



## Higher National Unit specification

### General information

**Unit title:** Aircraft Gas Turbine Engines (SCQF level 8)

**Unit code:** H94N 35

**Superclass:** XP

**Publication date:** May 2015

**Source:** Scottish Qualifications Authority

**Version:** 01

### Unit purpose

This Unit is designed to allow learners to acquire a knowledge and understanding of the operation and construction of a gas turbine engine that can be used to power an aircraft or helicopter.

This Unit is aimed at learners who wish to work in the aircraft engineering industry.

### Outcomes

On successful completion of the Unit the learner will be able to:

- 1 Analyse and evaluate the operating principles of a gas turbine engine.
- 2 Analyse and evaluate the performance criteria of a turbojet and turbofan engine.
- 3 Analyse and evaluate the performance criteria of a turboprop and turboshaft engine.
- 4 Analyse and evaluate engine installation and ground running operations.
- 5 Analyse the requirements, operating principles and performance of aircraft ancillary drive transmission systems.

### Credit points and level

2 Higher National Unit credits at SCQF level 8: (16 SCQF credit points at SCQF level 8)

### Recommended entry to the Unit

Access to this Unit will be at the discretion of the centre. The Unit has no mandatory pre-requisites, however, it is recommended that learners have completed Unit DR09 34 *Aircraft Propulsion Systems: Introduction* before commencing this Unit.

## Higher National Unit specification: General information (cont)

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### Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the Support Notes for this Unit specification.

There is no automatic certification of Core Skills or Core Skill components in this Unit.

### 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.

The Assessment Support Pack (ASP) for this unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website (<http://www.sqa.org.uk/sqa/46233.2769.html>).

### 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).

## Higher National Unit specification: Statement of standards

**Unit title:** Aircraft Gas Turbine Engines (SCQF level 8)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

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. Learners 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

Analyse and evaluate the operating principles of a gas turbine engine.

#### Knowledge and/or Skills

- ◆ Thermodynamic working cycle for airflow through an engine
- ◆ Air intake configurations
- ◆ Axial and centrifugal compressors
- ◆ Combustion chambers
- ◆ Impulse and reaction turbines
- ◆ Exhaust units
- ◆ Thrust reversers

### Outcome 2

Analyse and evaluate the performance criteria of a turbojet and turbofan engine

#### Knowledge and/or Skills

- ◆ Compressor stall and surge
- ◆ Thrust specific fuel consumption
- ◆ Engine rating and thrust limitations
- ◆ Factors influencing thrust
- ◆ Engine thrust calculations of a turbojet and turbofan engine
- ◆ Engine bypass ratios
- ◆ Engine efficiencies calculations

### Outcome 3

Analyse and evaluate the performance criteria of a turboprop and turboshaft engine

#### Knowledge and/or Skills

- ◆ Aircraft propellers and rotors blade theory
- ◆ Relationship between thrust and equivalent shaft horsepower
- ◆ Factors influencing propeller and rotor thrust
- ◆ Engine efficiencies calculations
- ◆ Equivalent specific fuel consumption

## Higher National Unit specification: Statement of standards (cont)

**Unit title:** Aircraft Gas Turbine Engines (SCQF level 8)

### Outcome 4

Analyse and evaluate engine installation and ground running operations.

#### Knowledge and/or Skills

- ◆ Engine to airframe configuration
- ◆ Engine start up procedures
- ◆ Engine indicating parameters
- ◆ Engine inspection and fault prediction

### Outcome 5

Analyse the requirements, operating principles and performance of aircraft ancillary drive transmission systems.

#### Knowledge and/or Skills

- ◆ Engine power transmission system arrangements including any modern innovations in this respect
- ◆ Aircraft power transmission gearboxes types and construction
- ◆ Aircraft power transmission systems fault detection and overspeed protection

#### Evidence Requirements for this Unit

Evidence for Outcomes 1, 2, 3 and 4 should be produced through sampling of the Knowledge and/or Skills of each individual Outcome. Learners are required to provide written and/or oral recorded evidence. The assessment should take place under supervised, closed-book conditions with a time limit of 45 minutes for each Outcome. Outcomes 1, 2, 3 and 4 could be assessed individually or as part of a combined assessment.

Learners are required to provide written and/or oral recorded evidence for Outcome 5. The assessment should be carried out under open-book conditions.

#### Outcome 1

Evidence for the Knowledge and/or Skills in this Outcome will be generated through sampling. Each learner will need to provide evidence to demonstrate they can examine four of the seven Knowledge and/or Skills items.

Any sampling process must be 'unseen' by the learner before the assessment. That is, learners are expected to fully prepare the range of Knowledge and/or Skills items and not be able to predict a chosen sample, and a new sample should be chosen for each assessment occasion.

