and training.

Methods of Assessment

This unit will be internally assessed, internally and externally moderated.

Evidence of Achievement

ABC Awards has produced an assessment pack for this unit which is available to approved centres from the ABC Awards website.

This assessment pack contains details of the requirements of the practical tasks and examinations in the ABC Level 3 Certificate and Diploma in Fabrication and Welding Practice. Prior to commencing the qualification(s), the learner, assessor and appointed Internal Quality Assurer should familiarise themselves with the contents of this pack and what is to be expected in order to achieve.

Additional Information

Additional guidance for delivering and assessing ABC Awards qualifications and information about Internal Quality Assurance is available on the ABC Awards web site.

4. Tungsten-Arc Gas Shielded Welding – (Vertical) Low Carbon Steel, Stainless Steel or Aluminium

Unit Reference	M/616/1294
Level	3
Credit Value	7
Guided Learning Hours	60
Unit Summary	This unit covering tungsten-arc gas shielded (TAGS) welding is designed to further the skills of the learner who has satisfactorily completed and achieved a level 2 qualification in fabrication and welding practice. Learners will further develop skills in the theory of safe working practice and the theoretical aspects of technology associated with this particular welding process. For this qualification all welding is to be carried out in the vertical welding position (PF/PG) covering a range of welded joints. Both the fillet weld and butt joint will be tested to ensure that they are structurally sound.

Learning Outcomes The learner will:	**Assessment Criteria The learner can:**
1. Understand health and safety legislation and follow safe working practices	1.1. Identify the responsibilities of both the employer and the employee when complying with the Health and Safety at Work Act 1974 1.2. Identify the use of current legislation, to include: • COSHH (Control of Substances Hazardous to Health) • PUWER (Provision and Use of Work Equipment) • RIDDOR (Reporting of Injuries, Diseases, and Dangerous Occurrences Regulations)

	1.3. Identify the use of a risk assessment procedure 1.4. Identify safe working practices when using the TAGS welding process, to include working: • in a confined space • at an height above 2 metres • with containers that have held chemicals or flammable liquids • in damp or wet conditions • with hazards from using high frequency units
2. Be able to identify and use, in a safe manner, equipment used for TAGS welding activities	2.1. Describe the function of the equipment used in the TAGS welding process, to include: • rectifier • inverter • high frequency units • welding lead cable and clamp • welding return cable and clamp • secondary earth and connector • torch • tungsten • collet • shroud • cooling system • gas supply, regulator and flow meter 2.2. Identify suitable maintenance checks that would be required on the items listed in 2.1 2.3. State the procedures to be followed for the safe storage of welding equipment when the welding activity has been completed
3. Be able to identify consumables used with the TAGS welding process	3.1. Identify a range of tungsten electrodes that are used for the TAGS welding process, to include: • types used • size (diameter) • alloying additions • preparation of electrode tip (shape/dimensions) 3.2. Identify a range of filler wires that are used for the TAGS welding process, to include: • types used

	• size (diameter) • alloying additions 3.3. Describe the effects of incorrect storage of tungsten electrode and filler wires 3.4. State the effect of using damaged tungsten electrode and filler wires when carrying out welding activities 3.5. Identify the shielding gas/es used in TAGS welding 3.6. Identify the function of the shielding gas used in TAGS welding
4. Understand the welding parameters used when carrying out TAGS welding in the vertical welding (PF/PG) position	4.1. Identify and select the welding parameters to be used when welding in the vertical welding position (PF/PG): • welding current • torch slope and tilt angles • filler wire slope and tilt angles • shielding gas flow rate • arc length • speed of travel 4.2. Identify the use of autogenous techniques when using the TAGS welding process
5. Know about material preparation and the setting up of TAGS welding equipment	5.1. Identify suitable welding preparations for the type of joint and material thickness being welded 5.2. Identify terms associated with welding preparations, to include: • included angle • angle of bevel • root face dimension • root gap dimension 5.3. Describe the application of distortion control techniques, to include: • pre-setting • restraint • joint geometry • chills • weld sequence

	5.4. Be able to follow instructions given on a WPS (Welding Procedure Sheet)
6. Be able to complete welds in the vertical welding position (PF/PG) using the TAGS welding process	6.1. Identify appropriate safety checks on the welding equipment prior to use 6.2. Select suitable welding parameters to enable the listed joints to be welded by the TAGS welding process on low carbon steel or stainless steel or aluminium • tee fillet (PF) • butt (PF) • open outside corner (PF or PG) • lap joint (PF or PG)
7. Know how to carry out visual inspection and destructive tests on completed welds	7.1. Carry out visual inspection of completed welds 7.2. Prepare and carry out nick break tests on completed fillet welds 7.3. Prepare and carry out destructive tests on completed butt welds, to include: • face bend • root bend • fracture test 7.4. Record the results of the weld examination as detailed in 7.1, 7.2 and 7.3
8. Know about defects found in welds produced by the TAGS welding process	8.1. Identify and describe typical defects found in the TAGS welding process joints, to include: • cracks • inclusions • undercut • lack of fusion • arc craters • porosity • lack of penetration 8.2. Identify possible causes of the defects listed in 8.1

Supporting Unit Information

Tungsten-Arc Gas Shielded Welding – (Vertical) Low Carbon Steel, Stainless Steel or Aluminium – M/616/1294 – Level 3

Indicative Content

Note: Indicative content provides an indication of the scope for the Learning Outcomes and Assessment Criteria. It is intended as a resource to help guide the delivery and assessment of the unit. Indicative content is NOT a statement of material which must be covered and evidenced for assessment.

Learning Outcome 1. Understand health and safety legislation and follow safe working practices

1.1 Identify the responsibilities of both the employer and employee when complying with the Health and Safety at Work Act.

1.2 Identify the use of current legislation – Control of Substances Hazardous to Health (COSHH), Provision and Use of Work Equipment (PUWER), Reporting of Injuries, Diseases, and Dangerous Occurrences Regulations (RIDDOR).

1.3 Identify the use of a risk assessment procedure.

1.4 Identify safe working practices – TAGS welding on containers holding chemicals and inflammable substances, confined spaces, at a height above 2 metres, flammable liquids, in damp or wet conditions, on site conditions and hazards from using high frequency units.

Learning Outcome 2. Be able to identify and use, in a safe manner, equipment used for TAGS welding activities

2.1 Describe the function of equipment used in TAGS welding – transformer, rectifier, inverter, high frequency unit, for welding. Welding lead cable, welding return cable, secondary earth and connector for a complete and safe welding circuit, welding torch, tungsten, collet, shroud, cooling system air or water, gas supply, regulator and flow meter.

2.2 Identify suitable maintenance checks that would be required with the equipment in 2.1 – reference to visual checks on cable condition and diameter, secure connections, insulation on the welding torch and the duty cycle of TAGS welding power source (AC/D.C).

2.3 State the procedures to be followed for the safe storage of welding equipment when the welding activity has been completed – avoidance of slip, trip and fall hazards.

Learning Outcome 3. Be able to identify consumables used when using the TAGS welding process

3.1 Identify a range of tungsten electrodes that are used for the TAGS welding process – alloying additions ceriated and thoriated type and diameter, preparation of electrode tip (shape/dimensions) to current BS, EN and/or ISO standards.

3.2 Identify a range of filler wires that are used for the TAGS welding process – types used, diameter and alloying additions (cerium and thorium).

3.3 Describe the effects of incorrect storage of tungsten electrode and filler wires – electrode damage and corrosion of the filler wire.

3.4 State the effect of using damaged tungsten electrode and filler wires when carrying out welding activities – reference to weld quality and defects such as porosity and tungsten inclusions.

3.5 Identify the shielding gas/es used in TAGS welding – pure argon and helium used for some non-ferrous metals. Semi-inert shielding gases, or active shield gases, include oxygen and hydrogen.

3.6 Identify the function of the shielding gas used in TAGS welding – purpose of the shielding gas is to prevent exposure of the molten weld pool to oxygen, nitrogen and hydrogen contained in the air atmosphere. The reaction of these elements with the weld pool can create a variety of problems, including porosity (holes within the weld bead) and excessive spatter.

Learning Outcome 4. Understand the welding parameters used when carrying out TAGS welding in the vertical welding position (PF/PG)

4.1 Identify and select the welding parameters to be used when welding materials in the vertical welding position (PF/PG) – welding current, torch slope and tilt angles, filler wire slope and tilt angles, shielding gas flow rate, arc length, speed of travel and electrode polarity necessary to produce a defect free welded joint.

Learning Outcome 5. Know about material preparation and the setting up of TAGS welding equipment

5.1 Identify suitable welding preparations for the type of joint and material thickness being welded to achieve butt and fillet welds in the vertical-up/vertical-down position.
5.2 Identify terms associated with welding preparations – included angle, angle of bevel, root face and root gap dimensions.
5.3 Describe the application of distortion control techniques – pre-setting, restraint, joint geometry, weld sequence and chills.
5.4 Be able to follow instructions given on a welding procedure sheet (WPS) – such as welding current, voltage, joint preparation, weld position, tungsten electrode type and diameter, wire type and diameter etc.

Learning Outcome 6. Be able to complete welds in the vertical welding position (PF/PG) using the TAGS welding process

6.1 Identify appropriate safety checks on the welding equipment prior to use – visual checks on cable condition/diameter, connections, insulation on the welding torch, high frequency unit (dust free).
6.2 Select suitable welding parameters to enable the listed joints to be welded by the TAGS welding process on low carbon steel or stainless steel – tee fillet (PF), butt (PF), open outside corner (PF or PG), lap joint (PF or PG).

Learning Outcome 7. Know how to carry out visual inspection and destructive tests on completed welds

7.1 Carry out visual inspection of completed welds.
7.2 Prepare and carry out nick break tests on the completed fillet welds.
7.3 Prepare and carry out destructive tests on completed butt welds – face bend, root bend and fracture test.
7.4 Record the results of the welding examination as detailed in 7.1, 7.2 and 7.3.

Learning Outcome 8. Know about defects found in welds produced by the TAGS welding process

8.1 Identify and describe typical defects found in TAGS welded joints – cracks, tungsten inclusions, undercut, lack of fusion, arc craters, porosity and lack of penetration.
8.2 Identify possible causes of the defects cracks, undercut, arc craters, porosity, lack of fusion and lack of penetration – material contamination, welding torch/wire slope and tilt angles, speed of travel, incorrect parameters, incorrect edge preparation, poor

welding technique, incorrect tungsten type and incorrect filler wire diameter/type.

Teaching Strategies and Learning Activities

Centres should adopt a delivery approach which supports the development of their particular learners. The aims and aspirations of all learners, including those with identified specific needs, including learning difficulties/disabilities, should be considered and appropriate support mechanisms put in place.

This unit provides material, scientific and mathematical background whilst enhancing (both in breadth and depth) the knowledge base of any of the other units contributing to the ABC Level 3 qualifications. This needs to be delivered in the context of Fabrication and Welding practice.

Health and safety aspects of fabrication and welding practice should be reinforced within all practical units.

Learning should be delivered through a combination of learner-centred classroom sessions, workshop practice and individual guided learning. The emphasis is on practical learning opportunities and individual action plans. The prospective learning group is likely to require a good deal of tutor support in achieving the planned outcomes.

It is suggested that a simulated working atmosphere/environment should be adopted. In addition, learners should be provided with real work experiences wherever possible and visits to places of interest and co-operation with local engineering establishments are strongly recommended.

Delivery may be enhanced by:

- liaising with employers with reference to delivery, work experience and/or resources
- visits to appropriate places of interest
- the provision of information and guidance to learners on the availability and type of employment the qualification may lead to and on the progression routes available for further education and training.

Methods of Assessment

This unit will be internally assessed, internally and externally moderated.

Evidence of Achievement

ABC Awards has produced an assessment pack for this unit which is available to approved centres from the ABC Awards website.

This assessment pack contains details of the requirements of the practical tasks and examinations in the ABC Level 3 Certificate and Diploma in Fabrication and Welding Practice. Prior to commencing the qualification(s), the learner, assessor and appointed Internal Quality Assurer should familiarise themselves with the contents of this pack and what is to be expected in order to achieve.

Additional Information

Additional guidance for delivering and assessing ABC Awards qualifications and information about Internal Quality Assurance is available on the ABC Awards web site.

5. Fabrication Processes – Plate (3 mm and above in thickness)

Unit Reference	T/616/1295
Level	3
Credit Value	7
Guided Learning Hours	60
Unit Summary	The practical content of this unit requires the learner to manufacture a fabricated assembly in material of 3 mm thickness or above to given dimensions and within a specified tolerance. Understanding safe working practices when carrying out fabrication activities is an important criterion in all aspects of this unit. Other areas include working from fabrication drawings, marking out, cutting, forming and assembly.

Learning Outcomes The learner will:	**Assessment Criteria The learner can:**
1. Understand safe working practices when carrying out fabrication activities	1.1. Identify safe lifting methods to be used when lifting and handling materials 3 mm in thickness or above using: • manual lifting methods • mechanical lifting methods 1.2. Identify the use of current legislation covering: LOLER (Lifting Operations and Lifting Equipment Regulations) 1.3. Identify the safe working practices required when using fabrication tools and equipment, to include: • hand tools • thermal cutting equipment • shearing machines • drilling machines

	• rolling machines (manual and powered) 1.4. Identify and describe the importance of safety features on powered machinery, to include: • guarding of moving parts • electrical isolators • emergency stop buttons
2. Understand how to read and interpret fabrication drawings	2.1. Identify the use of orthographic drawings when manufacturing fabricated assemblies 2.2. Understand the need for tolerances in fabrication assembly activities
3. Know about marking out materials greater than 3 mm in thickness	3.1. Identify the importance of the correct storage of marking out equipment when not in use 3.2. Use a range of marking out equipment to mark out material greater than 3 mm in thickness, to include: • rulers/tapes • dividers/trammels • scribers • squares • protractors 3.3. Describe the importance of working from a fixed datum edge, line or point when marking out 3.4. Describe features of marking out, to include: • progressive marking out • chain measuring • cumulative error • pitch circle diameter (PCD) 3.5. Calculate bending and rolling allowances in materials greater than 3 mm in thickness, to include: • bends at 90° in 3 mm thick material and above • length of flat section required to produce a cylinder of a fixed diameter using the neutral /mean line of the material
4. Be able to identify and use	4.1. Identify and describe the equipment used for thermal cutting operations, to include: • oxy/fuel gas methods

thermal cutting equipment	• plasma arc 4.2. Identify the cutting nozzle arrangements when using the following gas mixtures: • oxy/acetylene • oxy/propane 4.3. Use oxy/fuel gas or plasma arc cutting equipment to produce: • straight lines • circles or radii 4.4. Identify the cutting aids and attachments used with thermal cutting activities
5. Be able to identify and use mechanical cutting equipment	5.1. Identify the parameters when selecting a cutting machine, to include: • type of material to be cut • maximum thickness of material • maximum length of cut • blade clearance 5.2. Identify cutting equipment, to include: • powered guillotine • universal steel worker 5.3. Identify the use of cutting machine attachments, to include: • adjustable back stop • squaring arm • stroke counter 5.4. Identify drilling machines, to include: • bench drilling machine • pillar drilling machine 5.5. State the importance of regular maintenance on powered cutting equipment
6. Be able to identify and use forming equipment	6.1. Identify the parameters when selecting and using a forming machine, to include: • type of material to be formed • maximum thickness of material • maximum length of material to be formed • sectional shape required 6.2. Identify forming equipment, to include: • manual folding machine

	• powered press brake • manual sheet rollers • powered rollers (pyramid and pinch type) • powered section bending rollers
7. Know about methods of joining parts in fabricated assemblies in materials above 3 mm in thickness	7.1. Identify a range of mechanical fasteners to join and assemble fabricated components, to include: • black bolts • HSFG (High strength friction grip bolts) • turned barrel bolts 7.2. Identify a range of welding processes used to join and assemble fabricated components 7.3. Describe methods of distortion control that are used when welding fabricated components
8. Be able to assemble fabricated components to given specifications	8.1. Follow instructions given on a Fabrication Specification Sheet (FSS) 8.2. Identify a range of assembly aids used to locate parts and maintain alignment during assembly, to include: • bridge and wedges • draw bolts • cleats • clamps • drifts • magnets 8.3. Plan the sequence of manufacture and assembly of a fabricated component
9. Be able to produce a fabricated assembly in materials above 3 mm in thickness	9.1. Produce a fabricated component in material 3 mm in thickness or above, to include: • marking out • cutting material • rolling • bending/folding • drilling • assembling 9.2. Carry out the requirements as listed in 9.1 to the required tolerance and dimensional accuracy as detailed on the drawing

	9.3. Carry out inspection of the completed assembly using a range of inspection equipment

Supporting Unit Information

Fabrication Processes – Plate (3 mm and above in thickness) – T/616/1295 – Level 3

Indicative Content

Note: Indicative content provides an indication of the scope for the Learning Outcomes and Assessment Criteria. It is intended as a resource to help guide the delivery and assessment of the unit. Indicative content is NOT a statement of material which must be covered and evidenced for assessment.

Learning Outcome 1. Understand safe working practices when carrying out fabrication activities

1.1 Identify safe lifting methods to be used when lifting and handling materials 3 mm in thickness or above – manual lifting methods and mechanical lifting methods. Hazards in a fabrication workshop, associated with lifting, incorrect slinging methods used, using damaged equipment, incorrect SWL, SWA, centre of gravity. Incorrect lifting and handling of heavy materials, burns from hot material, incorrect use of powered machinery. Use of specialised PPE to include harnesses, hard hats, high visibility jackets. Describe safe lifting to include the use of risk assessments. SWL, SWA of slings, centre of gravity, planning lifting operation. Lifting slings, to include chains, wire ropes and nylon slings, single and multi-leg slings, lifting beams, shackles, plate lifting clamps, eye bolts.

1.2 Identify the use of current legislation - Health and Safety at Work Act, clean/tidy work area, use of appropriate safe equipment. Lifting Operations and Lifting Equipment Regulations (LOLER).

1.3 Identify the safe working practices required when using fabrication tools and equipment – Hand tools, thermal cutting equipment (Oxy-acetylene, Oxy-propane, plasma, laser), shearing machines, drilling machines, rolling machines (manual and powered). Hazards from portable power tools. Faulty electrical connections, use of LVSD (110 volts), inadequate guarding. Selection of PPE.

1.4 Identify and describe the importance of safety features on powered machinery – guarding of moving parts (fixed, light, laser, adjustable), electrical isolators and emergency stop buttons.

Learning Outcome 2. Understand how to read and interpret fabrication drawings

2.1 Identify the use of orthographic drawings when manufacturing fabricated assemblies, a means of representing a three-dimensional object in two dimensions consisting of a front view, a side view and a plan.

2.2 Understand the need for tolerances in fabrication assembly activities – permissible limits or limits of variation, a measured value of a fabricated component.

