City & Guilds Level 3 Diploma in Aircraft Maintenance (Military)

(4708-30)

Version 5.0 (January 2022)

Qualification Handbook

Qualification at a glance

Subject area	Engineering
City & Guilds number	4708
Age group approved	16-19, 19+
Assessment types	Centre Devised
Approvals	This product is restricted to centres that work with the Royal Air Force. Centres wishing to deliver this should contact their City & Guilds local office.
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	GLH	TQT	City & Guilds qualification number	Ofqual accreditation number
City & Guilds Level 3 Diploma in Aircraft Maintenance (Military - Electrical and Avionics)	600	665	4708-30	603/1392/4
City & Guilds Level 3 Diploma in Aircraft Maintenance (Military - Mechanical)	630	695	4708-30	603/1392/4
City & Guilds Level 3 Diploma in Aircraft Maintenance (Military - Weapons)	595	665	4708-30	603/1392/4
City & Guilds Level 3 Diploma in Aircraft Maintenance (Military – Aircraft Tech Rotary)	700	779	4708-30	603/1392/4
City & Guilds Level 3 Diploma in Aircraft Maintenance (Military – Avionic Tech Rotary)	670	749	4708-30	603/1392/4

Version and date	Change detail	Section
2.1 August 2018	Unit 304 amendment to AC 2.5 and 2.9 Layout and formatting corrections	Units Throughout
3.0 November 2018	Addition of Weapons pathway units 313-318.	Units, Structure
4.0 July 2019	305 - range added for AC1.1-1.4 307 - supporting information page added 312 - range for AC3.8 updated	Units
5.0 January 2022	Added two new pathways for Military – Aircraft Tech Rotary and Military – Avionic Tech Rotary	Units Throughout

Contents

1 Introduction

What is this qualification about?

This document tells you what you need to do to deliver the qualification:

Area	Description
Who is the qualification for?	This certificate is aimed at learners who work in the Aerospace and Aviation sector as an aircraft maintenance engineer within the Military.
What does the qualification cover?	The qualification allows candidates to learn, develop and practise the knowledge and skills required for employment and/or career progression in the Aerospace and Aviation sector within the Military.
What opportunities for progression are there?	On successful completion of the standard, candidates are able to progress to the Higher Technician Family of Apprenticeships, such as the Aircraft Maintenance Certifying Engineer Standard.
Who did we develop the qualification with?	These qualifications were developed by the Aerospace Engineering Trailblazer Employer Group led by BAE systems.
Is it part of an apprenticeship framework or initiative?	The qualification is included in the Apprenticeship standard Aircraft Maintenance Fitter/Technician (Fixed and Rotary Wing).

Qualification Structure

City & Guilds Level 3 Diploma in Aircraft Maintenance (Military)

City & Guilds unit number	Unit title	GLH
Learners must achieve the 3 Mandatory units, plus the optional units for their chosen pathway.		
Mandatory		
301	Military Aviation Mathematics and Science	90
302	Military Aviation Aerodynamics	50
303	Human Factors (HF) in a Military Aviation Environment	35
Optional – Electrical and Avionics		
304	Military Aviation Engineering (MAE) Policy and Regulation	55
305	Military Aircraft Avionics System Principles	110
306	Military Aviation Engineering Trade Knowledge	100
307	Military Aviation Electrical Principles	85
308	Maintaining Military Aircraft Electrical Systems	75
Optional – Mechanical		
304	Military Aviation Engineering (MAE) Policy and Regulation	55
309	Maintaining Military Gas Turbine Engines	90
310	Military Aircraft Materials Components and Structural Maintenance	140
311	Understanding Military Aircraft Electrical and Avionic Fundamentals	60
312	Maintaining Military Aircraft Mechanical Systems	110

Optional – Weapons

304	Military Aviation Engineering (MAE) policy and regulation	55
313	Armament Trade Electrical Principles	80
314	Maintaining Aircraft Weapons Systems	100
315	Explosive Storage and Handling	85
316	Aircraft Avionic and Armament Systems	100

Optional – Aircraft Tech Rotary

N.B. To achieve Aircraft Tech Rotary, learners must achieve all three mandatory units (301-303) plus a minimum of units 304, 309, 310, 311, 312, 317 and 318. 319 and 320 are elective and are not necessary to achieve this qualification, and do not count towards grading.

304	Military Aviation Engineering (MAE) policy and regulation	55
309	Maintaining Military Gas Turbine Engines	90
310	Military Aircraft Materials Components and Structural Maintenance	140
311	Understanding Military Aircraft Electrical and Avionic Fundamentals	60
312	Maintaining Military Aircraft Mechanical Systems	110
317	Military Helicopter Aerodynamics	32
318	Military Helicopter Transmission Systems	38
319	Maintaining Military Helicopter Flight Control Systems	25
320	Military Helicopter Integrity Monitoring	48

Optional – Avionic Tech Rotary

N.B. To achieve Avionic Tech Rotary, learners must achieve all three mandatory units (301-303) plus a minimum of units 304-308, 317 and 318.

304	Military Aviation Engineering (MAE) policy and regulation	55
305	Military Aircraft Avionics System Principles	110
306	Military Aviation Engineering Trade Knowledge	100
307	Military Aviation Electrical Principles	85
308	Maintaining Military Aircraft Electrical Systems	75
317	Military Helicopter Aerodynamics	32
318	Military Helicopter Transmission Systems	38

Total Qualification Time

Total Qualification Time (TQT) is the total amount of time, in hours, expected to be spent by a Learner to achieve a qualification. It includes both guided learning hours (which are listed separately) and hours spent in preparation, study and assessment.