## Higher National Unit specification: Statement of standards (cont)

### Unit title: Aircraft Gas Turbine Engines (SCQF level 8)

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ evaluate the arrangement of components in a gas turbine engine.
- ◆ analyse the working cycle of a gas turbine engine during its compression, combustion, expansion and exhaust phases.
- ◆ explain the effect an engine's intake has on engine performance.
- ◆ describe the operation and construction arrangement of either an axial or centrifugal compressor.
- ◆ describe the constructional arrangements of a gas turbine combustion chamber.
- ◆ analyse how impulse and reactive turbines operate.
- ◆ explain the operation of a gas turbine exhaust systems.
- ◆ analyse the operation and effect of gas turbine thrust reversers systems.

#### Outcome 2

Evidence for the Knowledge and/or Skills in this Outcome will be generated through sampling. Each learner will need to provide evidence to demonstrate they can examine four of the seven Knowledge and/or Skills items.

Any sampling process must be 'unseen' by the learner before the assessment. That is, learners are expected to fully prepare the range of Knowledge and/or Skills items and not be able to predict a chosen sample, and a new sample should be chosen for each assessment occasion.

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ explain airflow control mechanisms used to control compressor stall and surge.
- ◆ analyse how specific fuel consumption affects turbojet and turbofan engine performance.
- ◆ analyse the factors that will influence the thrust produced by an engine.
- ◆ analyse the limitations imposed on engines due to thrust rating.
- ◆ evaluate thrust calculations of turbojet and turbofan engine.
- ◆ evaluate the efficiency of a high and low bypass ratio engine.
- ◆ evaluate engine efficiencies calculations of turbojet and turbofan engines.

#### Outcome 3

Evidence for the Knowledge and/or Skills in this Outcome will be generated through sampling. Each learner will need to provide evidence to demonstrate they can examine three of the five Knowledge and/or Skills items.

Any sampling process must be 'unseen' by the learner before the assessment. That is, learners are expected to fully prepare the range of Knowledge and/or Skills items and not be able to predict a chosen sample, and a new sample should be chosen for each assessment occasion.

## Higher National Unit specification: Statement of standards (cont)

### Unit title: Aircraft Gas Turbine Engines (SCQF level 8)

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ describe the operation of aircraft propellers and rotor blades.
- ◆ describe and evaluate thrust and shaft horse power calculations of turboprop and turboshaft engines.
- ◆ evaluate engine efficiencies calculations of turboprop and turboshaft engines.
- ◆ analyse the factors that will influence thrust and shaft horse power produced by propellers and rotor blades.
- ◆ analyse how specific fuel consumption affects turboprop and turboshaft engine performance.

#### Outcome 4

Evidence for the Knowledge and/or Skills in this Outcome will be generated through sampling. Each learner will need to provide evidence to demonstrate they can examine two of the four Knowledge and/or Skills items.

Any sampling process must be 'unseen' by the learner before the assessment. That is, learners are expected to fully prepare the range of Knowledge and/or Skills items and not be able to predict a chosen sample, and a new sample should be chosen for each assessment occasion.

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ analyse the effect engine to airframe configuration has on both engine and aircraft performance.
- ◆ describe the engine start up procedures.
- ◆ analyse the engine indicating parameters and their limitations.
- ◆ describe the engine inspection and faults prediction procedures.

#### Outcome 5

Learners are required to produce written or oral recorded evidence. The assessment for Outcome 5 should be carried out under open-book conditions.

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ analyse engine transmission system arrangements including any modern innovations in this respect.
- ◆ analyse the types of current aircraft power transmission gearboxes and their construction.
- ◆ analyse the aircraft power transmission systems fault detection and overspeed protection.



## Higher National Unit Support Notes

**Unit title:** Aircraft Gas Turbine Engines (SCQF level 8)

Unit Support Notes are offered as guidance and are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 80 hours.

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

This Unit is designed to allow learners to acquire a knowledge and understanding of the operation and construction of a gas turbine engine that can be used to power an aircraft or helicopter.

Whilst many approaches can be utilised for the delivery of the above material it is desirable to set them in the context of the aviation technician. Wherever possible the delivery of the content of this Unit should utilise practical examples to supplement learning. Where this is not practicable or possible, simulation software could be used to confirm/visualise concepts and results.

