Higher National Unit specification

General information

Unit title: Aerodynamics and Flight Mechanics 1 (SCQF level 7)

Unit code: H94G 34

Superclass: RC

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Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to introduce learners to the subject of aircraft aerodynamics and how this influences how an aircraft performs throughout the flight envelope. The Unit should provide the learner with a working knowledge of the subject and develop the learner's awareness of how an aircraft flies and how the aerodynamic forces produced in flight are generated and affect an aircraft. Learners will also study the layout and configuration of different aircraft types and investigate aircraft control and lift augmentation.

The Unit is primarily aimed at learners who wish to work in the aircraft engineering industry, although may be of interest to learners of other disciplines.

Outcomes

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

1 Explain the physics of the atmosphere and how it affects flight.
2 Explain aircraft layout and configuration.
3 Explain aircraft lift and drag.
4 Explain high-lift devices and evaluate their impact on aircraft performance.

Credit points and level

1 Higher National Unit credit at SCQF level 7: (8 SCQF credit points at SCQF level 7)

Higher National Unit specification: General information (cont)

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Recommended entry to the Unit

Entry is at the discretion of the centre. Learners doing this Unit do not need prior knowledge or experience of Aerodynamics. However, good skills in Mathematics would be an advantage.

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**.

Higher National Unit specification: Statement of standards

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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.

Outcome 1

Explain the physics of the atmosphere and how it affects flight.

Knowledge and/or Skills

- The chemical composition of the atmosphere and its layers
- The variation in atmospheric properties (pressure, temperature, density, humidity) with increasing altitude
- The International Standard Atmosphere (ISA)
- The requirement for and operating principles of the pitot-static system

Outcome 2

Explain aircraft layout and configuration.

Knowledge and/or Skills

- Different aircraft layouts and configurations
- The purpose and design of the fuselage
- The purpose and design of the wing
- The requirement for different wing planform shapes
- Basic geometry (chord, camber, span, planform area, wing loading, aspect ratio and fineness ratio)
- The purpose and design of the horizontal and vertical stabiliser
- The location of flight control surfaces
- The operating principles of the primary flight controls and the secondary flight controls

Higher National Unit specification: Statement of standards

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Outcome 3

Explain aircraft lift and drag.

Knowledge and/or Skills

- The four main forces acting on an aircraft in flight and their points of action
- Generation of lift and drag
- The movement of the centre of pressure and centre of gravity
- The concept and significance of the boundary layer including flow types and flow separation
- Chord-wise and span-wise pressure distribution around the wing
- The relationship between lift and drag coefficients and angle of attack (lift and drag curves)
- Stalling in flight
- The drag polar
- The effect of aerofoil contamination on aerodynamic performance

Outcome 4

Explain high-lift devices and evaluate their impact on aircraft performance.

Knowledge and/or Skills

- The requirement for high-lift devices
- The location of the high-lift devices
- The operating principles of the different types of high-lift devices
- The impact deployment of high-lift devices has on aircraft performance

Higher National Unit specification: Statement of standards (cont)

Unit title: Aerodynamics and Flight Mechanics 1 (SCQF level 7)

Evidence Requirements for this Unit

Outcomes 1, 2 and 3 could be assessed on an Outcome be Outcome basis or as a combined assessment. Evidence should be generated under closed-book supervised conditions. The assessment for Outcome 4 should be carried out under open-book conditions.

Outcome 1

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

- define and explain the chemical composition of the atmosphere and identify the different layers in the atmosphere.
- define and explain how pressure, temperature, density and humidity vary with altitude in each of the layers of the atmosphere in which an aircraft flies.
- define The International Standard Atmosphere (ISA), explain why it is required and state its values at sea-level.
- describe the operating principles of the pitot-static system and explain its importance.

Outcome 2

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

- identify different aircraft layouts and configurations.
- explain the purpose of the fuselage and identify different fuselage designs.
- explain the purpose and design of the wing.
- identify and explain different wing planform shapes — to include stalling characteristics, aerodynamic efficiency, high-speed performance and low-speed performance.
- define and explain basic geometric terms — to include chord, camber, span, planform area, wing loading, aspect ratio and fineness ratio.
- explain the purpose and design of the horizontal and vertical stabiliser.
- identify and explain the location of flight control surfaces.
- explain the operating principles of the primary flight controls and the secondary flight controls.