Title and level	GLH	TQT
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City & Guilds Level 3 Diploma in Aircraft Maintenance (Military - Weapons)	595	665
City & Guilds Level 3 Diploma in Aircraft Maintenance (Military – Aircraft Tech Rotary)	700	779
City & Guilds Level 3 Diploma in Aircraft Maintenance (Military – Avionic Tech Rotary)	670	749

2 Centre requirements

Approval

This product is restricted to centres that work with the Royal Air Force. Centres wishing to deliver this should contact their City & Guilds local office.

To offer these qualifications, new centres will need to gain both centre and qualification approval. Please refer to the Centre Manual - Supporting Customer Excellence for further information.

Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualifications before designing a course programme.

Resource requirements

Centre staffing

Staff delivering these qualifications must be able to demonstrate that they meet the following occupational expertise requirements. They should:

- be occupationally competent or technically knowledgeable in the area[s] for which they are delivering training and/or have experience of providing training. This knowledge must be to the same level as the training being delivered
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

Centre staff may undertake more than one role, eg tutor and assessor or internal verifier, but cannot internally verify their own assessments.

Learner entry requirements

City & Guilds does not set entry requirements for these qualifications. However, centres must ensure that candidates have the potential and opportunity to gain the qualifications successfully.

Age restrictions

City & Guilds cannot accept any registrations for learners under 16 as these qualifications are not approved for learners under 16.

3 Delivering the qualification

Initial assessment and induction

An initial assessment of each candidate should be made before the start of their programme to identify:

- if the candidate has any specific training needs
- support and guidance they may need when working towards their qualifications
- any units they have already completed, or credit they have accumulated which is relevant to the qualifications
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the candidate fully understands the requirements of the qualification[s], their responsibilities as a candidate, and the responsibilities of the centre. This information can be recorded on a learning contract.

Recording documents

Candidates and centres may decide to use a paper-based or electronic method of recording evidence.

City & Guilds endorses several ePortfolio systems, including our own, Learning Assistant, an easy-to-use and secure online tool to support and evidence learners' progress towards achieving qualifications. Further details are available at: www.cityandguilds.com/eportfolios.

City & Guilds has developed a set of *Recording forms* including examples of completed forms, for new and existing centres to use as appropriate. Recording forms are available on the City & Guilds website.

Although new centres are expected to use these forms, centres may devise or customise alternative forms, which must be approved for use by the external verifier, before they are used by candidates and assessors at the centre. Amendable (MS Word) versions of the forms are available on the City & Guilds website.

4 Assessment

Summary of assessment methods

Candidates must:

- successfully complete one centre devised assignment for each unit.

Available assessments/assignments

City & Guilds has written guidance for centres to write their own assessments /assignments.

Guidance is available on the City & Guilds website.

All centre devised assessments need to be signed off by an EQA prior to the candidate sitting the assessment.

City & Guilds has developed a template which tutors/assessors can use to write their own assignments. This is also available from the City & Guilds website.

Recognition of prior learning (RPL)

Recognition of prior learning means using a person's previous experience, or qualifications which have already been achieved, to contribute to a new qualification.

For this qualification, RPL is allowed and is not sector specific.

Grading of Qualification

The Apprenticeship Employer Group has taken the decision to grade this qualification Pass/Merit/Distinction, through the aggregation of the individual unit assessments graded Pass/Merit/Distinction.

Grading can be of use both as a motivational tool within the learning environment and also to learners presenting evidence of their knowledge to prospective employers.

All assessments must be achieved at a minimum of Pass for the qualification to be achieved. All assessments are graded Pass/Merit/Distinction and contribute equally to the overall qualification grade.

Centres will need to calculate the qualification grade as follows:

- Centre will mark and grade each graded assessment using the model answer mark scheme provided by City & Guilds and available on www.cityandguilds.com
- The grade achieved by a learner will need to be converted into points as follows:

Individual assessment grade	Grade points
Pass	4
Merit	6
Distinction	8

Grade points for each assessment need to be added together and the overall qualification grade determined using the following conversion tables:

- City & Guilds Level 3 Diploma in Aircraft Maintenance (Military - Electrical and Avionics)
- City & Guilds Level 3 Diploma in Aircraft Maintenance (Military - Mechanical)
- City & Guilds Level 3 Diploma in Aircraft Maintenance (Military - Weapons)

Total grade points	Overall qualification grade
32 – 39	Pass
40 – 48	Merit
56 – 64	Distinction

- City & Guilds Level 3 Diploma in Aircraft Maintenance (Military – Aircraft Tech Rotary)
- City & Guilds Level 3 Diploma in Aircraft Maintenance (Military – Avionic Tech Rotary)

Total grade points	Overall qualification grade
40 – 49	Pass
50 – 69	Merit
70 – 80	Distinction

N.B. Where units 319 and 320 are completed, they do not count towards overall grading.

5 Units

Structure of the units

These units each have the following:

- City & Guilds reference number
- Title
- Level
- Guided learning hours (GLH)
- Learning outcomes, which are comprised of a number of assessment criteria

Centres must deliver the full breadth of the range. Specialist equipment or commodities may not be available to all centres, so centres should ensure that their delivery covers their use. This may be covered by a practical demonstration (e.g. video). For the practical assessments for this qualification, centres should ensure that there are sufficient resources to complete the task but are not required to use all the equipment or commodities in the range.

Unit 301 Military aviation mathematics and science

Unit level:	Level 3
GLH:	90
Unit aim:	This unit aims to give the learner the maths and science knowledge in a military aviation context to allow further study of aircraft maintenance practices.
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS Units 155, 177 etc.
Endorsed by	This unit is endorsed by SEMTA.

