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## Practical Metalworking: Fabrication and Thermal Joining

**SCQF:** level 5 (6 SCQF credit points)

**Unit code:** J2CT 75

### Unit outline

The general aim of this Unit is to help learners develop skills in fabrication, forming and joining of metalwork components. Learners will develop skills in thermal joining techniques and build their skills in measuring and marking out. In addition, learners will develop their knowledge and understanding of metalwork materials, recycling and sustainability issues, as well as an appreciation of safe working practices in a workshop environment.

Learners who complete this Unit will be able to:

- 1 Prepare for metalwork fabrication and joining tasks
- 2 Apply fabrication and joining techniques to form, bend and join metal
- 3 Manufacture a metalwork product from working drawings using fabrication and joining techniques

This Unit is available as a free-standing Unit. The Unit Specification should be read in conjunction with the *Unit Support Notes*, which provide advice and guidance on delivery, assessment approaches and development of skills for learning, skills for life and skills for work. Exemplification of the standards in this Unit is given in the *Unit Assessment Support*.

## **Recommended entry**

Entry to this Unit is at the discretion of the centre. However, learners would normally be expected to have attained the skills, knowledge and understanding required by the following or equivalent qualifications and/or experience:

- ◆ National 4 Practical Metalworking Course or relevant Units

## **Equality and inclusion**

This Unit Specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence. For further information, please refer to the *Unit Support Notes*.

# Standards

## Outcomes and assessment standards

### Outcome 1

The learner will:

- 1 Prepare for metalwork fabrication and joining tasks by:**
  - 1.1 Selecting metalworking tools, equipment, materials and fixings appropriate for tasks
  - 1.2 Confirming that metalworking tools and equipment are in good condition and safe working order before, during and after use
  - 1.3 Adjusting tools where necessary, following safe working practices
  - 1.4 Using correct names and terminology when referring to common metalworking tools, equipment, materials and processes
  - 1.5 Describing three or more industrial processes relating to fabrication and joining of metalwork

### Outcome 2

The learner will:

- 2 Apply fabrication and joining techniques to form, bend and join metal by:**
  - 2.1 Selecting appropriate metals in the form of sections and sheet materials to demonstrate fabrication and joining techniques
  - 2.2 Using forming techniques of bending, twisting, drawing down and flattening and to specified tolerance
  - 2.3 Carrying out welding, brazing or soldering operations, consistent in width and form and in several short runs, each to a minimum length of 50 mm
  - 2.4 Carrying out spot welding operations, consistent in quality and to form neat and effective joints
  - 2.5 Applying a range of mechanical fixings and/or adhesive bonding of metal sections and/or sheet materials such that connections are secure and without damage in torque and tightening, including pilot holes as required and to specified tolerance in marking out
  - 2.6 Using tools and equipment safely and correctly

### Outcome 3

The learner will:

- 3 Manufacture a metalwork product from working drawings using fabrication and joining techniques by:**
  - 3.1 Checking materials against working drawings
  - 3.2 Creating and using datum marks and marking out components
  - 3.3 Manufacturing a metalwork product with three or more component parts, such that connections are secure and without damage in torque and tightening and to specified tolerance in marking out.

- 3.4 Working in accordance with recognised procedures and safe working practices
- 3.5 Carrying out good practice in terms of sustainability and recycling

## Evidence Requirements for the Unit

Assessors should use their professional judgement, subject knowledge and experience, and understanding of their learners, to determine the most appropriate ways to generate evidence and the conditions and contexts in which they are used.

Evidence may be presented for individual Outcomes, or gathered for the Unit. If the latter approach is used, it must be clear how the evidence covers each Outcome

For this Unit, learners will be required to provide evidence of:

- ◆ knowledge and understanding of a range of practical metalwork fabrication and joining techniques, tools, equipment, materials and processes
- ◆ practical skills in using a range of practical metalworking tools, machines, equipment, materials for metalwork fabrication, joining and related processes
- ◆ knowledge and understanding of sustainability issues and good practice in recycling in practical metalworking activities and environments
- ◆ the ability to work in accordance with given procedures and safe working practices

The joining techniques applicable to this Unit include thermal joining, mechanical joining, and/or the use of adhesives.