Learning Outcome 3. Know about marking out materials greater than 3 mm in thickness

3.1 Identify the importance of the correct storage of marking out equipment when not in use.

3.2 Use a range of marking out equipment to mark out material greater than 3 mm in thickness – rules/tapes, dividers/trammels, scribers, squares and protractors. Marking out straight lines – straight edges, rules, chalk lines, standard back mark gauge, combination set. Cause of errors. Faulty equipment, reading drawing incorrectly, and using tools/equipment incorrectly, worn or damaged tools/equipment used, using incorrect dimensions when marking out i.e. accumulative errors.

3.3 Describe the importance of working from a fixed datum edge, line or point when marking out - difference in measurements when material has a sawn edge or sheared edge.

3.4 Describe features of marking out - progressive marking out, chain measuring, cumulative error and pitch circle diameter (PCD).

3.5 Calculate bending and rolling allowances in materials greater than 3 mm in thickness – bends at 90° in 3 mm thick material and above. Length of flat section required to produce a cylinder of a fixed diameter using the neutral/mean line of the material.

Learning Outcome 4. Be able to identify and use thermal cutting equipment

4.1 Identify and describe the equipment used for thermal cutting operations – oxy/fuel gas methods, oxygen and fuel gas, gas pressure regulators, flash back arrestors, hoses, hose check valves, torch and nozzle. Plasma arc power source (drooping characteristic) and a high voltage, plasma arc torch, electrode and nozzle, electrode negative polarity and the work piece a positive polarity.

4.2 Identify the cutting nozzle arrangements when using oxy/acetylene and oxy/propane.
4.3 Use oxy/fuel gas or plasma arc cutting equipment to produce straight lines, circles or radii.
4.4 Identify the cutting aids and attachments used with thermal cutting activities – circle cutting attachments, straight edges, bevel edges, radius bars.

Learning Outcome 5. Be able to identify and use mechanical cutting equipment

5.1 Identify the parameters when selecting a cutting machine - type of material to be cut, maximum thickness of material, maximum length of cut and blade clearance.
5.2 Identify cutting equipment – powered guillotine and universal steel worker. Advantages of shearing – fast, no material waste, clean cut edge, little or no distortion of material Limitations of shearing – limited to straight cuts on guillotine and shears, produces a work hardened cut edge, limitation on material thickness. Equipment checks to ensure safe working, regular maintenance of equipment to confirm status of blades, oil levels, electrical checks. State the importance of guarding on cutting equipment and the selection of the correct type of guard, finger guards on guillotine, electrical interlocking gate systems, blade guards on universal steel worker machines. Universal steel worker machines – can produce straight cuts, notches, punch (holes, squares), cut sectional material (angle section, channel section, round bar, square bar, flat bar).
5.3 Identify the use of cutting machine attachments – adjustable back stop, squaring arm and stroke counter Use of front and back stops to eliminate marking out, multi cuts and produce parallel cuts. Squaring arms used to ensure right angle cuts on material.
5.4 Identify drilling machines – bench drilling machine and pillar drilling machine.
5.5 State the importance of regular maintenance on powered cutting equipment.

Learning Outcome 6. Be able to identify and use forming equipment

6.1 Identify the parameters when selecting and using a forming machine – type of material to be formed, maximum thickness of material, maximum length of material to be formed, and sectional shape required.

Equipment and maintenance checks to include the condition of formers, position of formers, guards, fluid levels, electrical checks, trip wires. Guarding systems on forming machines – light guards, permanent/fixed, closed guard.

6.2 Identify forming equipment – manual folding machine, powered press brake, manual sheet rollers, powered rollers (pyramid and pinch type), powered section bending rollers. Range and application for manual and powered rolling machines using pyramid and pinch type, section bending, vertical type rolling machines to roll curves/arcs and full cylinders.
Range and application of forming machines – up-stand folders, press brake, double arm folding machine and the use of CNC forming machines. Form long straight 90° bends, form bends from 0° to 120°. Pre forming the plate edges prior to rolling – eliminate flats on cylinder.

Learning Outcome 7. Know about methods of joining parts in fabricated assemblies in materials above 3 mm in thickness

7.1 Identify a range of mechanical fasteners to join and assemble fabricated components – black bolts, high strength friction grip bolts (HSFG) and turned barrel bolts. Identify bolts by head type, thread size – metric and imperial - to include fitted and close tolerance bolts. Purpose and types of washers (plain, spring and taper). Locking devices – locking nuts, hexagonal nuts with split pin, self locking, wing. Defects in bolted connections – cross threaded, incorrect hole clearance, incorrect tension on bolts, absence of washers, incorrect bolt length used.

7.2 Identify a range of welding processes used to join and assemble fabricated components.

7.3 Describe methods of distortion control that are used when welding fabricated components – pre and post heat, pre-setting, weld sequences, tack welds, restraints, jigs, fixtures and chills.

Learning Outcome 8. Be able to assemble fabricated components to given specifications

8.1 Be able to follow instructions given on a Fabrication Specification Sheet (FSS) – gives a detailed sequence of operations to be carried out, list tools and equipment to be used in order to manufacture a fabrication to a given tolerance.

8.2 Identify a range of assembly aids used to locate parts and maintain alignment during assembly – bridge and wedges, draw bolts, cleats,

clamps, drifts and magnets. Methods used to achieve dimensional accuracy, distortion control, use of jigs/fixtures, clamping dogs, strong backs. State reason for tolerances on fabricated assemblies – heat input from welding, distortion of parts, lack of rigidity of assembly.

8.3 Be able to plan the sequence of manufacture and assembly of a fabricated component. Part assemblies and trial erections – ensure parts assemble together prior to final assembly.

Learning Outcome 9. Be able to produce a fabricated assembly in materials above 3 mm in thickness

9.1 Produce a fabricated component in material 3 mm in thickness or above – marking out, cutting material, rolling, bending/folding, drilling and assembling.

9.2 Carry out the requirements as listed in 9.1 to the required tolerance and dimensional accuracy as detailed on the drawing.

9.3 Carry out inspection of the completed assembly using a range of inspection equipment.

Teaching Strategies and Learning Activities

Centres should adopt a delivery approach which supports the development of their particular learners. The aims and aspirations of all learners, including those with identified specific needs, including learning difficulties/disabilities, should be considered and appropriate support mechanisms put in place.

This unit provides material, scientific and mathematical background whilst enhancing (both in breadth and depth) the knowledge base of any of the other units contributing to the ABC Level 3 qualifications. This needs to be delivered in the context of Fabrication and Welding practice.

Health and safety aspects of fabrication and welding practice should be reinforced within all practical units.

Learning should be delivered through a combination of learner-centred classroom sessions, workshop practice and individual guided learning. The emphasis is on practical learning opportunities and individual action plans. The prospective learning group is likely to require a good deal of tutor support in achieving the planned outcomes.

It is suggested that a simulated working atmosphere/environment should be adopted. In addition, learners should be provided with real work experiences wherever possible and visits to places of interest and co-operation with local engineering establishments are strongly recommended.

Delivery may be enhanced by:

- liaising with employers with reference to delivery, work experience and/or resources
- visits to appropriate places of interest
- the provision of information and guidance to learners on the availability and type of employment the qualification may lead to and on the progression routes available for further education and training.

Methods of Assessment

This unit will be internally assessed, internally and externally moderated.

Evidence of Achievement

ABC Awards has produced an assessment pack for this unit which is available to approved centres from the ABC Awards website.

This assessment pack contains details of the requirements of the practical tasks and examinations in the ABC Level 3 Certificate and Diploma in Fabrication and Welding Practice. Prior to commencing the qualification(s), the learner, assessor and appointed Internal Quality Assurer should familiarise themselves with the contents of this pack and what is to be expected in order to achieve.

Additional Information

Additional guidance for delivering and assessing ABC Awards qualifications and information about Internal Quality Assurance is available on the ABC Awards web site.

6. Fabrication Processes – Sheet Metal (Below 3 mm in Thickness)

Unit Reference	A/616/1296
Level	3
Credit Value	7
Guided Learning Hours	60
Unit Summary	The practical content of this unit requires the learner to manufacture a fabricated assembly in sheet metal (below 3 mm in thickness) to given dimensions and within a specified tolerance. Understanding safe working practices when carrying out sheet metal fabrication activities is an important criterion in all aspects of this unit. Other areas include working from fabrication drawings, marking out, cutting, forming and assembly.

Learning Outcomes **The learner will:**	**Assessment Criteria** **The learner can:**
1. Understand safe working practices when carrying out sheet metal activities	1.1. Identify safe lifting methods to be used when lifting and handling sheet metal below 3 mm in thickness using: • manual lifting methods • mechanical lifting methods 1.2. Identify the use of current legislation covering: LOLER (Lifting Operations and Lifting Equipment Regulations) 1.3. Identify the safe working practices required when using fabrication tools and equipment, to include: • hand tools • shearing machines • forming machines • drilling machines

	• rolling machines (manual and powered) 1.4. Identify and describe the importance of safety features on powered machinery, to include: • guarding of moving parts • electrical isolators • emergency stop buttons
2. Understand how to read and interpret fabrication drawings	2.1. Identify the use of orthographic drawings when manufacturing fabricated assemblies 2.2. Understand the need for tolerances in sheet metal fabrication assembly activities
3. Know about marking out materials less than 3 mm in thickness	3.1. Identify the importance of the correct storing of marking out equipment when not in use 3.2. Use a range of marking out equipment to mark out sheet metal, to include: • rulers/tapes • dividers/trammels • scribers • squares • protractors 3.3. Describe the importance of working from a fixed datum edge, line or point when marking out 3.4. Describe features of marking out, to include: • progressive marking out • chain measuring • cumulative error 3.5. Calculate bending and rolling allowances in sheet metal, to include: • bends at 90° in sheet metal material • length of flat section required to produce a cylinder of a fixed diameter using the neutral/mean line of the material
4. Be able to identify and use cutting equipment	4.1. Identify the parameters when selecting a cutting machine, to include: • type of material to be cut • maximum thickness of material • maximum length of cut • blade clearance

	4.2. Identify mechanical/manual cutting equipment, to include: • powered guillotine • nibbling machine • bench shears • tin snips 4.3. Identify the use of mechanical cutting machine attachments, to include: • adjustable back stop • squaring arm • stroke counter 4.4. Identify drilling machines, to include: • bench drilling machine • pillar drilling machine • hand held power drill 4.5. State the importance of regular maintenance on powered cutting equipment 4.6. Recognise the application and use of plasma arc cutting on materials less than 3 mm in thickness
5. Be able to identify and use forming equipment	5.1. Identify the parameters when selecting and using a forming machine, to include: • type of material to be formed • maximum thickness of material • maximum length of material to be formed • sectional shape required 5.2. Identify forming equipment, to include: • manual folding machine • powered press brake • manual sheet rollers(pyramid and pinch type) • powered rollers (pyramid and pinch type)
6. Know about methods of joining parts in fabricated assemblies in sheet metal	6.1. Identify a range of mechanical fasteners to join and assemble fabricated components, to include: • black bolts • hollow rivets • self tapping screws

	6.2. Identify a range of welding processes used to join and assemble fabricated components, to include: • MAGS welding • TAGS welding • resistance spot welding 6.3. Describe methods of distortion control that are used when welding fabricated components 6.4. Identify a range of self securing joints used to fasten materials less than 3 mm in thickness, to include: • grooved seam • knocked up • paned down 6.5. Recognise methods used to stiffen sheet metal assemblies
7. Be able to assemble fabricated components to given specifications	7.1. Follow instructions given on a Fabrication Specification Sheet(FSS) 7.2. Identify a range of assembly aids used to locate parts and maintain alignment during assembly, to include: • supports • jigs/fixtures • clamps • magnets 7.3. Plan the sequence of manufacture and assembly of a fabricated component
8. Be able to produce a fabricated assembly in sheet metal	8.1. Produce a fabricated component in sheet metal, to include: • marking out • cutting material • rolling • bending/folding • drilling • assembling 8.2. Carry out the requirements as listed in 8.1 to the required tolerance and dimensional accuracy as detailed on the drawing

	8.3. Carry out inspection of the completed assembly using a range of inspection equipment

Supporting Unit Information

Fabrication Processes – Sheet Metal (below 3 mm in Thickness) – A/616/1296 – Level 3

Indicative Content

Note: Indicative content provides an indication of the scope for the Learning Outcomes and Assessment Criteria. It is intended as a resource to help guide the delivery and assessment of the unit. Indicative content is NOT a statement of material which must be covered and evidenced for assessment.

Learning Outcome 1. Understand safe working practices when carrying out sheet metal activities

1.1 Identify safe lifting methods to be used when lifting and handling materials 3 mm in thickness or above – manual lifting methods and mechanical lifting methods. Hazards in a fabrication workshop, associated with lifting, incorrect slinging methods used, using damaged equipment, incorrect SWL, SWA, centre of gravity. Incorrect lifting and handling of sheet metal materials, protection of the surfaces, burns from hot material, incorrect use of powered machinery. Use of specialised PPE to include harnesses, hard hats, high visibility jackets. Describe safe lifting to include the use of risk assessments. SWL, SWA of slings, centre of gravity, planning lifting operation. Lifting slings, to include chains, wire ropes and nylon slings, single and multi-leg slings, lifting beams, shackles, plate lifting clamps, eye bolts.

1.2 Identify the use of current legislation - Health and Safety at Work Act, clean/tidy work area, use of appropriate safe equipment. Lifting Operations and Lifting Equipment Regulations (LOLER).

1.3 Identify the safe working practices required when using fabrication tools and equipment – Hand tools, thermal cutting equipment (Oxy-acetylene, Oxy-propane, plasma, laser), shearing machines, drilling machines, rolling machines (manual and powered). Hazards from portable power tools. Faulty electrical connections, use of LVSD (110 volts), inadequate guarding. Selection of PPE.

1.4 Identify and describe the importance of safety features on powered machinery – guarding of moving parts (fixed, light, laser, adjustable), electrical isolators and emergency stop buttons.

Learning Outcome 2. Understand how to read and interpret fabrication drawings

2.1 Identify the use of orthographic drawings when manufacturing fabricated assemblies, a means of representing a three-dimensional object in two dimensions consisting of a front view, a side view and a plan.

2.2 Understand the need for tolerances in sheet metal fabrication assembly activities – permissible limits or limits of variation, a measured value of a fabricated component.

Learning Outcome 3. Know about marking out materials less than 3 mm in thickness

3.1 Identify the importance of the correct storage of marking out equipment when not in use.

3.2 Use a range of marking out equipment to mark out sheet metal – rules/tapes, dividers/trammels, scribers, squares and protractors. Marking out straight lines – straight edges, rules, chalk lines, standard back mark gauge, combination set. Cause of errors. Faulty equipment, reading drawing incorrectly, and using tools/equipment incorrectly, worn or damaged tools/equipment used, using incorrect dimensions when marking out i.e. accumulative errors.

3.3 Describe the importance of working from a fixed datum edge, line or point when marking out - difference in measurements when material has a sawn edge or sheared edge.

3.4 Describe features of marking out - progressive marking out, chain measuring, cumulative error and pitch circle diameter (PCD)

3.5 Calculate bending and rolling allowances in materials greater than 3 mm in thickness – bends at 90° in 3 mm thick material and above. Length of flat section required to produce a cylinder of a fixed diameter using the neutral/mean line of the material.

Learning Outcome 4. Be able to identify and use cutting equipment

4.1 Identify the parameters when selecting a cutting machine - type of material to be cut, maximum thickness of material, maximum length of cut and blade clearance.

4.2 Identify cutting equipment – powered guillotine, nibbling machine, bench shears and tin snips. Advantages of shearing – fast, no material waste, clean cut edge, little or no distortion of material Limitations of shearing – limited to straight cuts on guillotine and shears, produces a work hardened cut edge, limitation on material

thickness. Equipment checks to ensure safe working, regular maintenance of equipment to confirm status of blades, oil levels, electrical checks. State the importance of guarding on cutting equipment and the selection of the correct type of guard, finger guards on guillotine, electrical interlocking gate systems, blade guards on universal steel worker machines. Universal steel worker machines – can produce straight cuts, notches, punch (holes, squares), cut sectional material (angle section, channel section, round bar, square bar, flat bar).

4.3 Identify the use of cutting machine attachments – adjustable back stop, squaring arm and stroke counter Use of front and back stops to eliminate marking out, multi cuts and produce parallel cuts. Squaring arms used to ensure right angle cuts on material.

4.4 Identify drilling machines – bench drilling machine, pillar drilling machine and hand held power drill.

4.5 State the importance of regular maintenance on powered cutting equipment.

4.6 Recognise the application and use of plasma arc cutting on materials less than 3 mm in thickness. Plasma arc power source (drooping characteristic) and a high voltage, plasma arc torch, electrode and nozzle, electrode negative polarity and the work piece a positive polarity.

Learning Outcome 5. Be able to identify and use forming equipment

5.1 Identify the parameters when selecting and using a forming machine – type of material to be formed, maximum thickness of material, maximum length of material to be formed, and sectional shape required.

Equipment and maintenance checks to include the condition of formers, position of formers, guards, fluid levels, electrical checks, trip wires. Guarding systems on forming machines – light guards, permanent/fixed, closed guard.

5.2 Identify forming equipment – manual folding machine, powered press brake, manual sheet rollers, powered rollers (pyramid and pinch type), powered rolers (pyramid and pinch type). Range and application for manual and powered rolling machines using pyramid and pinch type, section bending.

Range and application of forming machines – up-stand folders, press brake, double arm folding machine and the use of CNC forming machines. Form long straight 90° bends, form bends from

0° to 120°. Pre forming the plate edges prior to rolling – eliminate flats on cylinder.

Learning Outcome 6. Know about methods of joining parts in fabricated assemblies in sheet metal

6.1 Identify a range of mechanical fasteners to join and assemble fabricated components – black bolts, hollow rivets and self-tapping screws. Identify bolts by head type, thread size – metric and imperial. Purpose and types of washers (plain, spring and taper). Locking devices – locking nuts, hexagonal nuts with split pin, self-locking, wing. Defects in bolted connections – cross threaded, incorrect hole clearance, incorrect tension on bolts, absence of washers, incorrect bolt length used.

6.2 Identify a range of welding processes used to join and assemble fabricated components = MAGS welding, TAGS welding and resistance spot welding (spot and seam).

6.3 Describe methods of distortion control that are used when welding fabricated components – pre and post heat, pre-setting, weld sequences, tack welds, restraints, jigs, fixtures and chills.

6.4 Identify a range of self securing joints used to fasten materials less than 3 mm in thickness – grooved seam, knocked up and paned down.

6.5 Recognise methods used to stiffen sheet metal assemblies - forming, folding, safe edges and bending.

Learning Outcome 7. Be able to assemble fabricated components to given specifications

7.1 Be able to follow instructions given on a Fabrication Specification Sheet (FSS) – gives a detailed sequence of operations to be carried out, list tools and equipment to be used in order to manufacture a sheet metal fabrication to a given tolerance.

7.2 Identify a range of assembly aids used to locate parts and maintain alignment during assembly – supports, jigs/fixtures, clamps and magnets. Methods used to achieve dimensional accuracy, distortion control, use of jigs/fixtures, clamps. State the reason for tolerances on sheet metal fabricated assemblies – heat input from welding, distortion of parts, lack of rigidity of assembly.