Learning outcome

The learner will:

1 Be able to apply arithmetical techniques to solve engineering problems

Assessment criteria

The learner can:

1.1 explain and use the decimal counting system
1.2 estimate values for calculations
1.3 solve calculations using standard operators on arithmetical expressions
1.4 define and use arithmetical terms (directed numbers)
1.5 express fractions in different forms
1.6 solve calculations using standard operators on fractions
1.7 solve calculations using standard operators on decimals
1.8 apply the rules of rounding to 'significant figures' and 'decimal places'
1.9 define and use types of decimal numbers
1.10 convert between fractions, decimals and percentages
1.11 calculate percentage values for common engineering variables
1.12 manipulate simple arithmetic ratios
1.13 distinguish between direct and inverse proportion
1.14 calculate the constant of proportionality for arithmetical expressions
1.15 calculate the HCF and LCM of numerical expressions

Range

(AC1.1)
- Column Weighting
- Place Value
- Conventions

(AC1.2)
- Rules
- Correct Magnitude
- Implications Of Error

(AC1.3)
- Use 1st Degree Calculations
- Addition
- Subtraction
- Multiplication
- Division
- Rules

(AC1.4)
- Rules For Signs When Multiplying And Dividing
- Rules For Signs When Adding And Subtracting
- Use Number Line

(AC1.5)
- Lowest Forms
- Highest Forms
- Uses

(AC1.6)
- Addition
- Subtraction
- Multiplication
- Division

(AC1.7)
- Addition
- Subtraction
- Multiplication
- Division
- Importance Of Place Value

(AC1.8)
- Define ‘Significant Figures’
- Define ‘Decimal Places’
- Examples To 2 Decimal Places
- Examples To 4 Significant Figures

(AC1.9)
- Terminating Decimal Numbers
- Recurring Decimal Numbers
- Irrational Numbers

(AC1.10)
- Standard Fractions Found In Engineering (e.g.: Imperial Sizes 5/16 ≈ 8mm)
- Conversion process – fractions to decimal fractions to percentages and vice versa
- Convert decimals to fractions and vice versa
- Convert decimals to percentages and vice versa
- Convert fractions to percentages and vice versa

(AC1.11)
- Percentage Calculations
- Examples In Aeronautical Engineering Context

(AC1.12)
- Conventions
- Calculations

(AC1.13)
- Definitions
- Examples

(AC1.14)
- Constant Of Proportionality
- Calculations

(AC1.15)
- Concept
- Definition
- Calculations

Learning outcome

The learner will:

2 Be able to manipulate SI, Imperial and US customary units

Assessment criteria

The learner can:

2.1 use base SI units of measurement
2.2 use base Imperial units of measurement
2.3 convert compound and named derived units into base SI units
2.4 convert imperial units into base SI units
2.5 explain the terms ‘relative error’ and ‘absolute error’
2.6 apply error arithmetic to experimental data
2.7 convert aircraft fuel loads between US, Imperial and SI units
2.8 convert system pressures between Imperial and SI units
2.9 extract data from analogue and digital system gauges

Range

(AC2.1)
- metre
- kilogram
- second
- ampere
- Kelvin
- Pascal
- Newton
- names and symbols for preferred prefixes:
  - giga (g)
  - mega (m)
  - kilo (k)
  - nano (n)
  - pico (p)
- Include their typical uses

(AC2.2)
- foot (ft)
- pound (lb)
- minute (min)
- Fahrenheit (f)

Include their typical uses

(AC2.3) **:** Those commonly used in engineering

- Derived SI units eg:
  - Hertz
  - Newton
  - Pascal
  - Joule
  - Watt
  - Volt
  - Ohm

- °Celsius
- Kelvin

- Compound derived units eg:
  - Metres per second
  - Newton metre
- Relevant US imperial measures eg:
  - US gallons
- Imperial:
  - feet
  - inches
  - yards
  - pounds (lb)
  - Imp gallons

(AC2.4)
- Using both arithmetical means and standard reference tables/graphs/calculators
- For Imperial and SI systems

(AC2.5)
- Explanation of the definition
- Using suitable examples from engineering

(AC2.6)
- Relevant to engineering
- Tolerance

(AC2.7)
- pounds
- kilograms
- litres
- imperial gallons
- US gallons

Explain the reasons for doing this accurately eg:

- Pascal
- Bar
- Atmosphere
- Psi
- Nm-2
- Explain the reasons for doing this accurately

(AC2.8)
- Using common scales eg:
  - pounds
  - kilograms
  - litres
  - US gallons
- Aircraft and refueler fuel gauges
- Aircraft system pressure gauges
- Ground support system pressure gauges

Note: simulation in the form of representative drawings or photographs of relevant gauges can be used when real equipment is not available.

Learning outcome

The learner will:

3 Be able to use algebra to solve mathematical engineering problems

Assessment criteria

The learner can:

3.1 factorise 1st order algebraic expressions
3.2 define the 6 laws of indices
3.3 convert numbers to standard form and preferred standard form
3.4 simplify and solve arithmetic expressions in standard form and preferred standard form
3.5 define coefficient, variable, term, expression, equation and identity
3.6 simplify algebraic expressions containing fractions, brackets, powers and roots
3.7 solve linear equations
3.8 solve a pair of simultaneous equations using an algebraic method
3.9 solve second degree (quadratic) equations
3.10 transpose a formula to change the subject
3.11 use formulae to obtain engineering and scientific data

Range

(AC3.1)
- Methods of simplifying 1st order algebraic expressions.
- Grouping and extracting common factors
- Finding the HCF through inspection
- The techniques of factorisation

(AC3.2)
- Prove laws
- Calculations

(AC3.3)
- Problems with large or very small numbers
- Base and index in relation to Indices
- Numbers in Standard form (Scientific notation) and Preferred standard form (Engineering notation)
- Converting numbers to standard form and preferred standard form
- The link between preferred standard form (Engineering notation) and SI prefixes
- Give examples in an aeronautical engineering context