Higher National Unit specification: Statement of standards (cont)

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Outcome 3

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

- define and explain the four main forces acting on an aircraft in flight and their points of action.
- explain how lift is generated — to include the lift equation, lift coefficient and relationship between velocity and lift coefficient.
- identify the component drag forces and explain how they are generated.
- explain how the centre of pressure and centre of gravity move in flight.
- define the concept of the boundary layer and explain its significance — to include flow types (laminar and turbulent) and flow separation.
- explain the chord-wise and span-wise pressure distribution around the wing and how it changes in flight.
- explain the relationship between lift and drag coefficients and angle of attack (lift and drag curves).
- define and explain stalling of an aircraft — to include definition of critical angle of attack and stalling speed.
- define and explain the drag polar — to include the drag polar equation for a symmetrical and cambered aerofoils and associated graphs.
- explain the effect of aerofoil contamination on aerodynamic performance — to include the impact on lift, drag, stalling angle and stalling speed.

Outcome 4

Learners will need to provide written and/or oral recorded evidence, generated under open-book conditions, to demonstrate their Knowledge and/or Skills by showing that they can:

- explain the requirement for high-lift devices.
- identify and explain the location of the high-lift devices.
- explain the operating principles of the different types of high-lift devices.
- make use of data to evaluate the impact deployment of high-lift devices has on lift.
- make use of data to evaluate the impact deployment of high-lift devices has on drag.
- make use of data to evaluate the impact deployment of high-lift devices has on pitching moment.

Higher National Unit Support Notes

Unit title: Aerodynamics and Flight Mechanics 1 (SCQF level 7)

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 40 hours.

Guidance on the content and context for this Unit

This is a mandatory Unit delivered as part of the HNC/HND Aircraft Engineering Group Awards. The Unit is primarily intended to provide learners with the essential underpinning knowledge of basic aerodynamics to prepare them for a career in the aircraft engineering industry or for progression to HND Aircraft Engineering (SCQF level 8). The Unit should emphasise the influence a philosophy of 'good aerodynamics' has on how an aircraft flies and focus on how the aerodynamic forces produced in flight affect the performance and efficient operation of an aircraft.

Outcome 1 looks at the chemical composition of the Earth's atmosphere, the different layers of the atmosphere and the influence the variation in atmospheric properties (pressure, temperature, density and humidity) has on aircraft performance. The requirement for an International Standard Atmosphere should also be included and the values of this standard atmosphere at sea-level introduced. Learners should become familiar with the pitot-static system on an aircraft and how this system is used to generate flight critical information such as altitude and airspeed. This may include reference to the operating principles of the altimeter and Airspeed Indicator.

In Outcome 2 learners should be introduced to different aircraft layouts and configurations and encouraged to think about the following:

- the influence the operational role of the aircraft has on how it is designed
- the purpose, layout and design of major components such as:
  - the fuselage
  - the wings (including an overview of the different planform shapes)
  - the stabilising surfaces (horizontal stabiliser and vertical stabiliser)
  - the location of the primary and secondary flight control surfaces and their operating principles

The section on wing planforms should make reference to the advantages and disadvantages of each planform shape, with particular emphasis on low-speed and high-speed performance, aerodynamic efficiency and stalling characteristics.

Higher National Unit Support Notes (cont)

Unit title: Aerodynamics and Flight Mechanics 1 (SCQF level 7)

The section on flight control surfaces may also make reference to unconventional flight control surfaces (elevons and ruddervators), with reference made to an aircraft's three principal axes. The discussion may also include an investigation into how control surfaces are deployed to execute a constant speed, level turn and how equilibrium/trim is established.

As part of Outcome 2 learners should also become familiar with important parameters such as camber, chord, span, planform area, wing loading, aspect ratio and fineness ratio.

It is anticipated that Outcome 3 will introduce the four main forces acting on an aircraft in flight and focus on how the aerodynamic forces of lift and drag are generated and their point of action (the latter should include a discussion on how the centre of pressure moves as the configuration of the aircraft changes). The concept of the boundary layer should be presented, highlighting its significance in the determination of lift and drag. Reference to the characteristics of the different types of flow in the boundary layer may be included alongside a discussion on what causes the boundary layer to separate. The chord-wise and span-wise variation in pressure around the wing should be analysed emphasising how this is influenced by planform shape, aerofoil selection and angle of attack and how it changes in flight. Stalling in flight, lift and drag curves and the drag polar should also be considered.

Outcome 4 should consider the requirement for and location of the high-lift devices on an aircraft. The impact the operation of these devices has on the low speed performance of an aircraft could be discussed, with an appraisal of the different types of leading edge and trailing edge devices that are currently used by aircraft. The effect deploying these devices has on lift coefficient, drag coefficient, pitching moment, stalling angle, stalling speed and maximum lift coefficient could also be demonstrated.