7.3 Be able to plan the sequence of manufacture and assembly of a sheet metal fabricated component. Part assemblies and trial erections – ensure parts assemble together prior to final assembly.

Learning Outcome 8. Be able to produce a fabricated assembly in sheet metal

8.1 Produce a fabricated component in sheet metal – marking out, cutting material, rolling, bending/folding, drilling and assembling.

8.2 Carry out the requirements as listed in 8.1 to the required tolerance and dimensional accuracy as detailed on the drawing.

8.3 Carry out inspection of the completed assembly using a range of inspection equipment.

Teaching Strategies and Learning Activities

Centres should adopt a delivery approach which supports the development of their particular learners. The aims and aspirations of all learners, including those with identified specific needs, including learning difficulties/disabilities, should be considered and appropriate support mechanisms put in place.

This unit provides material, scientific and mathematical background whilst enhancing (both in breadth and depth) the knowledge base of any of the other units contributing to the ABC Level 3 qualifications. This needs to be delivered in the context of Fabrication and Welding practice.

Health and safety aspects of fabrication and welding practice should be reinforced within all practical units.

Learning should be delivered through a combination of learner-centred classroom sessions, workshop practice and individual guided learning. The emphasis is on practical learning opportunities and individual action plans. The prospective learning group is likely to require a good deal of tutor support in achieving the planned outcomes.

It is suggested that a simulated working atmosphere/environment should be adopted. In addition, learners should be provided with real work experiences wherever possible and visits to places of interest and co-operation with local engineering establishments are strongly recommended.

Delivery may be enhanced by:

- liaising with employers with reference to delivery, work experience and/or resources
- visits to appropriate places of interest

- the provision of information and guidance to learners on the availability and type of employment the qualification may lead to and on the progression routes available for further education and training.

Methods of Assessment

This unit will be internally assessed, internally and externally moderated.

Evidence of Achievement

ABC Awards has produced an assessment pack for this unit which is available to approved centres from the ABC Awards website.

This assessment pack contains details of the requirements of the practical tasks and examinations in the ABC Level 3 Certificate and Diploma in Fabrication and Welding Practice. Prior to commencing the qualification(s), the learner, assessor and appointed Internal Quality Assurer should familiarise themselves with the contents of this pack and what is to be expected in order to achieve.

Additional Information

Additional guidance for delivering and assessing ABC Awards qualifications and information about Internal Quality Assurance is available on the ABC Awards web site.

7. Manual Metal-Arc Welding – (Overhead) Low Carbon Steel, Stainless Steel or Aluminium

Unit Reference	F/616/1297
Level	3
Credit Value	7
Guided Learning Hours	60
Unit Summary	Learners will develop a high standard of practical skills to enable them to produce acceptable welded joints in the overhead (PE) welding position. This Diploma level qualification requires the learner to have a good understanding of health and safety, welding equipment, consumables, joint preparation and the quality assurance required to conform to relevant standards applicable to the welding industry. The learner has a choice of materials to weld by the manual metal-arc (MMA) welding process, these being low carbon steel stainless steel or aluminium.

Learning Outcomes The learner will:	**Assessment Criteria The learner can:**
1. Know about Health and Safety when carrying out MMA welding activities	1.1. Identify the roles of various organisations involved with safety in the workplace, to include: • Health and Safety Executive (HSE) • Environmental Health • Local Authorities 1.2. Identify the roles of various individuals involved with health and safety in the workplace, to include: • Company safety officers • Company safety representatives • Environmental health officers

	• HSE inspectors 1.3. Identify the purpose for and typical contents of an organisations' Health and Safety Policy 1.4. Describe the purpose of a risk assessment, to include: • who should carry out risk assessments • when to carry out a risk assessment • identification of the 5 steps of risk assessment 1.5. Identify the precautions to be taken when working in high risk areas, to include: • risk assessments • permits to work • high/low temperature working conditions • lock off systems • isolation of equipment 1.6. Describe the control and safe removal of welding fumes and gases created during the welding process, to include: • natural extraction • local extraction • PPE and specialist breathing equipment
2. Understand power sources and electrical features relating to the MMA welding process	2.1. Identify the different power sources used in MMA welding, to include: • transformer • generator • rectifier • invertor 2.2. Describe features of the power sources as listed in 2.1, to include: • type of current produced (AC/DC) • maintenance requirements • portability • suitable applications 2.3. Identify the advantages and limitations of using both alternating current (AC) and direct current (DC) 2.4. Describe how the electrical features listed affect the MMA welding process:

	• change of polarity when using direct current (DC) • current control (tapped, moving core and moving coil) • duty cycle of the power source • drooping characteristic feature
3. Understand the selection, use and storage of welding consumables used in the MMA welding process	3.1. Describe the importance of correct storage conditions for electrodes, to include: • location • ventilation • contamination • labelling 3.2. Identify the use of different types of electrodes, to include: • cellulosic • rutile • basic (low hydrogen) 3.3. Describe the reasons why basic (low hydrogen) electrodes require special conditions when being stored prior to use 3.4. Describe the effects of using damaged or damp electrodes 3.5. Identify the functions of: • flux coating on the electrode • slag covering on the weld deposit
4. Understand the welding parameters used when carrying out MMA welding in the overhead welding (PE) position to produce butt and fillet welds	4.1. Identify and select the welding parameters to be used when welding low carbon steel in the overhead welding position (PE), to include: • welding current • OCV (open circuit voltage) • electrode slope and tilt angles • arc length • speed of travel • electrode polarity 4.2. Identify which parameters may need a different selection when welding stainless steel or aluminium in the overhead position (PE)
5. Know about material preparation and	5.1. Identify suitable welding preparations for the type of joint and material thickness being welded, to include:

distortion control when using MMA welding	• included angle • angle of bevel • root face dimension • root gap dimension 5.2. Describe the advantages and limitations of the methods listed that are used to produce suitable welding preparations on materials, to include: • thermal methods • mechanical (chip forming) • shearing • bevelling machines • abrasive methods 5.3. Identify the main types of distortion found in completed welded joints, to include: • longitudinal • transverse • angular 5.4. Describe the significance of residual stress found in welded joint 5.5. Identify the main causes of distortion in welded joints 5.6. Identify methods used to control distortion in welded joints
6. Be able to complete welds in the overhead welding position (PE) using the MMA welding process	6.1. Identify appropriate safety checks on the welding equipment prior to use 6.2. Select suitable welding parameters to enable the listed joints to be welded by the MMA welding process on low carbon steel or stainless steel. • tee fillet (PE) • butt weld(PE) • open outside corner (PE) • lap joint (PE) 6.3. Carry out destructive tests on the completed welds and document the results. Tests to include: • face bend • root bend • fracture test

7. Know about defects found in welds produced by the MMA welding process	7.1. Identify defects and imperfections that may be found in welds completed in the overhead position (PE) by the MMA welding process 7.2. Identify the use of aids when carrying out visual inspection of welded joints, to include: • magnifying glass • welding gauge • fillet weld gauge • borescope
8. Know the function of inspection, quality control and quality assurance as applied to welding activities	8.1. Identify the function of: • weld inspection activities • quality control • quality assurance 8.2. Describe the importance of carrying out quality control checks on consumables used in MMA welding activities 8.3. Describe the range and purpose of destructive workshop tests used on welded joints 8.4. Identify the use and application of the four main methods of non-destructive testing (NDT), to include: • dye penetrant flaw detection • magnetic particle flaw detection • ultrasonic flaw detection • radiographic flaw detection using both X ray and gamma ray 8.5. Identify the importance of documenting weld inspection activities

Supporting Unit Information

Manual Metal-Arc Welding – (Overhead) Low Carbon Steel, Stainless Steel, Aluminium – F/616/1297 – Level 3

Indicative Content

Note: Indicative content provides an indication of the scope for the Learning Outcomes and Assessment Criteria. It is intended as a resource to help guide the delivery and assessment of the unit. Indicative content is NOT a statement of material which must be covered and evidenced for assessment.

Learning Outcome 1. Know about health and safety when carrying out MMA welding activities

1.1 Identify the roles of various organisation involved with safety in the workplace - Health and Safety Executive (HSE), Environmental Health and Local Authorities.

1.2 Identify the roles of various individuals involved with health and safety in the workplace – Company safety officers, Company safety representatives, Environmental health officers, HSE Inspectors.

1.3 Identify the purpose for and typical contents of an organisations Health and Safety Policy.

1.4 Describe the purpose of a risk assessment – who should carry out risk assessments, when to carry out a risk assessment and identification of the 5 steps of risk assessment.

1.5 Identify the precautions to be taken when working in high risk areas – risk assessments, permits to work, high/low temperature working conditions, lock off systems and isolation of equipment.

1.6 Describe the control and safe removal of welding fumes and gases created during the welding process – natural extraction, local extraction (hoods and hoses), PPE and specialist breathing equipment (welding helmets/screens).

Learning Outcome 2. Understand power sources and electrical features relating to the MMA welding process

2.1 Identify the different power sources used in MMA welding – transformer (AC step down), generator, rectifier (DC) and inverter.

2.2 Describe features of the power sources as listed in 2.1 – type of current produced (AC/DC), maintenance requirements, portability (oil filled transformers/invertors, generators) and suitable

applications (type of fabrications, site work, type and thickness of materials).

2.3 Identify the advantages and limitations of using both alternating current (AC) and direct current (DC).

2.4 Describe how the electrical features listed affect the MMA welding process = change of polarity when using direct current (DC), current control (tapped, moving core and moving coil), duty cycle of the power source and drooping characteristic feature with references to arc length changes on current and voltage values.

Learning Outcome 3. Understand the selection, use and storage of welding consumables used in the MMA welding process

3.1 Describe the importance of correct storage conditions for electrodes - location, ventilation, contamination and labelling.

3.2 Identify the use of different types of electrodes – cellulosic, rutile and basic low hydrogen.

3.3 Describe the reasons why basic low hydrogen electrodes require special conditions when being stored prior to use.

3.4 Describe the effects of using damaged or damp electrodes

3.5 Identify the functions of flux coating on the electrode and slag covering the weld deposit.

Learning Outcome 4. Understand the welding parameters used when carrying out MMA welding in the overhead welding position (PE) to produce butt and fillet welds

4.1 Identify and select the welding parameters to be used when welding low carbon steel in the overhead welding position (PE) – welding current type (AC or DC) and size (amperes), open circuit voltage (OCV), electrode slope and tilt angles, arc length, speed of travel and electrode polarity necessary to produce a defect free welded joint.

4.2 Identify which parameters may need a different selection when welding stainless steel or aluminium in the overhead position (PE).

Learning Outcome 5. Know about material preparation and distortion control when using MMA welding

5.1 Identify suitable welding preparations for the type of joint and material thickness being welded to achieve butt and fillet welds in the overhead position, included angle, angle of bevel, root face and root gap dimensions.

5.2 Describe the advantages and limitations of the methods listed that are used to produce suitable welding preparations on materials – thermal methods, mechanical (chip forming), shearing, bevelling machines and abrasive methods (grinding).
5.3 Identify the main types of distortion found in completed welded joints –longitudinal, transverse and angular.
5.4 Describe the significance of residual stress found in a welded joint – stresses caused by hammering, rolling, bending, forming, cold working, welding and cooling.
5.5 Identify the main causes of distortion in welded joints – heating and cooling rates, weld size and shape, welding process, heat input.
5.6 Identify methods used to control distortion in welded joints pre-setting, jigs, fixtures, clamps, pre and post heat, restraint, weld sequences.

Learning Outcome 6. Be able to complete welds in the overhead welding position (PE) using the MMA welding process

6.1 Identify appropriate safety checks on the welding equipment prior to use – visual checks on cable condition/diameter, connections, insulation on the welding electrode holder.
6.2 Select suitable welding parameters to enable the listed joints to be welded by the MMA welding process on low carbon steel, stainless steel or aluminium – tee fillet (PE), butt (PE), open outside corner (PE), lap joint (PE).
6.3 Carry out destructive tests on the completed welds and document the results – face bend, root bend, fracture test and nick break test.

Learning Outcome 7. Know about defects found in welds produced by the MMA welding process

7.1 Identify defects and imperfections that may be found in welds completed in the overhead position (PE) by the MMA welding process – cracking, undercut, slag inclusions, burn through, concavity, excessive weld metal, porosity, lack of penetration, arc craters, porosity, lack of fusion.
7.2 Identify the use of aids when carrying out visual inspection of welded joints – magnifying glass, welding gauge, fillet weld gauge and borescope.

Learning Outcome 8. Know the function of inspection, quality control and quality assurance as applied to welding activities

8.1 Identify the function of – weld inspection activities, quality control and quality assurance, and role of the welding inspector – carry out inspection of welds covering visual appearance, size of welds, and absence of surface defects. Confirm acceptance to required standard and advise when required on welding procedure. Identify the functions of inspection – involves the examination of welded joints by visual examination and assessing the results found against a standard.
Quality control – planning the inspection activities to ensure that the welded joint is produced to the required standard.
Quality assurance – embraces all aspects of quality to ensure that the completed weld is fit for purpose.

8.2 Describe the importance of carrying out quality control checks on consumables used in MMA welding activities – confirm the consumables are acceptable to use in terms of correct type, use by date. Consumables are not damaged, incorrect type or damaged consumables can lead to defects in the weld.

8.3 Describe the range and purpose of destructive workshop tests used on welded joints – root and face bend tests, macro and micro-etch tests, fracture tests.

8.4 Identify the use and application of the four main methods of non-destructive testing (NDT):
Dye penetrant flaw detection – advantages - enhances visual inspection, inexpensive method of testing, portable, easy to use. Limitations – slow process, only reveals surface breaking defects, not suitable for porous materials, health and safety issues with chemicals used in this process.
Magnetic particle flaw detection – advantages - fast results, portable, easy to use. Limitations - restricted to ferro-magnetic materials, only reveals surface and subsurface defects, safety issues when using power units for "prod" method. Defect orientation critical to magnetic field for detection.
Ultrasonic flaw detection – advantages - locates internal flaws/defects, fast results, no restriction on material thickness, portable most materials can be examined. Limitations - expensive equipment required, difficult to use, extensive training required, good surface finish required for testing.
Radiographic flaw detection using both X ray and gamma ray - advantages - permanent record of results found, shows the type of defect/flaw found. Limitations - safety aspects of using radiation source, expensive equipment required, extensive training required,

restrictions on portability due to safety issues. Use of fluorescent dye penetrant method - Uses a fluorescent dye which when developed under a black light source (ultra-violet) gives an enhanced sensitivity to the test. Use of fluorescent magnetic particle method - uses a fluorescent ink which when used under a black light source (ultra-violet) gives an enhanced sensitivity to the test.

8.5 Identify the importance of documenting weld inspection activities - Pre-weld inspection – confirmation of welding standard, correct consumables, condition of parent materials, joint preparation, joint set up, distortion control (pre-setting) tack welding (number, size, position), pre-heat requirements.
During welding – condition of deposited welds, distortion control, inter-pass temperature.
Post welding inspection – visual inspection of weld, surface defects, size of welds (throat, leg length) cooling rate, distortion of welded joint and cleanliness of completed weld.
Quality checks on welding consumables – confirm the consumables are acceptable to use in terms of correct type, use by date. Consumables are not damaged, incorrect type or damaged consumables can lead to defects in the weld.
Produce a welding inspection procedure sheet for a given welded joint.

Teaching Strategies and Learning Activities

Centres should adopt a delivery approach which supports the development of their particular learners. The aims and aspirations of all learners, including those with identified specific needs, including learning difficulties/disabilities, should be considered and appropriate support mechanisms put in place.

This unit provides material, scientific and mathematical background whilst enhancing (both in breadth and depth) the knowledge base of any of the other units contributing to the ABC Level 3 qualifications. This needs to be delivered in the context of Fabrication and Welding practice.

Health and safety aspects of fabrication and welding practice should be reinforced within all practical units.

Learning should be delivered through a combination of learner-centred classroom sessions, workshop practice and individual guided learning. The emphasis is on practical learning opportunities and individual action plans. The prospective learning group is likely to require a good deal of tutor support in achieving the planned outcomes.

It is suggested that a simulated working atmosphere/environment should be adopted. In addition, learners should be provided with real work experiences wherever possible and visits to places of interest and co-operation with local engineering establishments are strongly recommended.

Delivery may be enhanced by:

- liaising with employers with reference to delivery, work experience and/or resources
- visits to appropriate places of interest
- the provision of information and guidance to learners on the availability and type of employment the qualification may lead to and on the progression routes available for further education and training.

Methods of Assessment

This unit will be internally assessed, internally and externally moderated.

Evidence of Achievement

ABC Awards has produced an assessment pack for this unit which is available to approved centres from the ABC Awards website.

This assessment pack contains details of the requirements of the practical tasks and examinations in the ABC Level 3 Certificate and Diploma in Fabrication and Welding Practice. Prior to commencing the qualification(s), the learner, assessor and appointed Internal Quality Assurer should familiarise themselves with the contents of this pack and what is to be expected in order to achieve.

Additional Information

Additional guidance for delivering and assessing ABC Awards qualifications and information about Internal Quality Assurance is available on the ABC Awards web site.

8. Metal-Arc Gas Shielded Welding – (Overhead) Low Carbon Steel, Stainless Steel or Aluminium

Unit Reference	J/616/1298
Level	3
Credit Value	7
Guided Learning Hours	60
Unit Summary	Learners will develop a high standard of practical skills to enable them to produce acceptable welded joints in the overhead (PE) welding position. This Diploma level qualification requires the learner to have a good understanding of health and safety, welding equipment, consumables, joint preparation and the quality assurance required to conform to relevant standards applicable to the welding industry. The learner has a choice of materials to weld by the metal-arc gas shielded (MAGS) welding process, these being low carbon steel, stainless steel or aluminium.