- 1 The relationship between the gas turbine engines' working cycle and the laws of motion including calculating gas formula for airflow through a gas turbine engine. Gas turbine engines main components (Intake, Compressor, Combustion Chamber, Turbine, Exhaust and Thrust reversers) including their configurations, types, differences and their effects on each other.
- 2 The constructional arrangement of turbojet and turbofan engines. The thrust of turbojet and turbofan engines including their thrust rating. The effect specific fuel consumption has on engine performance. Turbojet and turbofan engines thrust output limitations and factors influencing thrust including the influence of speed, altitude and climate change. Bypass ratio in turbofan engines and its influence on their performance. The calculations of turbojet and turbofan engines' efficiencies and their relationships.
- 3 The constructional arrangement of turboprop and turboshaft engines. The aircraft propellers and blade theory. The shaft horsepower of turboprop and turboshaft engines and its relationship to thrust produced by both engines. Factors influencing propeller and rotor thrust including the influence of their physical design as well as the external factors of speed, altitude and climate change. The effect specific fuel consumption has on both engines performance.
- 4 The effect of aircraft engine to airframe configuration has on both engine and aircraft performance. The engine ignition and starting procedure on the ground and inflight. The flight deck instruments that are used to indicate engine parameters and how it can be used to inspect engines and predict faults.
- 5 The types of engine transmission systems used in turbojet, turbofan, turboprop and turboshaft engines including power transmission types, construction, faults detection and overspeed protection.

## Higher National Unit Support Notes (cont)

**Unit title:** Aircraft Gas Turbine Engines (SCQF level 8)

### Guidance on approaches to delivery of this Unit

This Unit is designed to provide learners with professional knowledge and skills for the specific occupational area of aircraft engineering. It is logical to deliver this Unit sequentially by Outcome, with a mixture of assignments, exercises and case studies with access to relevant publications as recommended.

### Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Evidence for Outcomes 1, 2, 3 and 4 should be produced through sampling of the knowledge and/or skills of each individual Outcome. Learners are required to provide written and/or oral recorded evidence. Assessment should take place under supervised, closed-book conditions with a time limit of 45 minutes for each Outcome. Outcomes 1, 2, 3 and 4 could be assessed individually or as part of a combined assessment.

Assessment for Outcomes 1, 2, 3 and 4 could consist of a number of appropriately structured short answer restricted response questions.

Evidence for Outcome 5 should be produced through written and/or oral recorded evidence demonstrating that the learner has achieved all of the Knowledge and/or Skills items. This assessment should be carried out under open-book conditions.

The assessment could be based upon a case study investigation into operating principles of engine transmission system. Learners could support their submission with sketches, computer printouts and diagrams. Sufficient time to complete the report should be given to learners, with ten hours of course time set aside for study research, the overall time allowed for completed submission being at the discretion of the centre.

### Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at [www.sqa.org.uk/e-assessment](http://www.sqa.org.uk/e-assessment).



## Higher National Unit Support Notes (cont)

**Unit title:** Aircraft Gas Turbine Engines (SCQF level 8)

### Opportunities for developing Core and other essential skills

There are opportunities in this Unit to develop the Core Skill *Numeracy* at SCQF level 6. Learners can achieve this by demonstrating that they can evaluate gas turbine engine performance data. There are also opportunities in the Unit to develop the Core Skills component *Communication (Written)* at SCQF level 6. This could be achieved through a case study investigation for Outcome 5. There are also opportunities within the Unit to develop the Core Skills component *Problem Solving (Critical Thinking)* at SCQF level 6. Learners can achieve this by demonstrating that they can analyse and evaluate complex issues such as engine performance data, the working cycle and the principles of airflow through a gas turbine engine.

## History of changes to Unit

Version	Description of change	Date

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## General information for learners

### Unit title: Aircraft Gas Turbine Engines (SCQF level 8)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This Unit is designed to enable you to acquire a knowledge and understanding of gas turbine engines used to power aircraft and helicopters. In particular the Unit will look at how gas turbine engines operate in an aircraft engineering maintenance environment and it is primarily intended for learners who are interested in aircraft engineering.

The Unit has five main areas, each area covered by a separate Outcome. The five main areas the Unit covers are:

- 1 Analyse and evaluate the operating principles of a gas turbine engine.
- 2 Analyse and evaluate the performance criteria of a turbojet and turbofan engine.
- 3 Analyse and evaluate the performance criteria of a turboprop and turboshaft engine.
- 4 Analyse and evaluate engine installation and ground running operations.
- 5 Analyse the requirements, operating principles and performance of aircraft ancillary drive transmission systems.

Assessment for each Outcome will take the form of written and/or oral recorded evidence.

Outcomes 1, 2, 3 and 4 may be assessed individually or as part of a combined assessment. The assessment for Outcomes 1, 2, 3 and 4 will take place under supervised closed-book conditions.

Outcome 5 will be assessed under open-book conditions.

This Unit will provide opportunities to develop the Core Skills *Numeracy*, *Communication* (Written Communication) and *Problem Solving* (Critical Thinking), although there is no automatic certification of Core Skills or Core Skills components.