(AC3.4)
- Simplifying and solving arithmetic expressions in standard form and preferred standard form
- Manipulation of the base and index to make the number more manageable for simple calculations
- Give examples in an aeronautical engineering context

(AC3.5) **:** Definitions

(AC3.6)
- BODMAS
- Nested brackets
- Utilising knowledge of indice laws

(AC3.7)
- The solving of simple linear equations
- Keeping the balance of equations

(AC3.8)
- Substitution
- Elimination

(AC3.9)
- Factorising
- Formula

(AC3.10)
- Transposition of engineering formulae
- Basic techniques

(AC3.11)
- Using formulae to obtain engineering and scientific data

- Contextualised by engineering task/relevant to student trade

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Learning outcome

The learner will:

4 Be able to solve simple engineering problems and interpolate engineering data

Assessment criteria

The learner can:

4.1 use coordinate systems
4.2 draw labelled graphs from Cartesian coordinates
4.3 interpolate linear graphs to determine x and y coordinates
4.4 extrapolate linear graphs to determine x and y coordinates
4.5 determine the values y, m, x, and c from linear graphs and formulate the equation of the line
4.6 solve simultaneous equations using the graphical method
4.7 draw graphical representations of sine and cosine waveforms
4.8 determine data values from graphs and tables
4.9 apply graphical techniques to the solution of engineering problems

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Range

(AC4.1)
- Cartesian
- Polar
- Conversion between the two

(AC4.2)
- Concept of a graph
- Origin
- Scale
- Best fit
- Independent and dependant variables
- Interpolation and Extrapolation
- Examining experimental data

(AC4.3)
- General Law for linear graph
- Interpolating between known points
- Determination of x and y coordinates

(AC4.4)
- General Law for linear graph
- Extrapolate graph trends
- Determination of x and y coordinates

(AC4.5)
- Determine graphically
- Check by substitution

(AC4.6)
- Calculate solution from graphs
- Check algebraically

(AC4.7)
- Sine
- Cosine
- Phase difference
- Peak values

Learning outcome

The learner will:

5 Be able to solve mathematical engineering problems using trigonometrical techniques

Assessment criteria

The learner can:

5.1 construct a right angled triangle from given data
5.2 apply Pythagoras' theorem
5.3 define sine, cosine and tangent ratios for angles 0° - 90°
5.4 determine angles and sides of a right angle triangle

Range

(AC5.1)
- Correct construction
- Labelling

(AC5.2)
- Pythagoras' Theorem
- Transposition
- Application

(AC5.3)
- Definitions
- Sine
- Cosine
- Tangent
- Application to solving problems

(AC5.4)
- Labelling conventions
- Determination of unknowns

Learning outcome

The learner will:

6 Be able to solve mathematical engineering problems involving area and volume

Assessment criteria

The learner can:

6.1 define the components of a circle
6.2 solve problems related to circular dimensions
6.3 create geometrical constructions
6.4 convert between linear, square and cubic units
6.5 use formulae to calculate perimeter and area of plane figures
6.6 use formulae to calculate surface area and volume of common solids

Range

(AC6.1)
- Radius
- Diameter

- Circumference
- Pi

(AC6.2)
- Relationships of components
- Application of pi to solving unknowns

(AC6.3)
- Square
- Rectangle
- Triangle
- Circle
- Cube
- Cuboid
- Triangular prism
- Cylinder
- Cone
- Sphere
- Combinations

(AC6.5) Area and Perimeter of 2D shapes:
- Square
- Rectangle
- Parallelogram
- Triangle
- Circle
- Combinations

(AC6.6) Volume and Surface Area of 3D shapes:
- Cube
- Cuboid
- Triangular prism
- Cylinder
- Cone
- Sphere
- Combinations

Learning outcome

The learner will:

7 Understand the nature of matter

Assessment criteria

The learner can:

7.1 explain the kinetic theory of matter
7.2 identify common engineering chemical elements by name and symbol
7.3 explain the three basic states of matter and the changes of state of common substances
7.4 explain the three main bonds at molecular level
7.5 describe the nature of molecules found in metals and non-metals
7.6 explain the difference between heat and temperature

7.7 explain the relationship between the common temperature scales

7.8 convert temperature values between the common temperature scales

Range

(AC7.1)
- Make up of matter
- Random motion of particles
- Brownian motion
- Gas properties
- Conduction
- Convection
- Radiation
- Adiabatic compression

(AC7.2)
- Periodic table
- Common engineering elements

(AC7.3)
- Solid
- Liquid
- Gas
- State changes
- Latent heat
- Vaporisation
- Evaporation
- Solidification
- Common features of state changes

(AC7.4)
- Atom
- Molecule
- Compound
- Mixture
- Metallic bonding
- Ionic bonding
- Covalent bonding
- Relative strengths of bonds

(AC7.5)
- Materials used in aircraft
- Metals
- Alloys
- Plastics
- Conductors
- Insulators

(AC7.7)
- Kelvin
- Celsius
- Fahrenheit
- Thermometers

Learning outcome

The learner will:

8 Understand the principles of ‘Statics’ in relation to aircraft loadings, buoyancy and hydrostatic pressure

Assessment criteria

The learner can:

8.1 identify forces represented graphically as vectors
8.2 explain the concept of equilibrium
8.3 solve problems graphically using the ‘parallelogram of forces’ theorem
8.4 solve problems graphically using the ‘triangle of forces’ theorem
8.5 define ‘the moment of a force about a point’
8.6 define centre of gravity
8.7 solve problems involving straight levers, bell cranks and aircraft loading
8.8 define pressure and its units
8.9 solve problems using the basic gas laws
8.10 explain the difference between gauge pressure and absolute pressure
8.11 solve problems involving atmospheric, gauge and absolute pressure
8.12 explain density and relative density
8.13 calculate pressures in liquids using basic physical measurement