Learning Outcomes The learner will:	**Assessment Criteria The learner can:**
1. Know about Health and Safety when carrying MAGS welding activities	1.1. Identify the roles of various organisations involved with Health and safety in the workplace, to include: • Health and Safety Executive (HSE) • Environmental Health • Local Authorities 1.2. Identify the roles of various individuals involved with Health and safety in the workplace, to include: • Company safety officers • Company safety representatives • Environmental health officers

	• HSE inspectors 1.3. Identify the purpose and typical contents of an organisations Health and Safety Policy 1.4. Describe the purpose of a risk assessment, to include: • who should carry out risk assessments • when to carry out a risk assessment • identification of the 5 steps of risk assessment 1.5. Identify the precautions to be taken when working in high risk areas, to include: • risk assessments • permits to work • high/low temperature working conditions • lock off systems • isolation of equipment 1.6. Describe the control and safe removal of welding fumes and gases created during the welding process, to include: • natural extraction • local extraction • PPE and specialist breathing equipment
2. Understand power sources and electrical features relating to the MAGS welding process	2.1. Identify the power sources used in MAGS welding 2.2. Describe the principle of the self adjusting arc mechanism as applied to MAGS welding 2.3. Describe how inductance can regulate the quality of the weld deposit 2.4. Identify the modes of metal transfer used in MAGS welding activities, to include: • dip • spray • pulse
3. Understand the selection, use and storage of welding consumables used in MAGS welding	3.1. Describe the importance of correct storage conditions for electrode wires, to include: • location • ventilation • contamination • labelling

	3.2. Identify the use of different types of electrode wire, to include: • non-coated • coated (copper) 3.3. Describe the content and use of deoxidising agents added to electrode wires 3.4. Describe the effects of using damaged or corroded electrode wires 3.5. Identify the range and application of shielding gases and gas mixtures used in MAGS welding
4. Understand the welding parameters used when carrying out MAGS welding in the overhead welding (PE) position to produce butt and fillet welds	4.1. Identify and select the welding parameters to be used when welding low carbon steel in the overhead welding position (PE), to include: • welding voltage • wire feed speed • torch slope and tilt angles • electrode extension • speed of travel • inductance • shielding gas flow rate (LPM) 4.2. Identify which parameters may need a different selection when welding stainless steel or aluminium in the overhead position (PE)
5. Know about material preparation and distortion control when using MAGS welding	5.1. Identify suitable welding preparations for the type of joint and material thickness being welded, to include: • included angle • angle of bevel • root face dimension • root gap dimension 5.2. Describe the advantages and limitations of the methods listed that are used to produce suitable welding preparations on materials, to include: • thermal methods • mechanical (chip forming) • shearing • bevelling machines • abrasive methods

	5.3. Identify the main types of distortion found in completed welded joints, to include: • longitudinal • transverse • angular 5.4. Identify the causes of distortion in welded joints 5.5. Identify methods used to control distortion in welded joints 5.6. Describe the significance of residual stress found in welded joints
6. Be able to complete welds in the overhead welding position (PE) using the MAGS welding process	6.1. Identify appropriate safety checks on the welding equipment prior to use 6.2. Select suitable welding parameters to enable the listed joints to be welded by the MAGS welding process on low carbon steel or stainless steel. • tee fillet (PE) • butt (PE) • open outside corner (PE) • lap joint (PE) 6.3. Carry out destructive tests on the completed welds and document the results. Tests to include: • face bend • root bend • fracture test • nick break test
7. Know the function of inspection, quality control and quality assurance as applied to welding activities	7.1. Identify the function of: • weld inspection activities • quality control • quality assurance 7.2. Describe the importance of carrying out quality control checks on consumables used in MAGS welding activities 7.3. Describe the range and purpose of destructive tests used on welded joints

	7.4. Identify the use and application of the four main methods of non-destructive testing (NDT), to include: • dye penetrant flaw detection • magnetic particle flaw detection • ultrasonic flaw detection • radiographic flaw detection using both X ray and gamma ray 7.5. Identify the importance of documenting weld inspection activities
8. Know about defects found in welds produced by the MAGS welding process	8.1. Identify defects and imperfections that may be found in welds completed in the overhead position (PE) by the MAGS welding process 8.2. Identify aids used when carrying out visual inspection of welded joints, to include: • magnifying glass • welding gauge • fillet weld gauge • borescope

Supporting Unit Information

Metal-Arc Gas Shielded Welding – (Overhead) Low Carbon Steel, Stainless Steel or Aluminium – J/616/1298 – Level 3

Indicative Content

Note: Indicative content provides an indication of the scope for the Learning Outcomes and Assessment Criteria. It is intended as a resource to help guide the delivery and assessment of the unit. Indicative content is NOT a statement of material which must be covered and evidenced for assessment.

Learning Outcome 1. Know about health and safety when carrying out MAGS welding activities

1.1 Identify the roles of various organisation involved with safety in the workplace - Health and Safety Executive (HSE), Environmental Health and Local Authorities

1.2 Identify the roles of various individuals involved with health and safety in the workplace – Company safety officers, Company safety representatives, Environmental health officers, HSE Inspectors

1.3 Identify the purpose for and typical contents of an organisations Health and Safety Policy

1.4 Describe the purpose of a risk assessment – who should carry out risk assessments, when to carry out a risk assessment and identification of the 5 steps of risk assessment.

1.5 Identify the precautions to be taken when working in high risk areas – risk assessments, permits to work, high/low temperature working conditions, lock off systems and isolation of equipment.

1.6 Describe the control and safe removal of welding fumes and gases created during the welding process – natural extraction, local extraction (hoods and hoses), PPE and specialist breathing equipment (welding helmets/screens)

Learning Outcome 2. Understand power sources and electrical features relating to the MAGS welding process

2.1 Identify the different power sources used in MAGS welding – rectifier (DC) and inverter

2.2 Describe the principle of the self-adjusting arc mechanism as applied to MAGS welding, the flat characteristic power source

feature with references to arc length changes on current and voltage values.

2.3 Describe how inductance can regulate the quality of the weld deposit – control of the rate in the rise of the short circuit current with dip transfer.

2.4 Identify the modes of metal transfer used in MAGS welding activities – dip, spray and pulse.

Learning Outcome 3. Understand the selection, use and storage of welding consumables used in the MAGS welding process

3.1 Describe the importance of correct storage conditions for electrode wires - location, ventilation, contamination and labelling.

3.2 Identify the use of different types of electrode wires – non-coated and coated (copper).

3.3 Describe the content and use of deoxidising agents added to electrode wires – silicon, manganese etc

3.4 Describe the effects of using damaged or corroded electrode wires

3.5 Identify the range and application of shielding gases and gas mixtures used in MAGS welding – argon, helium, carbon dioxide, argon/carbon dioxide mix, argon/oxygen mix, argon/helium mixes, argon/helium/nitrogen mix.

Learning Outcome 4. Understand the welding parameters used when carrying out MAGS welding in the overhead welding position (PE) to produce butt and fillet welds

4.1 Identify and select the welding parameters to be used when welding low carbon steel in the overhead welding position (PE) – welding current type (DC) and size (amperes), welding voltage, wire feed speed, torch slope and tilt angles, electrode extension, speed of travel, inductance, shielding gas flow rate necessary to produce a defect free welded joint

4.2 Identify which parameters may need a different selection when welding stainless steel or aluminium in the overhead position (PE)

Learning Outcome 5. Know about material preparation and distortion control when using MAGS welding

5.1 Identify suitable welding preparations for the type of joint and material thickness being welded to achieve butt and fillet welds in the overhead position, included angle, angle of bevel, root face and root gap dimensions

5.2 Describe the advantages and limitations of the methods listed that are used to produce suitable welding preparations on materials – thermal methods, mechanical (chip forming), shearing, bevelling machines and abrasive methods (grinding).
5.3 Identify the main types of distortion in welded joints – longitudinal, transverse and angular
5.4 Identify the main causes of distortion in welded joints - heating and cooling rates, weld size and shape, welding process, heat input
5.5 Identify methods used to control distortion in welded joints – pre setting, jigs, fixtures, clamps, pre and post heat, restraint, weld sequences
5.6 Describe the significance of residual stress found in welded joints - stresses caused by hammering, rolling, bending, forming, cold working, welding and cooling

Learning Outcome 6. Be able to complete welds in the overhead welding position (PE) using the MAGS welding process

6.1 Identify appropriate safety checks on the welding equipment prior to use – visual checks on cable condition/diameter, connections, insulation on the welding torch.
6.2 Select suitable welding parameters to enable the listed joints to be welded by the MAGS welding process on low carbon steel, stainless steel or aluminium – tee fillet (PE), butt (PE), open outside corner (PE), lap joint (PE)
6.3 Carry out destructive tests on the completed welds and document the results – face bend, root bend, fracture test and nick break test.

Learning Outcome 7. Know the function of inspection, quality control and quality assurance as applied to welding activities

7.1 Identify the function of – weld inspection activities, quality control and quality assurance, and role of the welding inspector – carry out inspection of welds covering visual appearance, size of welds, and absence of surface defects. Confirm acceptance to required standard and advise when required on welding procedure. Identify the functions of inspection – involves the examination of welded joints by visual examination and assessing the results found against a standard.
Quality control – planning the inspection activities to ensure that the welded joint is produced to the required standard.
Quality assurance – embraces all aspects of quality to ensure that the completed weld is fit for purpose

7.2 Describe the importance of carrying out quality control checks on consumables used in MAGS welding activities – confirm the consumables are acceptable to use in terms of correct type, use by date. Consumables are not damaged, incorrect type or damaged consumables can lead to defects in the weld

7.3 Describe the range and purpose of destructive workshop tests used on welded joints – root and face bend tests, macro and micro-etch tests, fracture tests

7.4 Identify the use and application of the four main methods of non-destructive testing (NDT):
Dye penetrant flaw detection – advantages - enhances visual inspection, inexpensive method of testing, portable, easy to use. Limitations – slow process, only reveals surface breaking defects, not suitable for porous materials, health and safety issues with chemicals used in this process.
Magnetic particle flaw detection – advantages - fast results, portable, easy to use. Limitations - restricted to ferro-magnetic materials, only reveals surface and subsurface defects, safety issues when using power units for "prod" method. Defect orientation critical to magnetic field for detection
Ultrasonic flaw detection – advantages - locates internal flaws/defects, fast results, no restriction on material thickness, portable most materials can be examined. Limitations - expensive equipment required, difficult to use, extensive training required, good surface finish required for testing
Radiographic flaw detection using both X ray and gamma ray - advantages - permanent record of results found, shows the type of defect/flaw found. Limitations - safety aspects of using radiation source, expensive equipment required, extensive training required, restrictions on portability due to safety issues. Use of fluorescent dye penetrant method - Uses a fluorescent dye which when developed under a black light source (ultra-violet) gives an enhanced sensitivity to the test. Use of fluorescent magnetic particle method - uses a fluorescent ink which when used under a black light source (ultra-violet) gives an enhanced sensitivity to the test.

7.5 Identify the importance of documenting weld inspection activities - Pre-weld inspection – confirmation of welding standard, correct consumables, condition of parent materials, joint preparation, joint set up, distortion control (pre-setting) tack welding (number, size, position), pre-heat requirements

During welding – condition of deposited welds, distortion control, inter-pass temperature
Post welding inspection – visual inspection of weld, surface defects, size of welds (throat, leg length) cooling rate, distortion of welded joint and cleanliness of completed weld
Quality checks on welding consumables – confirm the consumables are acceptable to use in terms of correct type, use by date. Consumables are not damaged, incorrect type or damaged consumables can lead to defects in the weld.
Produce a welding inspection procedure sheet for a given welded joint

Learning Outcome 8. Know about defects found in welds produced by the MAGS welding process

8.1 Identify defects and imperfections that may be found in welds completed in the overhead position (PE) by the MAGS welding process – cracking, lack of fusion, lack of penetration, porosity, oxide inclusions, undercut, overlap, excessive weld metal, concavity

8.2 Identify the use of aids when carrying out visual inspection of welded joints – magnifying glass, welding gauge, fillet weld gauge and borescope.

Teaching Strategies and Learning Activities

Centres should adopt a delivery approach which supports the development of their particular learners. The aims and aspirations of all learners, including those with identified specific needs, including learning difficulties/disabilities, should be considered and appropriate support mechanisms put in place.

This unit provides material, scientific and mathematical background whilst enhancing (both in breadth and depth) the knowledge base of any of the other units contributing to the ABC Level 3 qualifications. This needs to be delivered in the context of Fabrication and Welding practice.

Health and safety aspects of fabrication and welding practice should be reinforced within all practical units.

Learning should be delivered through a combination of learner-centred classroom sessions, workshop practice and individual guided learning. The emphasis is on practical learning opportunities and individual action plans.

The prospective learning group is likely to require a good deal of tutor support in achieving the planned outcomes.

It is suggested that a simulated working atmosphere/environment should be adopted. In addition, learners should be provided with real work experiences wherever possible and visits to places of interest and co-operation with local engineering establishments are strongly recommended.

Delivery may be enhanced by:

- liaising with employers with reference to delivery, work experience and/or resources
- visits to appropriate places of interest
- the provision of information and guidance to learners on the availability and type of employment the qualification may lead to and on the progression routes available for further education and training.

Methods of Assessment

This unit will be internally assessed, internally and externally moderated.

Evidence of Achievement

ABC Awards has produced an assessment pack for this unit which is available to approved centres from the ABC Awards website.

This assessment pack contains details of the requirements of the practical tasks and examinations in the ABC Level 3 Certificate and Diploma in Fabrication and Welding Practice. Prior to commencing the qualification(s), the learner, assessor and appointed Internal Quality Assurer should familiarise themselves with the contents of this pack and what is to be expected in order to achieve.

Additional Information

Additional guidance for delivering and assessing ABC Awards qualifications and information about Internal Quality Assurance is available on the ABC Awards web site.

9. Tungsten-Arc Gas Shielded Welding – (Overhead) Low Carbon Steel, Stainless Steel or Aluminium

Unit Reference	L/616/1299
Level	3
Credit Value	7
Guided Learning Hours	60
Unit Summary	Learners will develop a high standard of practical skills to enable them to produce acceptable welded joints in the overhead (PE) welding position. This Diploma level qualification requires the learner to have a good understanding of health and safety, welding equipment, consumables, joint preparation and the quality assurance required to conform to relevant standards applicable to the welding industry. The learner has a choice of materials to weld by the tungsten-arc gas shielded (TAGS) welding process, these being low carbon steel, stainless steel or aluminium.

Learning Outcomes The learner will:	**Assessment Criteria The learner can:**
1. Know about Health and Safety when carrying out TAGS welding activities	1.1. Identify the roles of various organisations involved with Health and safety in the workplace, to include: • Health and Safety Executive (HSE) • Environmental Health • Local Authorities 1.2. Identify the roles of various individuals involved with Health and Safety in the workplace, to include: • Company safety officers • Company safety representatives

	• Environmental health officers • HSE inspectors 1.3. Identify the purpose and typical contents of an organisations Health and Safety Policy 1.4. Describe the purpose of a risk assessment, to include: • who should carry out risk assessments • when to carry out a risk assessment • identification of the 5 steps of risk assessment 1.5. Identify the precautions to be taken when working in high risk areas, to include: • risk assessments • permits to work • high/low temperature working conditions • lock off systems • isolation of equipment 1.6. Describe the control and safe removal of welding fumes and gases created during the welding process, to include: • natural extraction • local extraction • PPE and specialist breathing equipment 1.7. Describe the hazards associated when using the TAGS welding process, to include: • arc radiation • using high frequency • production of phosgene gas
2. Understand power sources and electrical features relating to the TAGS welding process	2.1. Identify the power sources used in TAGS welding 2.2. Identify the type of welding current (AC/DC) and polarity to be used when welding: • low carbon steel • stainless steel • aluminium 2.3. Describe the application and use of equipment used in the TAGS welding process, to include: • high frequency unit • current control foot pedal

	• gas pressure regulator • gas flow meter • gas lens
3. Understand the selection, composition, use and storage of welding consumables used in TAGS welding	3.1. Describe the importance of correct storage conditions for tungsten electrodes and filler wires, to include: • location • ventilation • contamination • labelling 3.2. Identify the range of different alloying elements added to tungsten electrodes 3.3. Identify the electrode (tip) preparation required when using an AC or DC welding current 3.4. Identify the content and application of a range of filler wires used in the TAGS welding process 3.5. Describe the effects of using damaged tungsten electrodes and filler wires 3.6. Identify the range and application of shielding gases used in the TAGS welding process
4. Understand the welding parameters used when carrying out TAGS welding in the overhead welding (PE) position to produce butt and fillet welds	4.1. Identify and select the welding parameters to be used when welding low carbon steel, stainless steel or aluminium in the overhead welding position (PE), to include: • welding voltage • slope in/slope out control • torch slope and tilt angles • high frequency • speed of travel • pre/post gas flow • shielding gas flow rate (LPM) 4.2. Describe the application and function of gas backing /purging
5. Know about material preparation and distortion control	5.1. Identify suitable welding preparations for the type of joint and material thickness being welded, to include: • included angle • angle of bevel

when using TAGS welding	• root face dimension • root gap dimension 5.2. Describe the advantages and limitations of the methods listed that are used to produce suitable welding preparations on materials, to include: • thermal methods • mechanical (chip forming) • shearing • bevelling machines • abrasive methods 5.3. Identify the main types of distortion found in completed welded joints, to include: • longitudinal • transverse • angular 5.4. Identify the main causes of distortion in welded joints 5.5. Identify methods used to control distortion in welded joints 5.6. Describe the significance of residual stress found in welded joints
6. Be able to complete welds in the overhead welding position (PE) using the TAGS welding process	6.1. Identify appropriate safety checks on the welding equipment prior to use 6.2. Select suitable welding parameters to enable the listed joints to be welded by the TAGS welding process on one material type to cover, low carbon steel, stainless steel or aluminium in a thickness range of between 1.6 mm to 3 mm. • tee fillet (PE) • butt (PE) • open outside corner (PE) • lap joint (PE) 6.3. Carry out destructive tests on the completed welds and document the results. Tests to include: • face bend • root bend • fracture test

	• nick break test
7. Know the function of inspection, quality control and quality assurance as applied to welding activities	7.1. Identify the function of: • weld inspection activities • quality control • quality assurance 7.2. Describe the importance of carrying out quality control checks on consumables used in TAGS welding activities 7.3. Describe the range and purpose for destructive tests used on welded joints 7.4. Identify the use and application of the four main methods of non-destructive testing (NDT), to include: • dye penetrant flaw detection • magnetic particle flaw detection • ultrasonic flaw detection • radiographic flaw detection using both X ray and gamma ray 7.5. Identify the importance of documenting weld inspection activities
8. Know about defects found in welds produced by the TAGS welding process	8.1. Identify defects and imperfections that may be found in welds completed in the overhead position (PE) by the TAGS welding process 8.2. Identify aids used when carrying out visual inspection of welded joints, to include: • magnifying glass • welding gauge • fillet weld gauge • borescope

Supporting Unit Information

Tungsten-Arc Gas Shielded Welding – (Overhead) Low Carbon Steel, Stainless Steel or Aluminium – L/616/1299 – Level 3

Indicative Content

Note: Indicative content provides an indication of the scope for the Learning Outcomes and Assessment Criteria. It is intended as a resource to help guide the delivery and assessment of the unit. Indicative content is NOT a statement of material which must be covered and evidenced for assessment.

Learning Outcome 1. Know about health and safety when carrying out TAGS welding activities

1.1 Identify the roles of various organisation involved with safety in the workplace - Health and Safety Executive (HSE), Environmental Health and Local Authorities

1.2 Identify the roles of various individuals involved with health and safety in the workplace – Company safety officers, Company safety representatives, Environmental health officers, HSE Inspectors

1.3 Identify the purpose for and typical contents of an organisations Health and Safety Policy

1.4 Describe the purpose of a risk assessment – who should carry out risk assessments, when to carry out a risk assessment and identification of the 5 steps of risk assessment.

1.5 Identify the precautions to be taken when working in high risk areas – risk assessments, permits to work, high/low temperature working conditions, lock off systems and isolation of equipment.

1.6 Describe the control and safe removal of welding fumes and gases created during the welding process – natural extraction, local extraction (hoods and hoses), PPE and specialist breathing equipment (welding helmets/screens).

1.7 Describe the hazards associated when using the TAGS welding process – arc radiation, using high frequency (burns) and production of phosgene gas (use near degreasing operations).

