

## SQA Advanced Unit Specification

### General information for centres

**Unit title:** Tool Design

**Unit code:** HV56 48

**Unit purpose:** The purpose of this unit is to introduce the candidates to the design processes for a range of tools and the construction of the tools employed in an industrial environment. The unit allows the candidate to develop the skills and knowledge to allow them to understand the basic design and construction of a range of tools.

On completion of the unit the candidate should be able to:

- 1 design a blanking and piercing die set for a typical component
- 2 design a mould for a typical pressure die-casting component
- 3 design a press for a powder metallurgy component
- 4 design the dies for a plastic injection-moulding component

**Credit points and level:** 1 SQA Credit at SCQF level 8: (8 SCQF credit points at SCQF level 8\*)

*\*SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from National 1 to Doctorates.*

**Recommended prior knowledge and skills:** Access to this unit is at the discretion of the centre, but it would be beneficial if the candidate possesses a basic knowledge and understanding of manufacturing processes and graphical communications. This may be demonstrated by possession of NQ Units: Introduction to Graphical Communications and Engineering Manufacturing Processes 2.

**Core skills:** There may be opportunities to gather evidence towards the following listed core skills components in this unit, although there is no automatic certification of core skills or core skills components.

Written Communication	SCQF level 6
Using Graphical Information	SCQF level 6
Critical Thinking	SCQF level 6

## SQA Advanced Unit Specification

**Context for delivery:** If this unit is delivered as part of a group award, it is recommended that it should be taught and assessed within the subject area of the group award to which it contributes.

**Assessment:** This unit should be assessed on an outcome by outcome basis. For each outcome candidates will be presented with a component (eg washer, fixing bracket, pulley wheel, gearbox cover, bracket etc.) selected from a range of component drawings. The candidate will be required to design tooling which will allow the component to be manufactured.

For each outcome candidates will present evidence in the form of a report containing detailed engineering drawings and relevant commentary on the final design, materials and any calculations required in the selection process.

## SQA Advanced Unit Specification

### SQA Advanced Unit Specification: statement of standards

#### Unit title: Tool Design

The sections of the unit stating the outcomes, knowledge and/or skills, and evidence requirements are mandatory.

Where evidence for outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

#### Outcome 1

Design a blanking and piercing die set for a typical component

##### Knowledge and/or skills

- ◆ Types of press tools
- ◆ Actions of press tools
- ◆ Cost considerations of the manufacturing process
- ◆ Material selection of presswork manufacture
- ◆ Calculations of shear forces based on typical operations
- ◆ Clearance factors of punches and dies
- ◆ Design for a typical application

##### Evidence requirements

Evidence for the knowledge and/or skills for this outcome will be provided on a sample basis. Each candidate will need to demonstrate that they can produce correct responses based on a sample of the items shown under the knowledge and/or skills. In any assessment of the outcome, **the last knowledge and/or skills item must always be assessed** plus any **five out of the first six** knowledge and/or skills items.

In order to ensure that candidates will not be able to foresee what items they will be assessed on, a different sample of five out of six knowledge and/or skills items is required each time the unit is assessed.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ select a suitable press and delivery tonnage
- ◆ explain the cost considerations prior to manufacture
- ◆ select suitable tool material
- ◆ select suitable component material
- ◆ solve a clearance calculation for the punches and dies
- ◆ solve a shear force calculation for the given component

## SQA Advanced Unit Specification

- ◆ produce an annotated die set, designed and drawn, for a simple press component to include:
  - top and bottom bolsters
  - pillars and bushes
  - location and alignment of the bolsters
  - punches and dies
  - stripper plates
  - draw an economic strip layout for the component

Candidates will be supplied with the required report format. It is imperative that candidates' progress is closely monitored to ensure work is their own. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist may be used to record oral evidence of the candidate's knowledge and understanding.

### Assessment guidelines

ICT (Information and Communication Technology) resources may be used to develop further knowledge of tooling process, undertake calculations and prepare reports.