Guidance on approaches to delivery of this Unit

This Unit forms part of the HNC/HND Aircraft Engineering Group Awards, designed to provide learners with technical and professional knowledge and skills. Those who successfully complete the award are likely to progress on to an apprenticeship programme or on to further and/or higher education.

If delivered as part of the HNC/HND Aircraft Engineering, it is recommended that delivery takes place at the beginning of the programme as a good working knowledge of aerodynamics is required for the *Aircraft Engineering: Graded Unit 1* examination. The Unit should be delivered sequentially by Outcome, and could include a mixture of direct teaching lectures, interactive discussion, exercises and case studies. Having access to relevant publications is recommended and course work and laboratory reports must be the work of individuals.

Higher National Unit Support Notes (cont)

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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 this Unit could be generated through two assessment events.

The assessment of Outcomes 1, 2, and 3 could be combined as a single, holistic assessment lasting no longer than forty-five minutes and carried out under closed-book supervised conditions. The assessment could be multiple-choice questions. Learners should not know in advance the items on which they will be assessed.

The second assessment, covering Outcome 4, could be a laboratory exercise. Learners might conduct a series of wind tunnel tests to establish the impact that flap deployment has on lift, drag and pitching moment and submit a technical report. In generating the Evidence Requirements for this assessment, learners will need to show that they can evaluate and interpret information from a variety of sources such as wind tunnel experiments and textbooks, in order to produce a balanced report that is referenced as per the Harvard Referencing format. This assessment should be carried out under open-book conditions and all submissions should be the learner's own work.

Accurate records should be made of the assessment instruments used showing how evidence is generated for each assessment/examination, giving marking schemes and/or checklists, etc. Records of learners' achievements should be kept. These records will be available for external verification.

In order to achieve this Unit, learners are required to pass both assessments by presenting sufficient evidence that they have met the minimum Evidence Requirements, giving satisfactory response to the questions and a satisfactory compilation and of the report.

The assessment instruments used should follow the general guidelines offered by the Scottish Qualification Authority (SQA) assessment model and an integrative approach to assessment is encouraged.

The assessment instruments used for assessing this Unit should follow the general guidelines offered by the Scottish Qualification Authority (SQA) assessment model. Each centre should make a model answer as a marking guide for each question asked and learners awarded marks for key points and presentation of answers. Learners can supplement written answers with sketches and diagrams to clarify points and be allowed to use scientific calculators to carry out any calculation.

Higher National Unit Support Notes (cont)

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For learners who fail to meet the minimum Evidence Requirements for each assessment event, centres may allow learners to re-sit the assessments at an appropriate time using different questions based upon the same or another case study.

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**.

Opportunities for developing Core and other essential skills

Learners will have opportunities to develop the Core Skills of *Problem Solving* (Critical Thinking, Reviewing and Evaluating), *Working with Others, Communication* (Written) and *Numeracy* (Using Graphical Information) at SCQF level 5 in this Unit, although there is no automatic certification of Core Skills or Core Skills components. *Problem Solving* (Critical Thinking, Reviewing and Evaluating) and *Numeracy* (Using Graphical Information) could be achieved through the evaluation of aerodynamic data such as ISA tables, lift curves and drag curves, while *Working with Others* and *Communication* (Written) could be achieved by completing a wind tunnel test for Outcome 4 and producing a technical engineering report.

History of changes to Unit

Version	Description of change	Date

General information for learners

Unit title: Aerodynamics and Flight Mechanics 1 (SCQF level 7)

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 the basic aerodynamics of an aircraft. In particular the Unit will look at how an aircraft flies and how the aerodynamic forces produced in flight apply and affect an aircraft.

The Unit is primarily intended for learners who are interested in pursuing a career in aircraft engineering as an aerodynamicist or design engineering although it may be of interest to learners of other disciplines. It is a mandatory Unit in the HNC/HND Aircraft Engineering Group Awards and may be of interest in you intend to undertake degree level studies in Aircraft Engineering in the future.

The Unit has four main areas, each area covered by a separate Outcome:

1 Explain the physics of the atmosphere and how it affects flight.
2 Explain aircraft layout and configuration.
3 Explain aircraft lift and drag.
4 Explain high-lift devices and evaluate their impact on aircraft performance.

The Knowledge and/or Skills contained in Outcomes 1, 2 and 3 will be assessed under closed-book supervised conditions while Outcome 4 will be assessed under open-book conditions. To complete the Unit successfully you will have to achieve a satisfactory level of performance in the assessment event/s.