Learning Outcome 2. Understand power sources and electrical features relating to the TAGS welding process

2.1 Identify the different power sources used in TAGS welding – rectifier (DC) and inverter

2.2 Identify the type of welding current (AC/DC) and polarity to be used when welding low carbon steel (DC negative), stainless steel (DC negative) and aluminium (DC/AC).

2.3 Describe the application and use of equipment used in the TAGS welding process – high frequency unit, current control foot pedal, gas pressure regulator, gas flow meter and gas lens.

Learning Outcome 3. Understand the selection, composition, use and storage of welding consumables used in the TAGS welding process

3.1 Describe the importance of correct storage conditions for electrode wires - location, ventilation, contamination and labelling.

3.2 Identify the use of different alloying elements added to tungsten electrodes – cerium, thorium and zirconium, colour code and uses.

3.3 Identify the electrode (tip) preparation required when using an AC or DC welding current.

3.4 Identify the content and application of a range of filler wires used in the TAGS welding process

3.5 Describe the effects of using damaged tungsten electrodes and filler wires – poor arc control, stray arcing, porosity, tungsten inclusions and poor weld quality.

3.6 Identify the range and application of shielding gases used in TAGS welding – argon, helium, argon/helium, argon/nitrogen, argon/hydrogen, argon/helium/nitrogen.

Learning Outcome 4. Understand the welding parameters used when carrying out TAGS welding in the overhead welding position (PE) to produce butt and fillet welds

4.1 Identify and select the welding parameters to be used when welding low carbon steel in the overhead welding position (PE) – welding current type (AC/DC) and size (amperes), welding voltage, slope in/slope out control, torch slope and tilt angles, high frequency, speed of travel, pre/post gas flow, shielding gas flow rate (LPM) necessary to produce a defect free welded joint

4.2 Describe the applications and function of gas backing/purging – root run protection on stainless steel, removal of oxygen/air in the system).

Learning Outcome 5. Know about material preparation and distortion control when using TAGS welding

5.1 Identify suitable welding preparations for the type of joint and material thickness being welded to achieve butt and fillet welds in the overhead position, included angle, angle of bevel, root face and root gap dimensions

5.2 Describe the advantages and limitations of the methods listed that are used to produce suitable welding preparations on materials – thermal methods, mechanical (chip forming), shearing, bevelling machines and abrasive methods (grinding).

5.3 Identify the main types of distortion in welded joints – longitudinal, transverse and angular

5.4 Identify the main causes of distortion in welded joints - heating and cooling rates, weld size and shape, welding process, heat input

5.5 Identify methods used to control distortion in welded joints – pre setting, jigs, fixtures, clamps, pre and post heat, restraint, weld sequences

5.6 Describe the significance of residual stress found in welded joints - stresses caused by hammering, rolling, bending, forming, cold working, welding and cooling

Learning Outcome 6. Be able to complete welds in the overhead welding position (PE) using the TAGS welding process

6.1 Identify appropriate safety checks on the welding equipment prior to use – visual checks on cable condition/diameter, connections, insulation on the welding torch

6.2 Select suitable welding parameters to enable the listed joints to be welded by the TAGS welding process on low carbon steel, stainless steel or aluminium in a thickness range between 1.6m to 3 mm– tee fillet (PE), butt (PE), open outside corner (PE), lap joint (PE)

6.3 Carry out destructive tests on the completed welds and document the results – face bend, root bend, fracture test and nick break test.

Learning Outcome 7. Know the function of inspection, quality control and quality assurance as applied to welding activities

7.1 Identify the function of – weld inspection activities, quality control and quality assurance, and role of the welding inspector – carry out inspection of welds covering visual appearance, size of welds, and absence of surface defects. Confirm acceptance to required standard and advise when required on welding procedure. Identify the functions of inspection – involves the examination of welded

joints by visual examination and assessing the results found against a standard.
Quality control – planning the inspection activities to ensure that the welded joint is produced to the required standard.
Quality assurance – embraces all aspects of quality to ensure that the completed weld is fit for purpose

7.2 Describe the importance of carrying out quality control checks on consumables used in TAGS welding activities – confirm the consumables are acceptable to use in terms of correct type, use by date. Consumables are not damaged, incorrect type or damaged consumables can lead to defects in the weld

7.3 Describe the range and purpose of destructive workshop tests used on welded joints – root and face bend tests, macro and micro-etch tests, fracture tests

7.4 Identify the use and application of the four main methods of non-destructive testing (NDT):
Dye penetrant flaw detection – advantages - enhances visual inspection, inexpensive method of testing, portable, easy to use. Limitations – slow process, only reveals surface breaking defects, not suitable for porous materials, health and safety issues with chemicals used in this process.
Magnetic particle flaw detection – advantages - fast results, portable, easy to use. Limitations - restricted to ferro-magnetic materials, only reveals surface and subsurface defects, safety issues when using power units for "prod" method. Defect orientation critical to magnetic field for detection
Ultrasonic flaw detection – advantages - locates internal flaws/defects, fast results, no restriction on material thickness, portable most materials can be examined. Limitations - expensive equipment required, difficult to use, extensive training required, good surface finish required for testing
Radiographic flaw detection using both X ray and gamma ray - advantages - permanent record of results found, shows the type of defect/flaw found. Limitations - safety aspects of using radiation source, expensive equipment required, extensive training required, restrictions on portability due to safety issues. Use of fluorescent dye penetrant method - Uses a fluorescent dye which when developed under a black light source (ultra-violet) gives an enhanced sensitivity to the test. Use of fluorescent magnetic particle method - uses a fluorescent ink which when used under a

black light source (ultra-violet) gives an enhanced sensitivity to the test.

7.5 Identify the importance of documenting weld inspection activities - Pre-weld inspection – confirmation of welding standard, correct consumables, condition of parent materials, joint preparation, joint set up, distortion control (pre-setting) tack welding (number, size, position), pre-heat requirements
During welding – condition of deposited welds, distortion control, inter-pass temperature
Post welding inspection – visual inspection of weld, surface defects, size of welds (throat, leg length) cooling rate, distortion of welded joint and cleanliness of completed weld
Quality checks on welding consumables – confirm the consumables are acceptable to use in terms of correct type, use by date. Consumables are not damaged, incorrect type or damaged consumables can lead to defects in the weld.
Produce a welding inspection procedure sheet for a given welded joint

Learning Outcome 8. Know about defects found in welds produced by the TAGS welding process

8.1 Identify defects and imperfections that may be found in welds completed in the overhead position (PE) by the TAGS welding process – cracking, porosity, piping, craters, tungsten inclusion, undercut, burn through, underfill, oxidation, lack of penetration, lack of fusion

8.2 Identify the use of aids when carrying out visual inspection of welded joints – magnifying glass, welding gauge, fillet weld gauge and borescope.

Teaching Strategies and Learning Activities

Centres should adopt a delivery approach which supports the development of their particular learners. The aims and aspirations of all learners, including those with identified specific needs, including learning difficulties/disabilities, should be considered and appropriate support mechanisms put in place.

This unit provides material, scientific and mathematical background whilst enhancing (both in breadth and depth) the knowledge base of any of the

other units contributing to the ABC Level 3 qualifications. This needs to be delivered in the context of Fabrication and Welding practice.

Health and safety aspects of fabrication and welding practice should be reinforced within all practical units.

Learning should be delivered through a combination of learner-centred classroom sessions, workshop practice and individual guided learning. The emphasis is on practical learning opportunities and individual action plans. The prospective learning group is likely to require a good deal of tutor support in achieving the planned outcomes.

It is suggested that a simulated working atmosphere/environment should be adopted. In addition, learners should be provided with real work experiences wherever possible and visits to places of interest and co-operation with local engineering establishments are strongly recommended.

Delivery may be enhanced by:

- liaising with employers with reference to delivery, work experience and/or resources
- visits to appropriate places of interest
- the provision of information and guidance to learners on the availability and type of employment the qualification may lead to and on the progression routes available for further education and training.

Methods of Assessment

This unit will be internally assessed, internally and externally moderated.

Evidence of Achievement

ABC Awards has produced an assessment pack for this unit which is available to approved centres from the ABC Awards website.

This assessment pack contains details of the requirements of the practical tasks and examinations in the ABC Level 3 Certificate and Diploma in Fabrication and Welding Practice. Prior to commencing the qualification(s), the learner, assessor and appointed Internal Quality

Assurer should familiarise themselves with the contents of this pack and what is to be expected in order to achieve.

Additional Information

Additional guidance for delivering and assessing ABC Awards qualifications and information about Internal Quality Assurance is available on the ABC Awards web site.

10. Thick Plate Welding using Flux Cored Metal-Arc Gas Shielded Welding

Unit Reference	T/616/1300
Level	3
Credit Value	7
Guided Learning Hours	60
Unit Summary	Learners will develop a high standard of practical skills to enable them to produce acceptable welded joints in the flat (PA) or horizontal vertical (PB) welding positions. This Diploma level qualification requires the learner to have a good understanding of health and safety, welding equipment, consumables, joint preparation and the quality assurance required to conform to relevant standards applicable to the welding industry. Welds are produced by the metal-arc gas shielded (MAGS) welding process using flux cored wires. The material is low carbon steel in a range of thickness from 6 mm to 12 mm.

Learning Outcomes The learner will:	**Assessment Criteria The learner can:**
1. Know about Health and Safety when carrying MAGS welding activities using flux cored wires	1.1. Identify the roles of various organisations involved with health and safety in the workplace, to include: • Health and Safety Executive (HSE) • Environmental Health • Local Authorities 1.2. Identify the roles of various individuals involved with health and safety in the workplace, to include: • Company safety officers • Company safety representatives • Environmental health officers

	• HSE inspectors 1.3. Identify the purpose and typical contents of an organisations Health and Safety Policy 1.4. Describe the purpose of a risk assessment, to include: • who should carry out risk assessments • when to carry out a risk assessment • identification of the 5 steps of risk assessment 1.5. Identify the precautions to be taken when working in high risk areas, to include: • risk assessments • permits to work • high/low temperature working conditions • lock off systems • isolation of equipment 1.6. Describe the control and safe removal of welding fumes and gases created during the welding process, to include: • natural extraction • local extraction • PPE and specialist breathing equipment
2. Understand power sources and electrical features relating to the MAGS welding process using flux cored wires	2.1. Identify the power sources used in MAGS welding using flux cored wires 2.2. Describe the principle of the self-adjusting arc mechanism as applied to MAGS welding using flux cored wires 2.3. Describe how inductance can influence the quality of the weld deposit 2.4. Describe the characteristics of the mode of metal transfer, to include: • spray transfer • globular transfer
3. Understand the selection, use and storage of welding consumables	3.1. Describe the importance of correct storage conditions for flux cored electrode wires, to include: • location • ventilation • contamination • labelling

	3.2. Identify the use of different types of flux cored wires 3.3. Describe the content and use of fluxes added electrode wires 3.4. Describe the effects of using damaged or corroded flux cored electrode wires 3.5. Identify the range and application of shielding gases and gas mixtures used in flux cored MAGS welding
4. Understand the welding parameters used when carrying out MAGS welding using flux cored wires in the overhead welding (PE)position to produce butt and fillet welds	4.1. Identify and select the welding parameters to be used when welding low carbon steel in the flat (PA) or horizontal vertical (PB) welding positions, to include: • welding voltage range • welding amperage range • wire feed speed • torch slope and tilt angles • electrode extension • speed of travel • inductance • type of shielding gas (if used) • shielding gas flow rate (LPM)
5. Know about material preparation and distortion control when carrying out MAGS welding using flux cored wires	5.1. Identify suitable welding preparations for the type of joint and material thickness being welded, to include: • included angle • angle of bevel • root face dimension • root gap dimension 5.2. Describe the advantages and limitations of the methods listed that are used to produce suitable welding preparations on materials, to include: • thermal methods • mechanical (chip forming) • shearing • bevelling machines • abrasive methods 5.3. Identify the main types of distortion found in completed welded joints, to include: • longitudinal

	• transverse • angular 5.4. Identify the causes of distortion in welded joints 5.5. Identify methods used to control distortion in welded joints 5.6. Describe the significance of residual stress found in welded joints
6. Be able to complete welds in the flat (PA) or horizontal welding position (PB) by the MAGS welding process using flux cored wires	6.1. Identify appropriate safety checks on the welding equipment prior to use 6.2. Select suitable welding parameters to enable the listed joints to be welded by the MAGS welding process using flux cored wires on low carbon steel in a thickness range of between 6 mm to 12 mm. • tee fillet (PA or PC)) • single vee butt (PA) • double vee butt (PA)
7. Know the function of inspection, quality control and quality assurance as applied to welding activities	7.1. Identify the function of: • weld inspection activities • quality control • quality assurance 7.2. Describe the importance of carrying out quality control checks on consumables used in MAGS welding activities 7.3. Describe the range and purpose for destructive tests used on welded joints 7.4. Identify the use and application of the four main methods of non-destructive testing (NDT), to include: • dye penetrant flaw detection • magnetic particle flaw detection • ultrasonic flaw detection • radiographic flaw detection using both X ray and gamma ray 7.5. Identify the importance of documenting weld inspection activities
8. Know about defects found in	8.1. Identify defects and imperfections that may be found in welds completed in the flat (PA)

welds produced by the MAGS welding process using flux cored wires	or horizontal vertical position (PC) by the MAGS welding process using flux cored wires 8.2. Identify aids used when carrying out visual inspection of welded joints, to include: • magnifying glass • welding gauge • fillet weld gauge • borescope

Supporting Unit Information

Thick Plate Welding using Flux Cored Metal-Arc Gas Shielded Welding – T/616/1300 – Level 3

Indicative Content

Note: Indicative content provides an indication of the scope for the Learning Outcomes and Assessment Criteria. It is intended as a resource to help guide the delivery and assessment of the unit. Indicative content is NOT a statement of material which must be covered and evidenced for assessment.

Learning Outcome 1. Know about health and safety when carrying out MAGS welding activities using flux cored wires

1.1 Identify the roles of various organisation involved with safety in the workplace - Health and Safety Executive (HSE), Environmental Health and Local Authorities

1.2 Identify the roles of various individuals involved with health and safety in the workplace – Company safety officers, Company safety representatives, Environmental health officers, HSE Inspectors

1.3 Identify the purpose for and typical contents of an organisations Health and Safety Policy

1.4 Describe the purpose of a risk assessment – who should carry out risk assessments, when to carry out a risk assessment and identification of the 5 steps of risk assessment.

1.5 Identify the precautions to be taken when working in high risk areas – risk assessments, permits to work, high/low temperature working conditions, lock off systems and isolation of equipment.

1.6 Describe the control and safe removal of welding fumes and gases created during the welding process – natural extraction, local extraction (hoods and hoses), PPE and specialist breathing equipment (welding helmets/screens)

Learning Outcome 2. Understand power sources and electrical features relating to the MAGS welding process using flux cored wires

2.1 Identify the different power sources used in MAGS welding using flux cored wires – rectifier (DC) and inverter

2.2 Describe the principle of the self adjusting arc mechanism as applied to MAGS welding using flux cored wires, the flat

characteristic power source feature with references to arc length changes on current and voltage values.

2.3 Describe how inductance can regulate the quality of the weld deposit – control of the rate in the rise of the short circuit current with dip transfer.

2.4 Describe the characteristics of the mode of metal transfer - spray and globular.

Learning Outcome 3. Understand the selection, use and storage of welding consumables used in the MAGS welding process

3.1 Describe the importance of correct storage conditions for electrode wires - location, ventilation, contamination and labelling.

3.2 Identify the use of different types of flux cored wires.

3.3 Describe the content and use of fluxes added to electrode wires.

3.4 Describe the effects of using damaged or corroded flux core electrode wires

3.5 Identify the range and application of shielding gases and gas mixtures used in flux cored MAGS welding – carbon dioxide, argon/carbon dioxide mix.

Learning Outcome 4. Understand the welding parameters used when carrying out MAGS welding using flux cored wires in the overhead welding position (PE) to produce butt and fillet welds

4.1 Identify and select the welding parameters to be used when welding low carbon steel in the overhead welding position (PE) – welding current type (DC) and size (amperes), welding voltage, wire feed speed, torch slope and tilt angles, electrode extension, speed of travel, inductance, shielding gas type (if used), shielding gas flow rate (LPM) necessary to produce a defect free welded joint

Learning Outcome 5. Know about material preparation and distortion control when carrying out MAGS welding using flux cored wires

5.1 Identify suitable welding preparations for the type of joint and material thickness being welded to achieve butt and fillet welds in the overhead position, included angle, angle of bevel, root face and root gap dimensions

5.2 Describe the advantages and limitations of the methods listed that are used to produce suitable welding preparations on materials – thermal methods, mechanical (chip forming), shearing, bevelling machines and abrasive methods (grinding).

5.3 Identify the main types of distortion in welded joints – longitudinal, transverse and angular
5.4 Identify the main causes of distortion in welded joints - heating and cooling rates, weld size and shape, welding process, heat input
5.5 Identify methods used to control distortion in welded joints – pre setting, jigs, fixtures, clamps, pre and post heat, restraint, weld sequences
5.6 Describe the significance of residual stress found in welded joints - stresses caused by hammering, rolling, bending, forming, cold working, welding and cooling

Learning Outcome 6. Be able to complete welds in the overhead welding position (PE) by the MAGS welding process using flux cored wires

6.1 Identify appropriate safety checks on the welding equipment prior to use – visual checks on cable condition/diameter, connections, insulation on the welding torch.
6.2 Select suitable welding parameters to enable the listed joints to be welded by the MAGS welding process using flux cored wires on low carbon steel in a thickness range of between 6mm to 12mm – tee fillet (PE), single vee butt (PE), double vee butt (PE)
6.3 Carry out destructive tests on the completed welds and document the results – face bend, root bend, fracture test and nick break test.

Learning Outcome 7. Know the function of inspection, quality control and quality assurance as applied to welding activities

7.1 Identify the function of – weld inspection activities, quality control and quality assurance, and role of the welding inspector – carry out inspection of welds covering visual appearance, size of welds, and absence of surface defects. Confirm acceptance to required standard and advise when required on welding procedure. Identify the functions of inspection – involves the examination of welded joints by visual examination and assessing the results found against a standard.
Quality control – planning the inspection activities to ensure that the welded joint is produced to the required standard.
Quality assurance – embraces all aspects of quality to ensure that the completed weld is fit for purpose
7.2 Describe the importance of carrying out quality control checks on consumables used in MAGS welding activities – confirm the consumables are acceptable to use in terms of correct type, use by

date. Consumables are not damaged, incorrect type or damaged consumables can lead to defects in the weld

7.3 Describe the range and purpose of destructive workshop tests used on welded joints – root and face bend tests, macro and micro-etch tests, fracture tests

7.4 Identify the use and application of the four main methods of non-destructive testing (NDT):
Dye penetrant flaw detection – advantages - enhances visual inspection, inexpensive method of testing, portable, easy to use. Limitations – slow process, only reveals surface breaking defects, not suitable for porous materials, health and safety issues with chemicals used in this process.
Magnetic particle flaw detection – advantages - fast results, portable, easy to use. Limitations - restricted to ferro-magnetic materials, only reveals surface and subsurface defects, safety issues when using power units for "prod" method. Defect orientation critical to magnetic field for detection
Ultrasonic flaw detection – advantages - locates internal flaws/defects, fast results, no restriction on material thickness, portable most materials can be examined. Limitations - expensive equipment required, difficult to use, extensive training required, good surface finish required for testing
Radiographic flaw detection using both X ray and gamma ray - advantages - permanent record of results found, shows the type of defect/flaw found. Limitations - safety aspects of using radiation source, expensive equipment required, extensive training required, restrictions on portability due to safety issues. Use of fluorescent dye penetrant method - Uses a fluorescent dye which when developed under a black light source (ultra-violet) gives an enhanced sensitivity to the test. Use of fluorescent magnetic particle method - uses a fluorescent ink which when used under a black light source (ultra-violet) gives an enhanced sensitivity to the test.