## Outcome 2

Design a mould for a typical pressure die-casting component

### Knowledge and/or skills

- ◆ Types of pressure die-casting machines
- ◆ Advantages and limitations of the pressure die-casting
- ◆ Material selection compatible with the process
- ◆ Tooling material
- ◆ Component conformance
- ◆ Design for a typical application

### Evidence requirements

Evidence for the knowledge and/or skills for this outcome will be provided on a sample basis. Each candidate will need to demonstrate that they can produce correct responses based on a sample of the items shown under the knowledge and/or skills. In any assessment of the outcome, **the last knowledge and/or skills item must always be assessed plus any four out of the first five** knowledge and/or skills items.

In order to ensure that candidates will not be able to foresee what items they will be assessed on, a different sample of four out of the first five knowledge and/or skills items is required each time the unit is assessed.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ describe types of pressure die-casting machines
- ◆ state advantages and limitations of pressure die-casting machines
- ◆ establish suitable material for the given component
- ◆ select die material relative to component material
- ◆ select suitable tolerances for the process
- ◆ state the required surface finish of the tool component

## SQA Advanced Unit Specification

- ◆ produce an annotated pressure die-casting mould, designed and drawn for a typical pressure die cast component to include:
  - fixed and moving dies
  - fixed and moving platens
  - component split line
  - ejector plate/pins
  - injection of the metal
  - venting of the cavity
  - location and alignment of the closed dies
  - drafting angles are indicated

Candidates should be supplied with the required report format. It is imperative that candidates' progress is closely monitored to ensure work is their own. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist may be used to record oral evidence of the candidate's knowledge and understanding.

### Assessment guidelines

ICT resources may be used to develop further knowledge of tooling processes, undertake calculations and prepare reports.

## Outcome 3

Design a press for a powder metallurgy component

### Knowledge and/or skills

- ◆ Types of powder metallurgy presses
- ◆ Cost considerations of the process prior to manufacture
- ◆ Methods of atomisation of the component material
- ◆ Blending of the powder
- ◆ Compacting of the briquette
- ◆ Sintering and heat treatment of the component
- ◆ Advantages and limitations of powder metallurgy
- ◆ Design for a typical application

### Evidence requirements

Evidence for the knowledge and/or skills for this outcome will be provided on a sample basis. Each candidate will need to demonstrate that they can produce correct responses based on a sample of the items shown under the knowledge and/or skills. In any assessment of the outcome, **the last knowledge and/or skills item must always be assessed** plus any **five out of the first seven** knowledge and/or skills items.

In order to ensure that candidates will not be able to foresee what items they will be assessed on, a different sample of five out of seven knowledge and/or skills items is required each time the unit is assessed.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ describe a suitable press for a powder metallurgy process
- ◆ explain cost consideration prior to manufacture

## SQA Advanced Unit Specification

- ◆ describe production of raw materials
- ◆ describe the blending process of powdered metals
- ◆ explain pressing machine principles
- ◆ describe the sintering process
- ◆ state the advantages of using powder metal metallurgy
- ◆ produce a mould designed and drawn for a typical powder metallurgy component to include:
  - mould
  - upper and lower punches
  - location and alignment of the closed dies
  - material loading chute
  - ejection method of pressed briquette
  - split line for the component is indicated
  - a drafting angle
  - tolerance relative to the process
  - surface finish relative to the process

Candidates should be supplied with the required report format. It is imperative that candidates' progress is closely monitored to ensure work is their own. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist may be used to record oral evidence of the candidate's knowledge and understanding.

### Assessment guidelines

ICT resources may be used to develop further knowledge of tooling processes, undertake calculations and prepare reports.