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Range

(AC8.1)
- Definition of a Scalar and Vector
- Values
- Representing Force in a system

(AC8.2) Definitions:
- Static equilibrium
- Dynamic equilibrium
- Force diagrams

(AC8.3)
- Addition of co-planar forces
- Graphical solutions
- Equilibrant

(AC8.4)
- Equilibrium triangle
- Pin jointed structures
- Aircraft in flight

(AC8.5)
- Definition
- Magnitude
- Sign convention
- Principle of moment

(AC8.6)
- Definition
- Position in common symmetrical objects
- CofG of an aircraft

(AC8.7)
- Straight and bell crank lever problems
- Aircraft balance on the ground
- Formula for distance of the CofG from a fixed datum

(AC8.8)
- Definition
- Barometer
- Free liquids and gases
- Constrained liquids and gases

- Stress and strain
- Formulae
- Units
- Differential pressure

(AC8.9)
- Boyle's Law
- Charles' Law
- Gay-Lussac's Law
- Combined Gas Law

(AC8.10)
- Definitions
- Examples

(AC8.11)
- Calculations

(AC8.12)
- Density
- Relative Density
- Practical aviation engineering examples

(AC8.13)
- Principle
- Formula
- Calculations

Learning outcome

The learner will:

9 Understand how the principles of motion relate to aircraft

Assessment criteria

The learner can:

9.1 state Newton's Laws of Motion
9.2 solve problems related to an aircraft in flight using the equations of motion
9.3 define basic terms for angular and oscillating motion
9.4 explain simple harmonic motion in terms of mass-spring and simple pendulum systems
9.5 solve problems involving levers, pulleys, screw jacks and gears
9.6 define basic terms used in simple gyroscopes
9.7 solve problems involving potential and kinetic energy
9.8 solve problems involving friction on a horizontal surface

Range

(AC9.1) Definitions:

- Distance
- Time
- Speed
- Velocity
- Acceleration
- Gravity
- Newton's 3 Laws of Motion
- Application using aircraft related examples
- Calculations

(AC9.2)

- Derivation of linear motion equations
- F=ma and W=mg
- Calculations

(AC9.3)

- Angular motion
- Revolutions per minute
- Radians per second
- Centrepetal acceleration
- Centrifugal force

(AC9.4)

- Free vibration
- Forced vibration
- Resonance
- Time period
- Cycle
- Frequency
- Amplitude
- Simple harmonic motion
- Motion in a spring

- Pendulum
- Calculations

(AC9.5) Definitions:

- Simple machines
- Mechanical advantage
- Velocity ratio
- Efficiency
- % Efficiency
- Calculations

(AC9.6)

- Momentum
- Inertia
- Rigidity
- Precession

(AC9.7) Definitions:

- Work
- Energy
- Power
- Conservation of energy
- Potential and kinetic energy formula
- Calculations

(AC9.8)

- Laws of dry friction
- Static friction
- Dynamic friction
- Normal reaction
- Coefficient of friction
- Viscosity
- Calculations

Unit 301 Military aviation mathematics and science

Supporting Information

Unit guidance

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Functional Skills:

Mathematics

Unit 302 Military aviation aerodynamics

Unit level:	Level 3
GLH:	50
Unit aim:	This unit aims to give the learner the aerodynamics knowledge in a military aviation context to allow further study of aircraft maintenance practices.
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS Units 155, 177 etc.
Endorsed by	This unit is endorsed by SEMTA.

Learning outcome

The learner will:

1 Know the properties of and composition of the atmosphere

Assessment criteria

The learner can:

1.1 describe the basic nature of the Earth's atmosphere
1.2 describe the use of the International Standard Atmosphere (ISA) in aviation
1.3 use ISA tables to derive specific values
1.4 solve simple problems involving changing altitude

Range

(AC1.1)
- Properties in terms of:
  - Temperature
  - Pressure
  - Density
- Changes due to:
  - Altitude
  - Position on earth's surface
  - Climatic conditions
  - Main layers
  - Region of constant temperature

(AC1.2)
- Definition of ISA
- Values in SI and imperial units

(AC1.3)
- Use of the tables
- Find specific values through interpolation

(AC1.4)
- Calculations

Learning outcome

The learner will:

2 Understand airflow and aerofoils

Assessment criteria

The learner can:

2.1 describe the main characteristics of symmetrical and cambered aerofoils
2.2 describe the effects of streamlining on the properties of air over an aerofoil surface
2.3 explain Bernoulli's Principle for a non-viscous fluid
2.4 explain the relationship between Bernoulli's Principle, a venturi and lift on an aerofoil
2.5 explain the main terms associated with aerofoils in the airflow
2.6 explain the effect of a stalled aerofoil on an aircraft in flight

Range

(AC2.1)
- Chord
- Mean camber line
- Fineness ratio
- Thickness to chord ratio
- Calculations

(AC2.2)
- Properties of air
- Flow around solid objects
- Laminar and turbulent flow
- Streamlining
- Separation and turbulence
- Form drag

(AC2.3)
- Definition of non-viscous fluid
- Conservation of energy
- Total energy in a non-viscous fluid
- In terms of pressures
- Bernoulli's Principle

(AC2.4)
- Definition of a venturi
- Airflow in a venturi
- Changes in pressure
- Relationship with an aerofoil
- How lift force is created

(AC2.5)
- Laminar and turbulent flow
- Free stream
- Up and down wash
- Features of body
- Relative airflow
- Angle of attack
- Angle of incidence
- Bernoulli's Principle
- Total Air Reaction