7.5 Identify the importance of documenting weld inspection activities - Pre-weld inspection – confirmation of welding standard, correct consumables, condition of parent materials, joint preparation, joint set up, distortion control (pre-setting) tack welding (number, size, position), pre-heat requirements
During welding – condition of deposited welds, distortion control, inter-pass temperature

Post welding inspection – visual inspection of weld, surface defects, size of welds (throat, leg length) cooling rate, distortion of welded joint and cleanliness of completed weld
Quality checks on welding consumables – confirm the consumables are acceptable to use in terms of correct type, use by date. Consumables are not damaged, incorrect type or damaged consumables can lead to defects in the weld.
Produce a welding inspection procedure sheet for a given welded joint

Learning Outcome 8. Know about defects found in welds produced by the MAGS welding process using flux cored wires

8.1 Identify defects and imperfections that may be found in welds completed in the overhead position (PE) by the MAGS welding process using flux cored wires – cracking, lack of fusion, lack of penetration, porosity, oxide inclusions, undercut, overlap, excessive weld metal, concavity

8.2 Identify the use of aids when carrying out visual inspection of welded joints – magnifying glass, welding gauge, fillet weld gauge and borescope.

Teaching Strategies and Learning Activities

Centres should adopt a delivery approach which supports the development of their particular learners. The aims and aspirations of all learners, including those with identified specific needs, including learning difficulties/disabilities, should be considered and appropriate support mechanisms put in place.

This unit provides material, scientific and mathematical background whilst enhancing (both in breadth and depth) the knowledge base of any of the other units contributing to the ABC Level 3 qualifications. This needs to be delivered in the context of Fabrication and Welding practice.

Health and safety aspects of fabrication and welding practice should be reinforced within all practical units.

Learning should be delivered through a combination of learner-centred classroom sessions, workshop practice and individual guided learning. The emphasis is on practical learning opportunities and individual action plans.

The prospective learning group is likely to require a good deal of tutor support in achieving the planned outcomes.

It is suggested that a simulated working atmosphere/environment should be adopted. In addition, learners should be provided with real work experiences wherever possible and visits to places of interest and co-operation with local engineering establishments are strongly recommended.

Delivery may be enhanced by:

- liaising with employers with reference to delivery, work experience and/or resources
- visits to appropriate places of interest
- the provision of information and guidance to learners on the availability and type of employment the qualification may lead to and on the progression routes available for further education and training.

Methods of Assessment

This unit will be internally assessed, internally and externally moderated.

Evidence of Achievement

ABC Awards has produced an assessment pack for this unit which is available to approved centres from the ABC Awards website.

This assessment pack contains details of the requirements of the practical tasks and examinations in the ABC Level 3 Certificate and Diploma in Fabrication and Welding Practice. Prior to commencing the qualification(s), the learner, assessor and appointed Internal Quality Assurer should familiarise themselves with the contents of this pack and what is to be expected in order to achieve.

Additional Information

Additional guidance for delivering and assessing ABC Awards qualifications and information about Internal Quality Assurance is available on the ABC Awards web site.

11. Pipe Welding using Manual Metal-Arc Welding, Metal-Arc Gas Shielded Welding or Tungsten-Arc Gas Shielded Welding

Unit Reference	A/616/1301
Level	3
Credit Value	7
Guided Learning Hours	60
Unit Summary	Learners will develop a high standard of practical skills to enable them to produce acceptable welded joints in pipe assemblies covering fixed and rotated welding positions. This Diploma level qualification requires the learner to have a good understanding of health and safety, welding equipment, consumables, joint preparation and the quality assurance required to conform to relevant standards applicable to the welding industry. Welds will be produced in pipes of differing diameters and wall thicknesses. The learner will select one process from manual metal-arc (MMA), metal-arc gas shielded (MAGS) or tungsten-arc gas shielded (TAGS) welding to complete the welded joints required.

Learning Outcomes The learner will:	**Assessment Criteria The learner can:**
1. Know about Health and Safety when carrying out pipe welding activities	1.1. Identify the roles of various organisations involved with health and safety in the workplace, to include: • Health and Safety Executive (HSE) • Environmental Health • Local Authorities 1.2. Identify the roles of various individuals involved with health and safety in the workplace, to include:

	• Company safety officers • Company safety representatives • Environmental health officers • HSE inspectors 1.3. Identify the purpose and typical contents of an Organisations health and safety policy 1.4. Describe the purpose of a risk assessment, to include: • who should carry out risk assessments • when to carry out a risk assessment • identification of the 5 steps of risk assessment 1.5. Identify the precautions to be taken when working in high risk areas, to include: • risk assessments • permits to work • high/low temperature working conditions • lock off systems • isolation of equipment 1.6. Describe the control and safe removal of welding fumes and gases created during the welding process, to include: • natural extraction • local extraction • PPE and specialist breathing equipment 1.7. Identify the risk associated with pipe welding on site, to include: • location • environmental (wind, rain etc.) • availability of power supply • working/welding in trenches • welding at heights
2. Understand power sources and electrical features relating to welding processes used for pipe welding activities	2.1. Identify the different power sources used when welding with MMA, MAGS and TAGS welding, to include: • transformer • generator • rectifier • invertor 2.2. Describe features of the power sources as listed in 2.1, to include:

	• type of current produced (AC/DC) • maintenance requirements • portability • suitable applications 2.3. Identify specialist equipment used when carrying out pipe welding activities, to include: • pipe cutting equipment • jigs/fixtures • turntables/rotators/manipulators
3. Understand the selection, use and storage of welding consumables	3.1. Describe the importance of correct storage conditions for electrodes, wires and gas cylinders, to include: • location • ventilation • contamination • labelling 3.2. Identify the use of different types of electrodes, electrode wires and filler wires when carrying out pipe welding activities 3.3. Identify the range and application of shielding gases and gas mixtures used when pipe welding with the MAGS or TAGS welding process 3.4. Describe the effects of using damaged or corroded electrodes, electrode wires and filler wires when carrying out pipe welding activities
4. Understand the welding parameters required when using MMA, MAGS and TAGS welding to produce welds in low carbon steel pipes	4.1. Identify and select the required welding parameters to be used when welding low carbon steel pipes using MMA, MAGS and TAGS welding processes, to include: • welding voltage • welding current • electrode polarity • wire feed speed • torch slope and tilt angles • electrode extension • speed of travel • inductance • gas delay system • shielding gas type • shielding gas flow rate (LPM)

5. Know about material preparation and joint set-up when pipe welding	5.1. Identify suitable welding preparations for the type of joint, diameter and wall thickness of the pipe being welded, to include: • included angle • angle of bevel • root face dimension • root gap dimension 5.2. Identify different types of joints used in pipe work assemblies, to include: • butt welds • branch joints • slip on flange • set on flange 5.3. Describe the advantages and limitations of the methods listed that are used to produce suitable welding preparations on materials, to include: • thermal methods • mechanical (chip forming) • bevelling machines • abrasive methods 5.4. Identify the application of both permanent and temporary backing rings used in pipe welding 5.5. Identify methods used to ensure pipe alignment before and during welding activities 5.6. Identify different types of pipe work fittings, to include: • concentric reducers • eccentric reducers • equal diameter tee pieces • unequal diameter tee pieces • elbows 45° 60° 90° • blank ends (dished ends)
6. Be able to complete welds in pipe work using a selected welding process	6.1. Identify appropriate safety checks on the selected welding equipment prior to use 6.2. Select suitable welding parameters to enable the listed joints (given in 6.3.) to be welded by one process from the following: • MMA welding

	• MAGS welding • TAGS welding 6.3. Weld No 1 – single vee pipe butt weld – rotated. Weld No 2 – single vee pipe butt weld – fixed horizontal vertical position. Weld No 3 – pipe to flange weld – rotated. Weld No 4 – set on branch weld in unequal diameter pipes – rotated. 6.4. Identify the practice of using dual process techniques for pipe welding activities 6.5. Carry out destructive tests on the completed welds and document the results. Tests to include: • face bend • root bend • fracture test • nick break test
7. Know the function of inspection, quality control and quality assurance as applied to pipe welding activities	7.1. Identify the function of: • weld inspection activities • quality control • quality assurance 7.2. Describe the importance of carrying out quality control checks on consumables used for welding pipes 7.3. Describe the range and purpose of destructive tests used on welded joints 7.4. Identify the use and application of the four main methods of non-destructive testing (NDT), to include: • dye penetrant flaw detection • magnetic particle flaw detection • ultrasonic flaw detection • radiographic flaw detection using both X ray and gamma ray • visual inspection of pipe bores/root penetration using endoscope/borescope 7.5. Identify the importance of documenting weld inspection activities

8. Know about defects found in pipe welded joints produced by the MMA, MAGS and TAGS welding processes	8.1. Identify defects and imperfections that may be found in pipe welded assemblies using MMA, MAGS and TAGS welding processes 8.2. Identify aids used when carrying out visual inspection of welded joints, to include: • magnifying glass • welding gauge • fillet weld gauge • borescope

Supporting Unit Information

Pipe Welding using Manual Metal-Arc Welding, Metal-Arc Gas Shielded Welding or Tungsten-Arc Gas Shielded Welding – A/616/1301 – Level 3

Indicative Content

Note: Indicative content provides an indication of the scope for the Learning Outcomes and Assessment Criteria. It is intended as a resource to help guide the delivery and assessment of the unit. Indicative content is NOT a statement of material which must be covered and evidenced for assessment.

Learning Outcome 1. Know about health and safety when carrying out pipe welding activities

1.1 Identify the roles of various organisation involved with safety in the workplace - Health and Safety Executive (HSE), Environmental Health and Local Authorities

1.2 Identify the roles of various individuals involved with health and safety in the workplace – Company safety officers, Company safety representatives, Environmental health officers, HSE Inspectors

1.3 Identify the purpose for and typical contents of an organisations Health and Safety Policy

1.4 Describe the purpose of a risk assessment – who should carry out risk assessments, when to carry out a risk assessment and identification of the 5 steps of risk assessment.

1.5 Identify the precautions to be taken when working in high risk areas – risk assessments, permits to work, high/low temperature working conditions, lock off systems and isolation of equipment.

1.6 Describe the control and safe removal of welding fumes and gases created during the welding process – natural extraction, local extraction (hoods and hoses), PPE and specialist breathing equipment (welding helmets/screens)

1.7 Identify the risk associated with pipe welding on site – location, environmental (wind, rain etc), availability of power supply, working/welding in trenches (safe systems of work, confined space, fume enrichment), welding at heights (use of a harness, hard hat/helmet etc)

Learning Outcome 2. Understand power sources and electrical features relating to welding process used for pipe welding activities

2.1 Identify the different power sources used in when welding with MMA, MAGS and TAGS welding – transformer, generator, rectifier and inverter (AC/DC)

2.2 Describe features of the power sources as listed in 2.1 – type of current produced (C/DC), maintenance requirements, portability, suitable applications

2.3 Identify specialist equipment use when carrying out pipe welding activities – pipe cutting equipment, jigs/fixtures, turntables/rotators/manipulators

Learning Outcome 3. Understand the selection, use and storage of welding consumables

3.1 Describe the importance of correct storage conditions for electrodes, wires and gas cylinders - location, ventilation, contamination and labelling.

3.2 Identify the use of different types of electrodes, electrode wires and filler wires when carrying out pipe welding activities.

3.3 Identify the range and application of shielding gases and gas mixtures used when pipe welding with the MAGS or TAGS welding process –argon, helium, carbon dioxide, argon/carbon dioxide mix, argon/oxygen mix, argon/helium mixes, argon/helium/nitrogen mix.

3.4 Describe the effects of using damaged or corroded electrodes, electrode wires and filler wires when carrying out pipe welding activities

Learning Outcome 4. Understand the welding parameters required when using MMA, MAGS and TAGS welding to produce welds in low carbon steel pipes

4.1 Identify and select the required welding parameters to be used when welding low carbon steel pipes using MMA, MAGS and TAGS welding processes - welding current and size (amperes), welding voltage, electrode polarity, wire feed speed, torch slope and tilt angles, electrode extension, speed of travel, inductance, gas delay system, shielding gas type and shielding gas flow rate (LPM) necessary to produce a defect free welded joint

Learning Outcome 5. Know about material preparation and joint set up when pipe welding

5.1 Identify suitable welding preparations for the type of joint, diameter and wall thickness of the pipe being welded, included angle, angle of bevel, root face and root gap dimensions

5.2 Identify different types of joints used in pipe work assemblies – butt welds, branch joints, slip on flange, set on flange

5.3 Describe the advantages and limitations of the methods listed that are used to produce suitable welding preparations on materials – thermal methods, mechanical (chip forming), shearing, bevelling machines and abrasive methods (grinding).

5.4 Identify the application of both permanent and temporary backing rings used in pipe welding - material placed at the root of a weld joint for the purpose of supporting molten weld metal, function to facilitate complete joint penetration. Permanent backing is usually made from a base metal similar to that being welded and, as the name implies, becomes a permanent part of the joint because it is fused to the root of the weld and is not easy to remove. Temporary backing may be made from copper or a ceramic substance that do not become fused to the root and are easily removed when welding is finished. This type of backing is also referred to as removable backing.

5.5 Identify methods used to ensure pipe alignment before and during welding activities – pipe alignment clamps, single chain clamp, double chain clamps, internal pipe clamps, cage clamps, rim clamps.

5.6 Identify different types of pipe work fittings – concentric reducers, eccentric reducers, equal diameter tee pieces, unequal diameter tee pieces, elbows 45°, 60°, 90°, blank ends (dished ends).

Learning Outcome 6. Be able to complete welds in pipe work using a selected welding process

6.1 Identify appropriate safety checks on the selected welding equipment prior to use – visual checks on cable condition/diameter, connections, insulation on the welding holder/torch.

6.2 Select suitable welding parameters to enable the listed joints to be welded by the MMA, MAGS or TAGS welding process

6.3 Single vee pipe butt weld-rotated, single vee pipe butt weld-fixed, horizontal vertical position, pipe to flange weld-rotated, set on branch weld in unequal diameter pipes-rotated

6.4 Identify the practice of using dual process techniques for pipe welding activities (e.g. TAGS welding root, MMA welding fill)

6.5 Carry out destructive tests on the completed welds and document the results – face bend, root bend, fracture test and nick break test.

Learning Outcome 7. Know the function of inspection, quality control and quality assurance as applied to pipe welding activities

7.1 Identify the function of – weld inspection activities, quality control and quality assurance, and role of the welding inspector – carry out inspection of welds covering visual appearance, size of welds, and absence of surface defects. Confirm acceptance to required standard and advise when required on welding procedure. Identify the functions of inspection – involves the examination of welded joints by visual examination and assessing the results found against a standard.
Quality control – planning the inspection activities to ensure that the welded joint is produced to the required standard.
Quality assurance – embraces all aspects of quality to ensure that the completed weld is fit for purpose

7.2 Describe the importance of carrying out quality control checks on consumables used for welding pipes – confirm the consumables are acceptable to use in terms of correct type, use by date.
Consumables are not damaged, incorrect type or damaged consumables can lead to defects in the weld

7.3 Describe the range and purpose of destructive workshop tests used on welded joints – root and face bend tests, macro and micro-etch tests, fracture tests

7.4 Identify the use and application of the four main methods of non-destructive testing (NDT):
Dye penetrant flaw detection – advantages - enhances visual inspection, inexpensive method of testing, portable, easy to use. Limitations – slow process, only reveals surface breaking defects, not suitable for porous materials, health and safety issues with chemicals used in this process.
Magnetic particle flaw detection – advantages - fast results, portable, easy to use. Limitations - restricted to ferro-magnetic materials, only reveals surface and subsurface defects, safety issues when using power units for "prod" method. Defect orientation critical to magnetic field for detection
Ultrasonic flaw detection – advantages - locates internal flaws/defects, fast results, no restriction on material thickness,

portable most materials can be examined. Limitations - expensive equipment required, difficult to use, extensive training required, good surface finish required for testing
Radiographic flaw detection using both X ray and gamma ray - advantages - permanent record of results found, shows the type of defect/flaw found. Limitations - safety aspects of using radiation source, expensive equipment required, extensive training required, restrictions on portability due to safety issues. Use of fluorescent dye penetrant method - Uses a fluorescent dye which when developed under a black light source (ultra-violet) gives an enhanced sensitivity to the test. Use of fluorescent magnetic particle method - uses a fluorescent ink which when used under a black light source (ultra-violet) gives an enhanced sensitivity to the test.
Visual inspection of pipe bores/root penetration using endoscope/borescope

7.5 Identify the importance of documenting weld inspection activities - Pre-weld inspection – confirmation of welding standard, correct consumables, condition of parent materials, joint preparation, joint set up, distortion control (pre-setting) tack welding (number, size, position), pre-heat requirements
During welding – condition of deposited welds, distortion control, inter-pass temperature
Post welding inspection – visual inspection of weld, surface defects, size of welds (throat, leg length) cooling rate, distortion of welded joint and cleanliness of completed weld
Quality checks on welding consumables – confirm the consumables are acceptable to use in terms of correct type, use by date. Consumables are not damaged, incorrect type or damaged consumables can lead to defects in the weld.
Produce a welding inspection procedure sheet for a given welded joint

Learning Outcome 8. Know about defects found in pipe welded joints produced by the MMA, MAGS and TAGS welding processes

8.1 Identify defects and imperfections that may be found in pipe welded assemblies using MMA, MAGS and TAGS welding processes – cracking, lack of fusion, lack of penetration, porosity, oxide inclusions, undercut, overlap, excessive weld metal, concavity

8.2 Identify aids used when carrying out visual inspection of welded joints – magnifying glass, welding gauge, fillet weld gauge and borescope.

Teaching Strategies and Learning Activities

Centres should adopt a delivery approach which supports the development of their particular learners. The aims and aspirations of all learners, including those with identified specific needs, including learning difficulties/disabilities, should be considered and appropriate support mechanisms put in place.

This unit provides material, scientific and mathematical background whilst enhancing (both in breadth and depth) the knowledge base of any of the other units contributing to the ABC Level 3 qualifications. This needs to be delivered in the context of Fabrication and Welding practice.

Health and safety aspects of fabrication and welding practice should be reinforced within all practical units.

Learning should be delivered through a combination of learner-centred classroom sessions, workshop practice and individual guided learning. The emphasis is on practical learning opportunities and individual action plans. The prospective learning group is likely to require a good deal of tutor support in achieving the planned outcomes.