## Outcome 4

Design the dies for a plastic injection-moulding component

### Knowledge and/or skills

- ◆ Types of plastic injection machines
- ◆ Cost considerations prior to manufacture
- ◆ Material availability within the process
- ◆ Tooling material
- ◆ Injection of the material
- ◆ Component and ejection cooling
- ◆ Advantages and limitations of plastic injection moulding
- ◆ Design for a typical application

### Evidence requirements

Evidence for the knowledge and/or skills for this outcome will be provided on a sample basis. Each candidate will need to demonstrate that they can produce correct responses based on a sample of the items shown under the knowledge and/or skills. In any assessment of the outcome, **the last knowledge and/or skills item must always be assessed** plus any **five out of the first seven** knowledge and/or skills items.

In order to ensure that candidates will not be able to foresee what items they will be assessed on, a different sample of five out of eight knowledge and/or skills items is required each time the unit is assessed.

## SQA Advanced Unit Specification

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ select a suitable machine for the given application
- ◆ provide a cost consideration prior to production
- ◆ select component material
- ◆ state tooling material compatible to the component
- ◆ explain the production cycle
- ◆ state the advantages and limitations of the process
- ◆ describe the process cycle
- ◆ an annotated plastic injection-mould is designed and drawn/sketched for a typical component to include:
  - moulds
  - split line of component
  - material feed and plunger
  - heating element
  - location and alignment of the closed dies
  - material injection nozzle
  - cooling method
  - ejection method
  - injection pressure is stated on the drawing
  - material injection temperature is stated on the drawing

Candidates should be supplied with the required report format. It is imperative that candidates' progress is closely monitored to ensure work is their own. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist may be used to record oral evidence of the candidate's knowledge and understanding.

### Assessment guidelines

ICT resources may be used to develop further knowledge of tooling process, undertake calculations and prepare reports.

## SQA Advanced Unit Specification

### Administrative information

<b>Unit code:</b>	HV56 48
<b>Unit title:</b>	Tool Design
<b>Superclass category:</b>	VF
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## SQA Advanced Unit Specification

### SQA Advanced Unit Specification: support notes

#### Unit title: Tool Design

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

#### Guidance on the content and context for this unit

This unit has been written in order to allow the candidates to develop knowledge, understanding and skills in the following areas:

- 1 design a blanking and piercing die set for a typical component
- 2 design a mould for a typical pressure die-casting component
- 3 design a press for a simple powder metallurgy component
- 4 design the dies for a simple plastic injection-moulding component

In designing this unit, the unit writers have identified the range of topics that they would expect to be covered by the lecturers. Recommendations are also given as to how much time should be spent on each outcome. This has been done to help lecturers to decide what depth of treatment should be given to the topics attached to each of the outcomes. While it is not mandatory for centres to use this list of topics, it is recommended that they do so since the assessment exemplar for this unit is based on the knowledge and/or skills and list of topics in each of the outcomes.

#### Guidance on the delivery and assessment of this unit

A list of topics for each outcome is given below. Lecturers are advised to study this list in conjunction with the assessment exemplar pack so they can get a clear indication of the standard of achievement expected of candidates in this unit.

##### Outcome 1

Design a die set for a typical component and explain the press tool process in the manufacture  
**(10 hours)**

- ◆ Purposes of press tools
- ◆ Types of press tools:
  - fly press
  - transfer press
  - brake press
- ◆ Actions of press tools to include:
  - single action
  - double action

## SQA Advanced Unit Specification

- ◆ The functions of a press tool are explained correctly and to include:
  - blanking
  - piercing
  - cropping
  - bending
  - forming
  - drawing
- ◆ Composite parts of the die set:
  - top and bottom bolsters
  - pillars and bushes
  - stripper plates
  - locators
  - tool materials
- ◆ Presswork component materials
- ◆ Progression and combination tools
- ◆ Clearance and shear calculations for pre-set conditions
- ◆ Common failures within the process
- ◆ Economics of the process (batch, part size, fixed costs, cycle times)
- ◆ Shear calculation for blanking and piercing

### Outcome 2

Design a mould for a typical pressure die-casting component and explain the process in the manufacture (**10 hours**)