- Centre of pressure
- Lift and drag
- Vortices

(AC2.6)
- Stall mechanism in terms of airflow
- Effect of passage through the air
- Degree of control

Learning outcome

The learner will:

3 Understand aerofoil lift and drag

Assessment criteria

The learner can:

3.1 use standard equations to explain how lift and drag can vary

3.2 explain how lift and drag affect aircraft performance

3.3 explain how the total drag of an aircraft is generated

3.4 describe common methods of drag reduction

Range

(AC3.1)
- Lift coefficient
- Drag coefficient
- Air density
- Velocity
- Wing area
- CL CD graphs
- Calculations

(AC3.2)
- Lift and weight relationship
- Thrust and drag relationship
- Wing efficiency
- Angle of incidence

(AC3.3)
- Induced drag
- Profile drag
- Pressure or form drag
- Skin friction
- Interference drag

(AC3.4)
- Polished surfaces
- Fairings
- Special materials
- Shape
- Winglets
- Aspect ratio
- Washout

Learning outcome

The learner will:

4 Know the characteristics of basic wing planforms

Assessment criteria

The learner can:

4.1 describe basic wing planforms and their typical applications

4.2 apply simple dimensional calculations for each basic wing planform

4.3 describe the airflow over each basic wing planform

Range

(AC4.1)
- Rectangular
- Tapered
- Swept
- Delta

(AC4.2)
- Terms associated with planforms:
  - span
  - chord and average chord
  - aspect ratio
  - taper ratio
  - gross wing area

(AC4.3)
- Differences in normal flight
- Flow pattern at or near the stall

Learning outcome

The learner will:

5 Know the forces acting in flight

Assessment criteria

The learner can:

5.1 describe the relationship between the main forces acting on an aircraft

5.2 describe their effect on aircraft performance during level flight and manoeuvring

5.3 describe how turning flight is related to stall and structural problems

Range

(AC5.1)
- Lift
- Thrust
- Drag
- Weight

- Balancing effect of the tail plane

(AC5.2)
- Straight and level
- Climb
- Dive
- Glide
- Turn
- Use trigonometry to show relationship between forces
- Effects in changes of velocity

(AC5.3)
- Relationship between wing lift, weight and ‘g’ loading
- Structural integrity effects of wing lift
- Stall speeds in level flight and a turn
- Tip stall and spin

Learning outcome

The learner will:

6 Know the basic principles of aircraft stability

Assessment criteria

The learner can:

6.1 explain the difference between stable, unstable and neutral

6.2 explain the relationship between the three axes of freedom and the types of stability

6.3 describe typical methods of enhancing stability

Range

(AC6.1)
- Definition
- Active and passive stability
- Static
- Dynamic
- Positive stability
- Negative stability
- Zero stability

(AC6.2)
- Longitudinal stability
- Lateral stability
- Directional stability

(AC6.3)
- Position and size of fins
- Shape and mounting of wings
- Tail planes and canards
- Centre of gravity
- Centre of pressure
- Weather cocking
- Effect on manoeuvrability

Learning outcome

The learner will:

7 Understand the purpose and operation of flying control surfaces

Assessment criteria

The learner can:

7.1 describe the operation of primary aircraft control surfaces
7.2 explain the effects of airspeed on flying controls and give the methods to overcome this problem
7.3 explain the operation of control surface trimming devices
7.4 describe control surface flutter
7.5 explain mass balance
7.6 describe secondary effects of roll and yaw and methods of overcoming them
7.7 describe the arrangement and operation of alternative and combined flying controls

Range

(AC7.1)
- Definition of aircraft control
- Primary controls for different types of aircraft
- Effect on movement about the 3 axes
- Turning moment and the factors that affect it

(AC7.2)
- Need for instinctive control
- Force proportional to speed2
- Effectiveness increases with speed
- Aerodynamic balancing
- Powered controls
- High and low speed controls

(AC7.3)
- Types of tab
- Internal balancing

(AC7.4)
- Undesirable oscillation/ vibration
- Increase with speed
- Effect of vibration on:
  - pilot
  - airframe
  - control linkage

(AC7.5)
- Requirement
- Out of balance force
- Forward and rear limits
- Position of controls CofG

(AC7.6)
- Aileron adverse yaw
- Ways of counteracting adverse yaw
- Co-ordinated use of rudder with aileron
- Effect in V tailed aircraft

(AC7.7)
- All moving tail plane
- Tailerons

- Canards
- Elevons
- Flaperons
- Ruddervator

Learning outcome

The learner will:

8 Understand high lift and high drag devices

Assessment criteria

The learner can:

8.1 explain how a high lift device alters the flow characteristics of an aerofoil

8.2 describe boundary layer control

8.3 describe airbrake operation and the uses of spoilers

Range

(AC8.1)
- High lift devices and the way they affect:
  - airflow separation
  - lift and drag coefficients
  - relative angle of attack
  - camber
  - control of the boundary layer
- Aerodynamic effectiveness of:
  - plain flap
  - split flap
  - slotted flap
  - Fowler Flap
  - Krueger Flap
  - leading edge droop
  - slots
  - slats
- Uses
- Amount of deployment
- Asymmetric flap/ slat and effect on aircraft

(AC8.2)
- Methods of boundary layer control:
  - blown air
  - suction
  - wing fences
  - Vortex generators
  - notched leading edges

(AC8.3)
- Location and operation
- Limitations in flight and on the ground
- Uses of spoilers:
  - roll control
  - lift dumpers
  - speed brakes

Learning outcome

The learner will:

9 Know the effects of high speed flight

Assessment criteria

The learner can:

9.1 explain terms related to high speed flight
9.2 describe the formation and development of shock waves
9.3 explain terms related to transonic flight
9.4 explain methods of overcoming problems during transonic flight
9.5 describe the factors affecting airflow through an intake of a high speed aircraft

Range

(AC9.1)
- Definition of the 'speed of sound'
- Variation of the 'speed of sound'
- Mach number and Critical Mach number
- Subsonic
- Transonic
- Supersonic

(AC9.2)
- How and why shock waves are formed:
  - position and movement with velocity
  - intensity
  - shock induced separation
  - regions of subsonic and supersonic flow
  - bow wave formation and movement changes in lift and drag
  - differences between normal and oblique shockwaves

(AC9.3)
- Compressibility
- Buffet
- Span wise flow
- Shock stall
- Control ineffectiveness
- Instability
- Kinetic heating

(AC9.4)
- Thin delta and swept wings
- Sharp leading edges
- Wing fences
- Notched leading edges
- Vortex generators
- Area rule
- Spoilers
- Active stability devices
- High speed aerofoils
- Specialist materials

(AC9.5)
- Velocity

- Mass flow rate
- Stability
- Static pressure
- Auxiliary intake doors
- Spill valves
- Variable geometry intakes
- Boundary layer control devices

Unit 302 Military aviation aerodynamics

Supporting Information

Unit guidance

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Functional Skills:

Mathematics

Unit 303 Human Factors (HF) in a military aviation environment

Unit level:	Level 3
GLH:	35
Unit aim:	This unit aims to give a working knowledge of the influence of HF in a military aerospace environment.
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 2 NOS Units 001, 002 etc.
Endorsed by	This unit is endorsed by SEMTA.

Learning outcome

The learner will:

1 Describe Human Factors (HF) and human performance limitations

Assessment criteria

The learner can:

1.1 state the meaning of the term Human Factors (HF)
1.2 describe the effects HF have on performance
1.3 describe the military requirements for HF
1.4 describe psychological limitations and their effects
1.5 describe physiological limitations and their effects
1.6 describe environmental limitations and their effects.

Range

(AC1.1)
- Definition
- Scope
- Workable solutions

(AC1.2)
- Safety
- Damage
- Inefficiency

(AC1.3)
- Safety of personnel
- Safety of assets
- Long term health
- Efficiency
- Training

(AC1.4)
- Individual and group responsibility
- Motivatiion

- Peer pressure
- Culture
- Stress

(AC1.5)
- Injury
- Illness
- Tiredness

(AC1.6)
- Noise
- Heat
- Light
- Fumes
- Vibration

Learning outcome

The learner will:

2 Describe managing factors in HF

Assessment criteria

The learner can:

2.1 describe 'managing factors' and their effect on performance

2.2 describe the importance of checklists, procedures and documentation in HF management

2.3 describe techniques for effective management of emergencies and conflicts

2.4 describe techniques for effective management of workload

2.5 describe techniques to enhance the team's performance.

Range

(AC2.1)
- Individual
- Organisational
- Techniques
- Processes

(AC2.2)
- Rational
- Context
- Appropriate use

(AC2.3)
- Training
- Priorities
- Reporting

(AC2.4)
- Resource management
- Planning
- Monitoring
- Managing distraction

(AC2.5)
- Team dynamics
- Appropriate behaviour
- Own effect
- Leadership

- Fellowship
- Situational awareness
- Decision making
- Communication

Learning outcome

The learner will:

3 Describe potential factors

Assessment criteria

The learner can:

3.1 explain the effect potential factors have on performance
3.2 describe the interrelation between potential factors
3.3 describe why errors are made
3.4 describe the factors that contribute to errors being made

---

Range

(AC3.1)
- Organisational
- Operational
- Environmental
- Ergonomic
- Systemic
- Technical

(AC3.2)
- Case studies
- Combinations
- Impact
- Risk assessment

(AC3.3)
- Types of error
- Error processes
- Pressure
- Reporting

(AC3.4)
- Individual
- Organisational
- Error management
- Error reduction techniques

Learning outcome

The learner will:

4 Describe organisational regulation and guidance

Assessment criteria

The learner can:

4.1 describe the organisation’s safety management system

4.2 describe the organisation’s health and safety policy

4.3 describe the organisation’s just culture and disciplinary policy

4.4 describe the components of effective safety reporting

Range

(AC4.1)
- Location
- Contents
- Responsibilities
- Tools

(AC4.2)
- Location
- Contents
- Responsibilities
- How to mitigate error
- Risk

(AC4.3)
- Location
- Contents
- Responsibilities
- Error reporting

(AC4.4)
- Necessity
- System
- Processes

Unit 303 Human Factors (HF) in a military aviation environment

Supporting Information

Unit guidance

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Functional Skills:

Communication

Improving Own Learning and Performance

Problem Solving

Working with Others

Unit 304 Military Aviation Engineering (MAE) policy and regulation

Unit level:	Level 3
GLH:	55
Unit aim:	This unit aims to give a working knowledge of military aviation policy and regulation and how aircraft maintenance records are created and archived.
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 2 NOS Units 001, 002 etc.
Endorsed by	This unit is endorsed by SEMTA.