- ◆ Thermal — permitted thermal joining techniques come under the three headings of: welding, brazing, and soldering. There are several distinct techniques to be found under each of these headings. Evidence Requirements for this Unit do not preclude any particular thermal joining technique. However, it is acknowledged that, in practice, the range of thermal joining equipment available in educational workshops is likely to be limited.
- ◆ Mechanical — mechanical joining techniques that may be used in this Unit include riveting, bolting, screw fixing, and the use of proprietary metalwork fixings.
- ◆ Adhesive — adhesives used in joining metal sections and sheet workpieces must be of a proprietary metalworking variety.

In Outcome 3, the metalwork product must be comprised of three or more component parts, and show evidence of using a minimum of:

- ◆ one forming and one bending technique to specified tolerances
- ◆ welding, brazing or soldering operations to form neat and effective joins (with consistency in width)
- ◆ a number of mechanical fixings and/or adhesive bonding of metal sections and/or sheet materials (including pilot holes as required), such that fixings are secure, neat and free of excess materials, and accurate to specified tolerance in marking out

It is assumed that metalwork component/workpieces and products in this Unit are readily portable. The specified tolerances referred to in the Assessment Standards are:

Operation	Tolerance
Marking out	±0.5mm
Forming techniques (twisting, drawing down, flattening)	±3mm
Bending work — sheet metal	±2mm
Bending work — metal strip/metal bar	± 5mm

The tolerances are also given assuming that available machinery and equipment can reasonably meet these expectations.

Exemplification of assessment for this Unit is provided in the *Unit Assessment Support*. Advice and guidance on possible approaches to assessment is provided in the *Unit Support Notes*.

## Assessment standard thresholds

If a candidate successfully meets the requirements of the specified number of Assessment Standards they will be judged to have passed the Unit overall and no further re-assessment will be required.

The specific requirements for this Unit is as follows:

- ◆ 11 out of 16 Assessment Standards must be achieved.

It should be noted that there will still be the requirement for candidates to be given the opportunity to meet all Assessment Standards. The above threshold has been put in place to reduce the volume of re-assessment where that is required.

# Development of skills for learning, skills for life and skills for work

It is expected that learners will develop broad, generic skills through this Unit. The skills that learners will be expected to improve on and develop through the Unit are based on SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work* and drawn from the main skills areas listed below. These must be built into the Unit where there are appropriate opportunities.

## **2 Numeracy**

2.2 Money, time and measurement

## **4 Employability, enterprise and citizenship**

4.3 Working with others

## **5 Thinking skills**

5.3 Applying

5.5 Creating

Amplification of these is given in SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work*. The level of these skills should be at the same SCQF level of the Unit and be consistent with the SCQF level descriptor. Further information on building in skills for learning, skills for life and skills for work is given in the *Unit Support Notes*.

# Appendix: Unit support notes

## Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering and assessing this Unit. They are intended for teachers and lecturers who are delivering this Unit. They should be read in conjunction with:

- ◆ the *Unit Specification*
- ◆ the *Unit Assessment Support packs*

## Developing skills, knowledge and understanding

Teachers and lecturers are free to select the skills, knowledge, understanding and contexts which are most appropriate for delivery in their centres.

# Approaches to learning, teaching and assessment

The use of jigs is permitted in fabrication work. A note must be taken of when jigs are used and also when jigs are made by learners themselves; the manufacture of jigs could also be used as evidence of manufacturing skills if appropriate.

It should be noted that, where thermal joining techniques are used, there must be a continuous unbroken run of at least 50mm with consistency relating to the width of the joint, and the weld must be free from defects. Spot welds should be consistent and neatly applied.

Mechanical joining techniques – the joints produced should be secure, with the fixing free from damage in the case of bolting and screw fixing. Rivets should have well-formed heads with the surrounding material free from any major hammer marks.