It is suggested that a simulated working atmosphere/environment should be adopted. In addition, learners should be provided with real work experiences wherever possible and visits to places of interest and co-operation with local engineering establishments are strongly recommended.

Delivery may be enhanced by:

- liaising with employers with reference to delivery, work experience and/or resources
- visits to appropriate places of interest
- the provision of information and guidance to learners on the availability and type of employment the qualification may lead to and on the progression routes available for further education and training.

Methods of Assessment

This unit will be internally assessed, internally and externally moderated.

Evidence of Achievement

ABC Awards has produced an assessment pack for this unit which is available to approved centres from the ABC Awards website.

This assessment pack contains details of the requirements of the practical tasks and examinations in the ABC Level 3 Certificate and Diploma in Fabrication and Welding Practice. Prior to commencing the qualification(s), the learner, assessor and appointed Internal Quality Assurer should familiarise themselves with the contents of this pack and what is to be expected in order to achieve.

Additional Information

Additional guidance for delivering and assessing ABC Awards qualifications and information about Internal Quality Assurance is available on the ABC Awards web site.

12. Advanced Fabrication Processes – Plate (3 mm and Above in Thickness)

Unit Reference	F/616/1302
Level	3
Credit Value	7
Guided Learning Hours	60
Unit Summary	The practical content of this unit requires the learner to demonstrate skills in reading complex drawings, marking out, cutting, forming and assembling parts of a fabricated assembly that meet the required dimensional accuracy and tolerance in low carbon steel greater than 3 mm in thickness. The theoretical aspects of this unit covers the features of fabrication work that enable the practical work to be carried out safely and understanding the various processes involved which are required to produce complex assemblies.

Learning Outcomes The learner will:	**Assessment Criteria The learner can:**
1. Know about Health and Safety when carrying out plate work fabrication activities	1.1. Identify the roles of various organisations involved with health and safety in the workplace, to include: • Health and Safety Executive (HSE) • Environmental Health • Local Authorities 1.2. Identify the roles of various individuals involved with health and safety in the workplace, to include: • Company safety officers • Company safety representatives • Environmental health officers • HSE inspectors

	1.3. Identify the purpose and typical contents of an organisations Health and Safety Policy 1.4. Describe the purpose of a risk assessment to include: • who should carry out risk assessments • when to carry out a risk assessment • identification of the 5 steps of risk assessment 1.5. Identify the precautions to be taken when working in high risk areas, to include: • risk assessments • permits to work • high/low temperature working conditions • lock off systems • isolation of equipment
2. Know about the safe handling and moving of materials greater than 3 mm in thickness	2.1. Identify current legislation and regulations relating to both manual and mechanical lift operations, to include: • manual handling operations regulations • lifting operations and lifting equipment • regulations (LOLER) 2.2. Describe safe manual lifting operations, to include: • planning the lifting manoeuvre • use of suitable PPE • correct posture when lifting • maximum recommended weight limit • use of lifting aids 2.3. Describe mechanical lifting operations, to include: • planning the lifting manoeuvre • safe working load (SWL) • recommended maximum spread angle of slings • selecting slings appropriate to load being lifted/moved • correct use of slinging techniques • use of hand signals to crane operator 2.4. Identify the use and application of a range of mechanical lifting accessories, to include: • friction grip plate clamp • "D" shackle

	• lifting beam • eye bolt • nylon, wire and rope slings
3. Know how to mark out fabricated assemblies from complex drawings	3.1. Read complex fabrication assembly drawings that show: • symbols • abbreviations • standard drawing conventions 3.2. Identify a range of instruments/equipment to mark out complex fabricated assemblies 3.3. Use a range of methods to mark out complex fabricated assemblies, to include: • direct marking onto the material • use of templates 3.4. Identify the importance of safe storage of marking out instruments/equipment 3.5. Mark out on materials greater than 3 mm in thickness fabricated assemblies, to include: • bending allowances • calculating mean/neutral diameters
4. Know about thermal cutting techniques used on materials greater than 3 mm in thickness	4.1. Identify safe working practices when using thermal cutting equipment 4.2. Identify the advantages and limitations of using a range of thermal cutting equipment to cut material greater than 3 m in thickness, to include: • oxy/acetylene cutting equipment • oxy/propane cutting equipment • plasma cutting • laser cutting 4.3. Use thermal cutting equipment to produce a Range of cuts in plate to a given tolerance, to include: • straight cuts • circles and radii 4.4. Describe methods used to control distortion when cutting materials greater than 3 mm in thickness using thermal cutting equipment

5. Know about mechanical cutting techniques used on materials greater than 3 mm in thickness	5.1. Identify safe working practices when using mechanical cutting equipment 5.2. Identify a range of safety features used on mechanical cutting equipment, to include: • emergency stop buttons • fixed guards • movable guards • micro switch locking devices 5.3. Identify chip forming and non-chip forming methods of mechanical cutting applications 5.4. Describe how the capacity of a mechanical guillotine is determined 5.5. Identify the principle of shearing material greater than 3 mm in thickness, to include: • blade clearance • shearing angle • blade rake angle 5.6. Use mechanical cutting equipment to produce cuts in material greater than 3 mm in thickness
6. Know about forming operations used on materials greater than 3 mm in thickness	6.1. Identify safe working practices when using forming equipment 6.2. Identify a range of safety features used on forming equipment, to include: • emergency stop buttons • fixed guards • movable guards • micro switch locking devices 6.3. Identify the difference in the tooling for a press brake when carrying out: • air bending • coining 6.4. Identify the features and application of both manual and mechanical rolling equipment, to include: • pinch type rolling machines • pyramid type rolling machine • section bending rollers • cone rollers

	6.5. Use forming machines to produce fabricated assemblies in material greater than 3 mm in thickness
7. Know about methods of joining parts in fabricated assemblies in materials above 3 mm in thickness	7.1. Identify a range of welding processes used to join and assemble fabricated components, to include: • MMA • MAGS 7.2. Identify the specific application of mechanical fasteners, to include: • high strength friction grip bolts • turned barrel bolts • black bolts 7.3. Describe how high strength friction grip bolts, nuts and washers can be positively identified 7.4. Identify faults that may arise in the joints of a fabricated assembly when using mechanical fasteners 7.5. Describe the advantages and limitations of joining fabricated assemblies by welding compared to using mechanical fasteners
8. Be able to assemble Fabricated components to given specifications	8.1. Identify the use of a fabrication procedure sheet 8.2. Identify a range of assembly aids that can be used to maintain alignment of parts, avoid twisting and control distortion before and during assembly 8.3. Identify a range of tools/equipment that can be used to inspect fabricated assemblies to ensure the accuracy of the finished product, to include: • rule/tape measure • squares/protractors • straight edge • vernier gauge • profile gauge
9. Produce a fabricated assembly in	9.1. Produce a fabricated component in material greater than 3 mm in thickness, to include: • marking out

materials greater than 3 mm in thickness	• cutting material • rolling • bending/folding • drilling • assembling 9.2. Carry out the requirements as listed in 9.1. to the required tolerance and dimensional accuracy as detailed on the drawing 9.3. Carry out inspection of the completed assembly using a range of inspection equipment

Supporting Unit Information

Advanced Fabrication Processes – Plate (3 mm and Above in Thickness)– F/616/1302 – Level 3

Indicative Content

Note: Indicative content provides an indication of the scope for the Learning Outcomes and Assessment Criteria. It is intended as a resource to help guide the delivery and assessment of the unit. Indicative content is NOT a statement of material which must be covered and evidenced for assessment.

Learning Outcome 1. Know about health and safety when carrying out plate work fabrication activities

1.1 Identify the roles of various organisation involved with safety in the workplace - Health and Safety Executive (HSE), Environmental Health and Local Authorities

1.2 Identify the roles of various individuals involved with health and safety in the workplace – Company safety officers, Company safety representatives, Environmental health officers, HSE Inspectors

1.3 Identify the purpose for and typical contents of an organisations Health and Safety Policy

1.4 Describe the purpose of a risk assessment – who should carry out risk assessments, when to carry out a risk assessment and identification of the 5 steps of risk assessment.

1.5 Identify the precautions to be taken when working in high risk areas – risk assessments, permits to work, high/low temperature working conditions, lock off systems and isolation of equipment.

Learning Outcome 2. Know about the safe handling and moving of materials greater than 3 mm in thickness

2.1 Identify current legislation and regulations relating to both manual and mechanical lifting operations – Manual handling operations regulations, lifting operations and lifting equipment regulations (LOLER)

2.2 Describe safe manual lifting operations – planning the lifting manoeuvre, use of suitable PPE, correct posture when lifting, maximum recommended weight limit (SWL), use of lifting aids. Identify factors for a safe lift – lifting capacity, load being lifted (shape, size) planning route, qualified person carrying out the lift.

Annual checks made to lifting equipment, inspection of lifting equipment, subject to heat, damage to chains/slings, inspection requirements of lifting equipment.

2.3 Describe mechanical lifting operations – planning the lifting manoeuvre, safe working load (SWL), recommended maximum spread angle of slings, selecting slings appropriate to the load being lifted/moved, correct use of slinging techniques, use of hand signals to crane operator, overhead cranes, wall mounted cranes

2.4 Identify the use and application of a range of mechanical lifting accessories – friction grip plate clamp, 'D'shackle, lifting beam, eye bolt, nylon, wire and rope slings, chains, wire and fibre rope, nylon straps (single and multi leg).

Learning Outcome 3. Know how to mark out fabricated assemblies from complex drawings

3.1 Read complex fabrication assembly drawings that show symbols, abbreviations, standard drawing conventions - Interpret dimensional requirements, orientation of parts, bending requirements on complex fabricated drawings to cover BS, EN and/or ISO standards

3.2 Identify a range of instruments/equipment to mark out complex fabricated assemblies - a range of tools/equipment to mark fabricated assemblies to a given tolerance

3.3 Use a range of methods to mark out complex fabricated assemblies – direct marking onto the material, use of templates, Mark out on paper/card using the parallel line method of pattern development for a 90° tee piece in unequal diameter pipes. Mark out on paper/card using the triangulation method of pattern development square/rectangle to round transformers on and off centre

3.4 Identify the importance of safe storage at marking out instruments/equipment

3.5 Mark out on materials greater than 3 mm in thickness fabricated assemblies – bending allowances, calculating mean/neutral diameters, use calculations to determine the bend and rolling allowances required when forming materials greater than 3 mm in thickness

Learning Outcome 4. Know about thermal cutting techniques used on materials greater than 3 mm in thickness

4.1 Identify safe working practices when using thermal cutting equipment

4.2 Identify the advantages and limitations of using a range of thermal cutting equipment to cut material greater than 3 mm in thickness – oxy/acetylene and oxy/propane cutting equipment, principles of oxy/fuel gas cutting – only cut ferrous metals, high temperature flame to pre heat, heat to ignition point, chemical reaction between heat, oxygen and oxide in metal. Production of an exothermic reaction to cut steel. Oxy/fuel gas cutting equipment – cylinders containing oxygen and fuel gas (acetylene or propane) gas pressure regulators, flash back arrestors, hoses, hose protectors, cutting torch, nozzles (size, types). Use oxy/fuel gas cutting equipment to produce cuts in plate sections to a given tolerance.
Plasma cutting and laser cutting - high temperature thermal cutting method and used to cut both ferrous and non ferrous materials in a range of thicknesses. Features of plasma and laser cutting – clean, neat cuts, little or no distortion

4.3 Use thermal cutting equipment to produce a range of cuts in plate to a given tolerance – straight cuts, circles and radii, use of cutting aids to produce straight, circle/curve and chamfers in material greater than 3 mm in thickness. Causes of imperfections in thermal cutting operations – incorrect flame setting, gas pressures, nozzle size, speed of travel, height of cutting nozzle from metal and cutting unclean material

4.4 Describe methods used to control distortion when cutting materials greater than 3 mm in thickness using thermal cutting equipment – clamps, chills, steel bars/angle iron, supports

Learning Outcome 5. Know about mechanical cutting techniques used on materials greater than 3 mm in thickness

5.1 Identify safe working practices when using mechanical cutting equipment

5.2 Identify a range of safety features used on mechanical cutting equipment – emergency stop buttons, fixed guards, movable guards, micro switch locking devices, guarding (finger, trip wire, electrical and touch type), electrical isolators

5.3 Identify chip forming and non-chip forming methods of mechanical cutting applications - Non chip shearing machines – guillotine, universal cropping machine, bench shears. Chip forming machines – saws (reciprocating, band) nibbling and rotary bevelling machines. Drilling machines - portable/hand held, bench, pillar, radial arm and magnetic (rotor broach). Effect of sheared edge – can produce a work hardened edge which is susceptible to cracking in some alloys.

Working capacity – calculated by the maximum length of cutting blade by the maximum thickness of low carbon steel the machine can shear.

5.4 Describe how the capacity of a mechanical guillotine is determined – cutting of low carbon steel

5.5 Identify the principle of shearing material greater than 3 mm in thickness - blade clearance, shearing angles, blade rake angle.

5.6 Use mechanical cutting equipment to produce cuts in material greater than 3 mm in thickness.

Learning Outcome 6. Know about forming operations used on materials greater than 3 mm in thickness

6.1 Identify safe working practices when using forming equipment

6.2 Identify a range of safety features used on forming equipment – emergency stop buttons, fixed guards, movable guards, micro switch locking devices

6.3 Identify the difference in the tooling for a pres brake when carrying out air bending and coining. Equipment and tooling used with forming machines – bottom vee former (width ratio 8:1). Back stops/front stops, squaring arms

6.4 Identify the features and applications of both manual and mechanical rolling equipment – pinch type rolling machines, pyramid type rolling machines, section bending rollers, and cone rollers. Techniques to ensure dimensional accuracy – correct alignment of rolls/tooling/formers, correct position of material in machine (square, aligned).

6.5 Use forming machines to produce fabricated assemblies in material greater than 3 mm in thickness

Learning Outcome 7. Know about methods of joining parts in fabricated assemblies in materials above 3 mm in thickness

7.1 Identify a range of welding processes used to join and assemble fabricated components – MMA, MAGS

7.2 Identify the specific application of mechanical fasteners - high strength friction grip (HSFG), turned barrel bolts, fitted and close tolerance bolts, load indicator, torshear and black bolts

7.3 Describe how high strength friction grip bolts, nuts and washers can be positively identified – High friction grip bolts are commonly used in structural steelwork. They normally consist of high tensile strength bolts and nuts with washers that have protrusions on their surface. The bolts are tightened to a shank tension so that the

transverse load across the joint is resisted by the friction between the plated rather than the bolt shank's shear strength.

7.4 Identify faults that may arise in the joints of a fabricated assembly when using mechanical fasteners – becoming loose, damaged threads, cross threading, stripped threads, fatigue failure, vibration, and corrosion

7.5 Describe the advantages and limitations of joining fabricated assemblies by welding compared to using mechanical fasteners – welding creates low stress concentration while bolting always have stress concentrations at each bolt. The strength of welded joint is more as compared to the bolting joint. The welded joints are better for fatigue load, impact load & vibrations. There is no deduction in the area because there are no holes and the cross-section is effective to carry loads. Bolts are removable, no distortion, less skill required, more economic, importance of alignment of holes, hole clearance, correct tension and clean surfaces

Learning Outcome 8. Be able to assemble fabricated components to given specifications

8.1 Identify the use of a fabrication procedure sheet – measurement, marking out, cutting, forming, assembling, joining and quality checks at each stage and post assembly work

8.2 Identify a range of assembly aids that can be used to maintain alignment of parts, avoid twisting and control distortion before and during assembly - maintaining alignments – assembly aids, supports, adequate tack welding/bolting and avoid twisting by the use of supports, jigs/fixtures, strong backs.

8.3 Identify a range of tools/equipment that can be used to inspect fabricated assemblies to ensure the accuracy of the finished product – rule/tape measure, squares/protractors, straight edge, vernier gauge, profile gauge. Alignment of parts – straight edges, spirit levels, measuring equipment squareness – squares, straight edges, angles, shape and profile – protractors, bevel gauges, templates.
Manufacturing defects:
Critical – out of tolerance, welding defects (cracks, lack of fusion) distortion of parts, incorrect material used or deep surface marks.
Non critical – incorrect dimensions (within tolerance) weld spatter, minor surface indications

Learning Outcome 9. Produce a fabricated assembly in materials greater than 3 mm in thickness

9.1 Produce a fabricated component in material greater than 3m in thickness – marking out, cutting material, rolling, bending/folding, drilling, and assembling

9.2 Carry out the requirements as listed in 9.1, to the required tolerance and dimensional accuracy as detailed on the drawing

9.3 Carry out inspection of the completed assembly using a range of inspection equipment - material traceability, cutting, drilling, bevelling, welding operations, fit-up, high-strength fastener installation, and dimensional accuracy throughout steel fabrication. Welding inspection, NDT, quality control and assurance.

Teaching Strategies and Learning Activities

Centres should adopt a delivery approach which supports the development of their particular learners. The aims and aspirations of all learners, including those with identified specific needs, including learning difficulties/disabilities, should be considered and appropriate support mechanisms put in place.

This unit provides material, scientific and mathematical background whilst enhancing (both in breadth and depth) the knowledge base of any of the other units contributing to the ABC Level 3 qualifications. This needs to be delivered in the context of Fabrication and Welding practice.

Health and safety aspects of fabrication and welding practice should be reinforced within all practical units.

Learning should be delivered through a combination of learner-centred classroom sessions, workshop practice and individual guided learning. The emphasis is on practical learning opportunities and individual action plans. The prospective learning group is likely to require a good deal of tutor support in achieving the planned outcomes.

It is suggested that a simulated working atmosphere/environment should be adopted. In addition, learners should be provided with real work experiences wherever possible and visits to places of interest and co-operation with local engineering establishments are strongly recommended.

Delivery may be enhanced by:

- liaising with employers with reference to delivery, work experience and/or resources
- visits to appropriate places of interest
- the provision of information and guidance to learners on the availability and type of employment the qualification may lead to and on the progression routes available for further education and training.

Methods of Assessment

This unit will be internally assessed, internally and externally moderated.

Evidence of Achievement

ABC Awards has produced an assessment pack for this unit which is available to approved centres from the ABC Awards website.

This assessment pack contains details of the requirements of the practical tasks and examinations in the ABC Level 3 Certificate and Diploma in Fabrication and Welding Practice. Prior to commencing the qualification(s), the learner, assessor and appointed Internal Quality Assurer should familiarise themselves with the contents of this pack and what is to be expected in order to achieve.

Additional Information

Additional guidance for delivering and assessing ABC Awards qualifications and information about Internal Quality Assurance is available on the ABC Awards web site.

13. Advanced Fabrication Processes – Sheet Metal (Below 3 mm in Thickness)

Unit Reference	J/616/1303
Level	3
Credit Value	7
Guided Learning Hours	60
Unit Summary	The practical content of this unit requires the learner to demonstrate skills in reading complex drawings, marking out, cutting, forming and assembling parts of a fabricated assembly that meet the required dimensional accuracy and tolerance in low carbon steel less than 3 mm in thickness. The theoretical aspects of this unit covers the features of fabrication work that enable the practical work to be carried out safely and understanding the various processes involved which are required to produce complex assemblies.