- ◆ Definition of the high and low-pressure process
- ◆ Composite parts of the tooling (platens, dies, ejector plates/pins)
- ◆ Cycle times and batch volumes
- ◆ Draft angles split lines
- ◆ Die-casting materials

### Outcome 3

Design a press for a powder metallurgy component and explain the process in the manufacture (**10 hours**)

- ◆ Manufacture of the powder
- ◆ Blending
- ◆ Pressing
- ◆ Sintering
- ◆ Coining
- ◆ Porosity
- ◆ Difficult materials
- ◆ Impregnated bearings
- ◆ Stress distributions
- ◆ Comparison of the process with traditional processes (casting, forging)
- ◆ Costs

## SQA Advanced Unit Specification

### Outcome 4

Design a mould for a plastic injection component and explain the process in the manufacture (10 hours)

- ◆ Materials for injection moulding — granulated thermoplastics (nylon, polypropylene, polycarbonate, polystyrene, polythene) shot weight
- ◆ Components of the injection-moulding machine (ie hydraulic rams, toggle clamps, dies, water/gas cooling systems, hopper loading, platens nozzles/sprue, ejector pins etc)
- ◆ Die design (materials, location, draft angles, interchangeability)
- ◆ Heating, hardening
- ◆ Injection pressure (hydraulic ram) and dwell time
- ◆ Material feed (Archimedes screw)
- ◆ Component quality (material flow, tolerance, surface finish, shrinkage)
- ◆ Cycle times
- ◆ Cost of the process

The unit will be assessed by separate assessments for each outcome. Candidates should be encouraged to adopt the same component for Outcomes 2, 3 and 4. Each instrument of assessment will take the form of an assignment report involving the design for manufacture of a given component with candidates being asked to describe the tooling requirements and specifications for the process of manufacture indicated. The candidate should also include an engineering or CAD drawing of the tooling. The assignment report should also identify the advantages and limitations of the resulting tooling relative to the cost and quality of the product. Tooling material and component material should also be investigated. The component specification should be supplied to the candidate either as a CAD drawing or file with any necessary manufacturing detail requirements. Reference should also be made to limitations or compromises adopted. The standard components selected should be from a common catalogue.

#### *Opportunities for developing core skills*

There may be opportunities to gather evidence towards the following core skills components in this unit, although there is no automatic certification of core skills or core skills components.

Written Communication	SCQF level 6
Using Graphical Information	SCQF level 6
Critical Thinking	SCQF level 6

### Open learning

This Unit could be delivered by distance learning, which might incorporate some degree of online support. However, with regard to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that the written assessment was conducted under controlled, supervised conditions

For information on normal open learning arrangements, please refer to the SQA guide *Assessment and Quality Assurance of Open and Distance Learning* (SQA 2000).

### **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.

Further advice can be found on our website [www.sqa.org.uk/assessmentarrangements](http://www.sqa.org.uk/assessmentarrangements).

### General information for candidates

#### Unit title: Tool Design

Tool design is a critical part of the manufacturing process. Therefore, this unit has been designed to give you a broad based introduction to a range of tooling used in a range of manufacturing processes.

To assist your understanding of the subject your lecturer may integrate your coursework with a series of industrial visits to local companies. Further learning support may also be provided by the use of videos and physical tools and manufactured component examples. You may also be encouraged to undertake online research on tool design.

To assist you in the design of the tooling requirements for each process a comprehensive catalogue of standard parts will be at your disposal. These catalogues can also be sourced online at the discretion of the centre. A modified catalogue of standard parts may be created by the centre in the form of a standard parts library which will enable you to select parts for your design.

Each outcome will be assessed separately. For each outcome you will be given a simple part drawing and asked to submit a short report reflecting the manufacturing process and an engineering drawing of the tooling requirements. By using a common component there will be opportunities to combine the reports for 2, 3 and 4. However, each outcome will require one engineering drawing of the tool design.