<b>Application of the knowledge, processes and skills related to the following, appropriate:</b>	
<b>Measuring and marking out</b>	<p>Tools and equipment:</p> <ul style="list-style-type: none"> <li>◆ scriber and scribing block</li> <li>◆ steel rule</li> <li>◆ combination set</li> <li>◆ engineer's square</li> <li>◆ centre finder</li> <li>◆ spring dividers</li> <li>◆ calipers (oddleg, inside, outside, and Vernier or digital)</li> <li>◆ micrometer (analogue or digital)</li> <li>◆ centre punch</li> <li>◆ witness marks</li> <li>◆ surface table</li> <li>◆ angle block</li> <li>◆ v-block</li> </ul> <p>Knowledge and understanding of:</p> <ul style="list-style-type: none"> <li>◆ units of measurement: datum, functional dimensions</li> <li>◆ engineer's blue</li> <li>◆ allowances for expansion, bending, stretching, forming, trimming, welding, brazing and soldering</li> </ul>
<b>Reading and interpreting drawings and documents</b>	<p>Working drawings, pictorial drawings, diagrams, cutting lists.</p> <p>Knowledge and understanding of orthographic projection, scale, dimensioning (linear, radial angular dimensions and diameter) and basic drawing conventions including: line types, centre lines and hidden detail.</p>

<b>Materials</b>	<p>Knowledge of a variety of common metalworking materials:</p> <ul style="list-style-type: none"> <li>◆ ferrous metals (steel, high carbon steel, iron)</li> <li>◆ non-ferrous metals (aluminium, copper, nickel)</li> <li>◆ alloys (bronze, brass, stainless steel)</li> <li>◆ common sections (square bar, round bar, hexagonal bar, angle iron, tube)</li> <li>◆ sheet materials (tin plate, copper, brass, steel, aluminium)</li> </ul> <p>Common metals associated with different fabrication and joining techniques.</p>
<b>Bench work</b>	<p>Common bench tools, including where appropriate:</p> <ul style="list-style-type: none"> <li>◆ hammers (ball-pein)</li> <li>◆ cold chisels</li> <li>◆ files</li> <li>◆ saws</li> <li>◆ taps, dies, tap wrench and die stock for tapping and threading and awareness of twist drill size</li> <li>◆ rivet set and snap</li> </ul>
<b>Sheet metal tools and machines</b>	<ul style="list-style-type: none"> <li>◆ bending equipment including folding bars</li> <li>◆ notchers</li> <li>◆ guillotine</li> <li>◆ hide or rubber mallets</li> <li>◆ tin snips</li> <li>◆ pop riveter</li> <li>◆ spot welder</li> <li>◆ formers and jigs (as appropriate)</li> </ul>
<b>Care and maintenance of tools and equipment</b>	<p>Knowledge and understanding of:</p> <ul style="list-style-type: none"> <li>◆ reporting faults and fault reporting systems</li> <li>◆ general condition before, during and after use</li> <li>◆ position and condition of guards</li> <li>◆ position and security of cutting tools on machine tools</li> <li>◆ secure holding techniques</li> </ul>
<b>Fabrication and thermal joining</b>	<p>Hot-forming techniques including twisting, drawing down and flattening.</p> <p>Hot-bending techniques including metal bar bending and metal strip bending.</p> <p>Thermal joining techniques including welding, soldering or brazing.</p> <p>Mechanical fixing techniques including riveting, screw-fixing and proprietary fixings.</p> <p>Proprietary metalwork adhesives</p>

	<p>Heat-treatment methods of annealing, hardening and tempering.</p> <p>Knowledge and understanding of metals associated with different fabrication and joining techniques.</p> <p>Knowledge of industrial welding techniques</p>
<b>Safe working practices</b>	<p>Good practices and safe systems for general workshop and individual activities as appropriate.</p> <p>Personal Protective Equipment</p>
<b>Sustainability and recycling</b>	<p>Best practice in selecting materials appropriate for use.</p> <p>Understanding and following workshop recycling practices and processes.</p>

## **Combining assessment within Units**

Assessment could be combined in this Unit by holistically assessing all the Outcomes of the Unit in a single assessment. When assessment within the Unit is holistic, teachers and lecturers should take particular care to track the evidence for each individual Outcome.

# Administrative information

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## History of changes to National Unit Specification

Version	Description of change	Authorised by	Date
1.1	Unit Support Notes added. Assessment standard threshold added.	Qualifications Manager	September 2018
2.0	Unit code updated	Qualifications Manager	July 2019

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