Learning Outcomes The learner will:	**Assessment Criteria The learner can:**
1. Know about Health and Safety when carrying out sheet metal fabrication activities	1.1. Identify the roles of various organisations involved with health and safety in the workplace, to include: • Health and Safety Executive (HSE) • Environmental Health • Local Authorities 1.2. Identify the roles of various individuals involved with health and safety in the workplace, to include: • Company safety officers • Company safety representatives • Environmental health officers • HSE inspectors

	1.3. Identify the purpose and typical contents of an organisations Health and Safety Policy 1.4. Describe the purpose of a risk assessment, to include: • who should carry out risk assessments • when to carry out a risk assessment • identification of the 5 steps of risk assessment 1.5. Identify the precautions to be taken when working in high risk areas, to include: • risk assessments • permits to work • high/low temperature working conditions • lock off systems • isolation of equipment
2. Know about the safe handling and moving of material less than 3 mm in thickness	2.1. Identify current legislation and regulations relating to both manual and mechanical lift operations, to include: • manual handling operations regulations • lifting operations and lifting equipment • regulations (LOLER) 2.2. Describe the safe manual lifting operations, to include: • planning the lifting manoeuvre • use of suitable PPE • correct posture when lifting • maximum recommended weight limit • use of lifting aids 2.3. Describe mechanical lifting operations, to include: • planning the lifting manoeuvre • safe working load (SWL) • recommended maximum spread angle of slings • selecting slings appropriate to load being lifted/moved • correct use of slinging techniques • use of hand signals to crane operator
3. Know how to mark out fabricated assemblies from complex drawings	3.1. Read complex fabrication assembly drawings that show: • symbols • abbreviations • standard drawing conventions

	3.2. Identify a range of instruments/equipment to mark out complex fabricated assemblies in low carbon steel less than 3 mm in thickness 3.3. Use a range of methods to mark out complex fabricated assemblies, to include: • direct marking onto the material • use of templates 3.4. Identify the importance of safe storage of marking out instruments/equipment 3.5. Mark out on materials less than 3 mm in thickness fabricated assemblies, to include: • bending allowances • calculating mean/neutral diameter s
4. Know about hand tools used in the manufacture of sheet metal assemblies	4.1. Identify a range of hand tools/equipment that are used to manufacture fabricated assemblies in low carbon steel less than 3 mm in thickness, to include the following processes: • cutting material • forming material • assembling parts
5. Know about mechanical cutting techniques used on materials less than 3 mm in thickness	5.1. Identify safe working practices when using mechanical cutting equipment 5.2. Identify a range of safety features used on mechanical cutting equipment, to include: • emergency stop buttons • fixed guards • movable guards • micro switch locking devices 5.3. Identify chip forming and non-chip forming methods of mechanical cutting applications 5.4. Describe how the capacity of a mechanical guillotine is determined 5.5. Identify the principles of shearing material less than 3 mm in thickness, to include: • blade clearance • shearing angle • blade rake angle

	5.6. Use mechanical cutting equipment to produce cuts in material less than 3 mm in thickness
6. Know about forming operations used on sheet metal assemblies	6.1. Identify safe working practices when using forming equipment 6.2. Identify a range of safety features used on forming equipment, to include: • emergency stop buttons • fixed guards • movable guards • micro switch locking devices 6.3. Identify the difference in the tooling for a press brake when carrying out: • air bending • coining 6.4. Identify the features and application of both manual and mechanical rolling equipment, to include: • pinch type rolling machines • pyramid type rolling machine 6.5. Use forming machines to produce fabricated assemblies in material less than 3 mm in thickness
7. Know about methods of joining parts in sheet metal fabricated assemblies	7.1. Identify a range of welding processes used to join and assemble fabricated components in material less than 3 mm in thickness, to include: • MAGS welding • TAGS welding • resistance welding (spot and seam) 7.2. Identify a range of self secured joints used to join and assemble sheet metal components, to include: • grooved seam • paned down joint • knocked up joint 7.3. Identify the specific application of mechanical fasteners, to include: • black bolts • self tapping screws

	• hollow rivets (blind/pop) 7.4. Identify the specific application of adhesives used to join sheet metal components
8. Be able to assemble fabricated components to given specifications	8.1. Identify the use of a fabrication procedure sheet 8.2. Identify a range of assembly aids that can be used to maintain alignment of parts, avoid twisting and control distortion before and during assembly 8.3. Identify a range of tools/equipment that can be used to inspect fabricated assemblies to ensure the accuracy of the finished product, to include: • rule/tape measure • squares/protractors • straight edge • vernier gauge • profile gauge
9. Produce a fabricated assembly in low carbon steel less than 3 mm in thickness	9.1. Produce a fabricated component in low carbon steel less than 3 mm in thickness, to include: • marking out • cutting material • rolling • bending/folding • drilling • assembling 9.2. Carry out the requirements as listed in 9.1. to the required tolerance and dimensional accuracy as detailed on the drawing 9.3. Carry out inspection of the completed assembly using a range of inspection equipment

Supporting Unit Information

Advanced Fabrication Processes – Sheet Metal (Below 3 mm in Thickness)– J/616/1303 – Level 3

Indicative Content

Note: Indicative content provides an indication of the scope for the Learning Outcomes and Assessment Criteria. It is intended as a resource to help guide the delivery and assessment of the unit. Indicative content is NOT a statement of material which must be covered and evidenced for assessment.

Learning Outcome 1. Know about health and safety when carrying out sheet metal work fabrication activities

1.1 Identify the roles of various organisations involved with safety in the workplace - Health and Safety Executive (HSE), Environmental Health and Local Authorities

1.2 Identify the roles of various individuals involved with health and safety in the workplace – Company safety officers, Company safety representatives, Environmental health officers, HSE Inspectors

1.3 Identify the purpose for and typical contents of an organisations Health and Safety Policy

1.4 Describe the purpose of a risk assessment – who should carry out risk assessments, when to carry out a risk assessment and identification of the 5 steps of risk assessment.

1.5 Identify the precautions to be taken when working in high risk areas – risk assessments, permits to work, high/low temperature working conditions, lock off systems and isolation of equipment.

Learning Outcome 2. Know about the safe handling and moving of material less than 3 mm in thickness

2.1 Identify current legislation and regulations relating to both manual and mechanical lifting operations – Manual handling operations regulations, lifting operations and lifting equipment regulations (LOLER)

2.2 Describe safe manual lifting operations – planning the lifting manoeuvre, use of suitable PPE, correct posture when lifting, maximum recommended weight limit (SWL), use of lifting aids. Identify factors for a safe lift – lifting capacity, load being lifted (shape, size) planning route, qualified person carrying out the lift.

Annual checks made to lifting equipment, inspection of lifting equipment, subject to heat, damage to chains/slings, inspection requirements of lifting equipment.

2.3 Describe mechanical lifting operations – planning the lifting manoeuvre, safe working load (SWL), recommended maximum spread angle of slings, selecting slings appropriate to the load being lifted/moved, correct use of slinging techniques, use of hand signals to crane operator, overhead cranes, wall mounted cranes

Learning Outcome 3. Know how to mark out fabricated assemblies from complex drawings

3.1 Read complex fabrication assembly drawings that show symbols, abbreviations, standard drawing conventions - Interpret dimensional requirements, orientation of parts, bending requirements on complex fabricated drawings to cover BS, EN and/or ISO standards

3.2 Identify a range of instruments/equipment to mark out complex fabricated assemblies in low carbon steel less than 3 mm in thickness - a range of tools/equipment to mark fabricated assemblies to a given tolerance

3.3 Use a range of methods to mark out complex fabricated assemblies – direct marking onto the material, use of templates, Mark out on paper/card using the parallel line method of pattern development for a 90° tee piece in unequal diameter pipes. Mark out on paper/card using the triangulation method of pattern development square/rectangle to round transformers on and off centre

3.4 Identify the importance of safe storage at marking out instruments/equipment

3.5 Mark out on materials less than 3 mm in thickness fabricated assemblies – bending allowances, calculating mean/neutral diameters, use calculations to determine the bend and rolling allowances required when forming materials greater than 3 mm in thickness

Learning Outcome 4. Know about hand tools used in the manufacture of sheet metal assemblies

4.1 Identify a range of hand tools/equipment that are used to manufacture fabricated assemblies in low carbon steel less than 3 mm in thickness – cutting material, forming material, assembling parts

Learning Outcome 5. Know about mechanical cutting techniques used on materials less than 3 mm in thickness

5.1 Identify safe working practices when using mechanical cutting equipment

5.2 Identify a range of safety features used on mechanical cutting equipment – emergency stop buttons, fixed guards, movable guards, micro switch locking devices, guarding (finger, trip wire, electrical and touch type), electrical isolators

5.3 Identify chip forming and non-chip forming methods of mechanical cutting applications - Non chip shearing machines – guillotine, universal cropping machine, bench shears. Chip forming machines – saws (reciprocating, band) nibbling and rotary bevelling machines. Drilling machines - portable/hand held, bench, pillar, radial arm and magnetic (rotor broach). Effect of sheared edge – can produce a work hardened edge which is susceptible to cracking in some alloys. Working capacity – calculated by the maximum length of cutting blade by the maximum thickness of low carbon steel the machine can shear.

5.4 Describe how the capacity of a mechanical guillotine is determined – cutting of low carbon steel

5.5 Identify the principles of shearing material less than 3 mm in thickness - blade clearance, shearing angles, blade rake angle.

5.6 Use mechanical cutting equipment to produce cuts in material less than 3 mm in thickness.

Learning Outcome 6. Know about forming operations used on sheet metal assemblies

6.1 Identify safe working practices when using forming equipment – Risk Assessment, reducing noise from CNC punch presses, safety in the use of hand and foot operated presses, preventing injuries from the manual handling of sharp edges, machine guards.

6.2 Identify a range of safety features used on forming equipment – emergency stop buttons, fixed guards, movable guards, micro switch locking devices

6.3 Identify the difference in the tooling for a press brake when carrying out air bending and coining. Equipment and tooling used with forming machines – bottom vee former (width ratio 8:1). Back stops/front stops, squaring arms

6.4 Identify the features and applications of both manual and mechanical rolling equipment – pinch type rolling machines, pyramid type rolling machines, section bending rollers, and cone

rollers. Techniques to ensure dimensional accuracy – correct alignment of rolls/tooling/formers, correct position of material in machine (square, aligned).

6.5 Use forming machines to produce fabricated assemblies in material less than 3 mm in thickness –folders, bending machines, box pan folder, single arm, double arm, press brake

Learning Outcome 7. Know about methods of joining parts in sheet metal fabricated assemblies

7.1 Identify a range of welding processes used to join and assemble fabricated components in materials less than 3 mm in thickness – MAGS welding, TAGS welding, resistance welding (spot and seam)

7.2 Identify a range of self secured joints used to join and assemble sheet metal components – grooved seam, paned down joint, knocked up joint

7.3 Identify the specific application of mechanical fasteners – black bolts, self-tapping screws, hollow rivets (blind/pop)

7.4 Identify the specific applications of adhesives used to join sheet metal components – machinery adhesives, structural adhesives (Polyurethanes Cyanoacrylates or instant adhesives)

Learning Outcome 8. Be able to assemble fabricated components to given specifications

8.1 Identify the use of a fabrication procedure sheet – measurement, marking out, cutting, forming, assembling, joining and quality checks at each stage and post assembly work

8.2 Identify a range of assembly aids that can be used to maintain alignment of parts, avoid twisting and control distortion before and during assembly - maintaining alignments – assembly aids, supports, adequate tack welding/bolting and avoid twisting by the use of supports, jigs/fixtures, strong backs.

8.3 Identify a range of tools/equipment that can be used to inspect fabricated assemblies to ensure the accuracy of the finished product – rule/tape measure, squares/protractors, straight edge, vernier gauge, profile gauge. Alignment of parts – straight edges, spirit levels, measuring equipment squareness – squares, straight edges, angles, shape and profile – protractors, bevel gauges, templates. Manufacturing defects:
Critical – out of tolerance, welding defects (cracks, lack of fusion) distortion of parts, incorrect material used or deep surface marks.

Non critical – incorrect dimensions (within tolerance) weld spatter, minor surface indications

Learning Outcome 9. Produce a fabricated assembly in low carbon steel less than 3 mm in thickness

9.1 Produce a fabricated component in material less than 3m in thickness – marking out, cutting material, rolling, bending/folding, drilling, and assembling

9.2 Carry out the requirements as listed in 9.1, to the required tolerance and dimensional accuracy as detailed on the drawing

9.3 Carry out inspection of the completed assembly using a range of inspection equipment - material traceability, cutting, drilling, bevelling, welding operations, fit-up, high-strength fastener installation, and dimensional accuracy throughout steel fabrication. Welding inspection, NDT, quality control and assurance.

Teaching Strategies and Learning Activities

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operation with local engineering establishments are strongly recommended.

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Methods of Assessment

This unit will be internally assessed, internally and externally moderated.

Evidence of Achievement

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This assessment pack contains details of the requirements of the practical tasks and examinations in the ABC Level 3 Certificate and Diploma in Fabrication and Welding Practice. Prior to commencing the qualification(s), the learner, assessor and appointed Internal Quality Assurer should familiarise themselves with the contents of this pack and what is to be expected in order to achieve.

Additional Information

Additional guidance for delivering and assessing ABC Awards qualifications and information about Internal Quality Assurance is available on the ABC Awards web site.

End-of-programme MCQ examination: 'Welding Practice and Procedures' or 'Fabrication Practice and Procedures'

Methods of Assessment

At the end of their programme and in order to achieve the qualification, learners are required to complete a 40 question externally set MCQ (multiple choice question) exam to be completed in one and a half hours.

Learners need to complete the examination on 'Welding Practice and Procedures' or 'Fabrication Practice and Procedures', dependent on their chosen pathway.

In order to achieve a pass grade, a minimum mark of 60% will be required (24 correct questions out of 40). The grade recorded will be pass/fail only.

The format of the questions will be standard multi-choice type, i.e. one question with four possible answers, only one of which is correct.

Evidence of Achievement

The examinations will cover the following subject specific areas of learning according to the following split.

The examination should be conducted at the Centre where the course delivery has taken place and should be carried out in accordance with the examination requirements of ABC Awards.

It is required that an independent invigilator should oversee the examination and that course tutors/assessors should not have access to the examination room before, during or after the examination.

ABC Awards reserve the right to attend examinations to undertake an audit of the centre's procedures relating to compliance with these invigilation instructions.

Area of learning – Welding Practice and Procedures	Number of questions
1 Health and safety in welding	5
2 Power sources and electrical features	5
3 Consumables	5
4 Welding parameters	5
5 Material preparation	5
6 Defects	5
7 Distortion	5
8 Inspection, QC and QA	5
Total	**40**

Area of learning – Fabrication Practice and Procedures	Number of questions
1 Health and safety in fabrication	5
2 Safe lifting and handling of materials	5
3 Marking out for fabricated assemblies	5
4 Thermal cutting techniques	5
5 Mechanical cutting techniques	5
6 Forming techniques	5
7 Joining fabricated assemblies	5
8 Inspection of fabricated assemblies	5
Total	**40**

Appendices

Recognition of Prior Learning, Exemption and Credit Transfer

ABC Awards policy enables learners to avoid duplication of learning and assessment in a number of ways:

- Recognition of Prior Learning (RPL) – a method of assessment that considers whether a learner can demonstrate that they can meet the assessment requirements for a unit through knowledge, understanding or skills they already possess and do not need to develop through a course of learning.
- Exemption - Exemption applies to any certificated achievement which is deemed to be of equivalent value to a unit within ABC qualification but which does not necessarily share the exact learning outcomes and assessment criteria. It is the assessor's responsibility, in conjunction with the Internal Moderator, to map this previous achievement against the assessment requirements of the ABC qualification to be achieved in order to determine its equivalence. Any queries about the relevance of any certificated evidence, should be referred in the first instance to your centre's internal moderator and then to ABC.
  It is important to note that there may be restrictions upon a learner's ability to claim exemption or credit transfer which will be dependent upon the currency of the unit/qualification and a learner's existing levels of skill or knowledge.
  Where past certification only provides evidence that could be considered for exemption of part of a unit, learners must be able to offer additional evidence of previous or recent learning to supplement their evidence of achievement.
- Credit Transfer – ABC may attach credit to a qualification, a unit or a component. Credit transfer is the process of using certificated credits achieved in one qualification and transferring that achievement as a valid contribution to the award of another qualification. Units / Components transferred must share the same learning outcomes and assessment criteria along with the same unit number. Assessors must ensure that they review and verify the evidence through sight of:
  - original certificates OR
  - copies of certificates that have been signed and dated by the internal moderator confirming the photocopy is a real copy

and make these available for scrutiny be the External Moderator.

- Equivalencies – opportunities to count credits from the unit(s) from other qualifications or from unit(s) submitted by other recognised organisations towards the place of mandatory or optional unit(s) specified in the rule of combination. The unit must have the same credit value or greater than the unit(s) in question and be at the same level or higher.

ABC encourages its centres to recognise the previous achievements of learners through RPL, Exemption and Credit Transfer. Prior achievements may have resulted from past or present employment, previous study or voluntary activities.

Centres should provide advice and guidance to the learner on what is appropriate evidence and present that evidence to the external moderator in the usual way.

Further guidance can be found in 'Delivering and Assessing ABC Qualifications' which can be downloaded from http://www.abcawards.co.uk/centres-2/policies-procedures/

Certification

Learners will be certificated for all units and qualifications that are achieved and claimed.

ABC's policies and procedures are available on the ABC website.

Glossary of Terms

Guided Learning Hours (GLH)
GLH is where the learner participates in education or training under the immediate guidance or supervision of a tutor (or other appropriate provider of education or training). It may be helpful to think – 'Would I need to plan for a member of staff to be present to give guidance or supervision?'

GLH is calculated at the unit/component level and added up at the qualification level.
Examples of guided learning include:

- Face-to-face meeting with a tutor
- Telephone conversation with a tutor
- Instant messaging with a tutor
- Taking part in a live webinar
- Classroom-based instruction
- Supervised work
- Taking part in a supervised or invigilated assessment
- The learner is being observed.

TQT (Total Qualification Time)
'The number of notional hours which represents an estimate of the total amount of time that could reasonably be expected to be required, in order for a learner to achieve and demonstrate the achievement of the level of attainment necessary for the award of a qualification.' The size of a qualification is determined by the TQT.

TQT is made up of the GLH plus all other time taken in preparation, study or any other form of participation in education or training but not under the direct supervision of a lecturer, supervisor or tutor.

TQT is calculated at qualification level and not unit/component level.

Examples of unsupervised activities that could contribute to TQT include:
- Researching a topic and writing a report
- Watching an instructional online video at home/e-learning
- Watching a recorded webinar
- Compiling a portfolio in preparation for assessment
- Completing an unsupervised practical activity or work
- Rehearsing a presentation away from the classroom
- Practising skills unsupervised
- Requesting guidance via email – will not guarantee an immediate response.