Learning outcome

The learner will:

1 Know the safety precautions necessary in an MAE environment

Assessment criteria

The learner can:

1.1 describe the safety precautions to be observed when working on an aircraft flight line, in a hangar or in a workshop environment

1.2 describe the safety precautions to be observed when working on or in close proximity of aircraft

1.3 identify the safety precautions to be observed when working in the vicinity of aircraft avionic systems

1.4 describe the implications of the Health and Safety at Work Act and the Environmental Protection Act legislation

1.5 explain the reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995

1.6 explain Control of Substances Hazardous to Health (COSHH) regulations

1.7 describe the use of aircraft Personnel Protective Equipment (PPE)

Range

(AC1.1)
- Working on aircraft:
  - flight line
  - in a hanger
  - workshop

(AC1.2)
- Noise

- Jet efflux
- Intakes
- Propellers / rotors
- Down wash
- Strobes
- Aircraft movement
- Armament/ejection seats

(AC1.3)
- Lethal voltages
- Safety distances for aerial / radar
- Chaff and flare
- Cooling fans

(AC1.4)
- Health and safety at work
- Environmental Protection Act
- Relevance to an aircraft environment

(AC1.5)
- Reporting procedures
- Relevance to an aircraft environment

(AC1.6)
- Control of Substances Hazardous to Health
- Relevance to an aircraft environment

(AC1.7)
- MAE Policy regarding personnel protective equipment
- HSE Policy regarding personnel protective equipment
- Relevance to an aircraft environment

Learning outcome

The learner will:

2 Understand military aviation policy and regulations

Assessment criteria

The learner can:

2.1 describe the Military Aviation Authority (MAA)
2.2 describe the basic policy for flight servicing on aircraft and standards required
2.3 describe the Air Safety Management System
2.4 explain the regulations regarding independent checks
2.5 describe Safety, Health, Environment and Fire (SHEF) within the MOD or an Approved Maintenance Organisation
2.6 describe the policy for Aviation Engineering Training
2.7 explain engineering responsibilities within Queens Regulations (QRs) (Service Personnel only)
2.8 explain the authority level system
2.9 explain the purpose of Aircraft Engineering Standing Orders (AESOs) or equivalent processes and procedures operated by an Approved Maintenance Organisation

---

Range

(AC2.1)
- Explain what the Military Aviation Authority is, and how it was created
- Describe how airworthiness is achieved

- Understand the areas and regulations pertinent to Royal Air Force technicians
- Describe the Flight Safety policy
- Explain the MAA Regulatory Publications (MRP) and the 3 documentation levels:
  - overarching documents
  - regulatory articles
  - MAA manuals
- Military applicability of the regulatory articles

(AC2.2)
- Types of flight servicing
- Continuous Charge Operations (CCO)
- Training and Authorisations to Carry out Flight Servicing
- Flight Servicing Competency Checks (FSCCs)

(AC2.3)
- Duty holder
- Chief air engineer
- Reporting errors - Air Safety Information Management System (ASIMS)
- RAF in-form
- Air safety occurrences
- Armament accidents and incidents
- Continuing Airworthiness Management Organisations (CAMO)

(AC2.4)
- Where systems subject to independent inspections are defined
- Basic process for independent inspections

(AC2.5)
- Aim of SHEF
- Relevant publications
- All members of staff, service and civilian, are bound by health and safety law
- organising
- Planning & implementation
- Measuring performance
- Reviewing performance
- Audit
- Employer responsibilities
- Line manager responsibilities
- Staff responsibilities
- SHEF incidents

(AC2.6)
- What is a competent person?
- Elements of competence
- Relevant publications

(AC2.7)
- Principal engineer (OC Eng)
- Subordinate engineers (SEngO, JEngO, WO)
- Managers (SNCO)
- Supervisors (SNCO/JNCO)
- Operatives (SNCO/JNCO/Airman)

(AC2.8)
- Who grants authorisations (auth level)
- Auth level on completion of training
- Relevant regulatory articles
- Explanation of max standard and max special auths
- Recording engineering authorisations

(AC2.9)
- Issued on behalf of who?
- Example content
- Relevant aviation engineering orders

- Who should read them?

Learning outcome

The learner will:

3 Know MAE maintenance procedures

Assessment criteria

The learner can:

3.1 describe aircraft engineering Air Publications (AP) and their structure
3.2 describe the technical Information and form amendment process
3.3 explain the policy for preventative and corrective maintenance
3.4 explain different scheduled maintenance systems
3.5 describe the regulations for zonal maintenance and the zone referencing system
3.6 describe condition-based maintenance and Life Measuring Units (LMU)
3.7 explain the terms conditioning and conditioners
3.8 describe the cannibalisation policy of aircraft parts and uninstalled aircraft equipment

Range

(AC3.1)
- Relevant aircraft maintenance documentation
- Electronic maintenance publications
- Copied documents

(AC3.2)
- Detail the technical form amendment process.
- Advanced information leaflets
- Service amendment leaflets

(AC3.3)
- Preventative maintenance
- Corrective maintenance
- Inspect and repair as necessary

(AC3.4)
- Flexible maintenance system
- Grouped maintenance system
- Equalised maintenance system

(AC3.5)
- Cleaning and examining
- Zone referencing system
- Group identification

(AC3.6)
- HUMS
- NDT
- Out-of-phase maintenance
- Life measuring units

(AC3.7)
- Conditioning
- Conditioners
- Policy on technical equipment conditioning
- Approved conditioning terms
- Conditioned technical equipment for movement or storage

(AC3.8)
- Cannibalisation of parts from aircraft
- Uninstalled aircraft equipment

Learning outcome

The learner will:

4 Understand military aviation maintenance recording

Assessment criteria

The learner can:

4.1 explain the correct use of 1st, 2nd and 3rd signatures on aircraft /equipment engineering documentation

4.2 describe the management and co-ordination of electronic aircraft engineering documentation

4.3 describe the management and co-ordination of paper based aircraft engineering documentation

4.4 describe the compilation of on-aircraft documentation

4.5 describe the compilation of off-aircraft documentation

4.6 explain how to complete the equipment conditioning record

4.7 describe the methods employed in the military air environment for asset management and configuration control

4.8 explain the requirements for shift and task handovers

4.9 describe the methods of documenting aircraft and systems modifications

4.10 describe the purpose of independent inspections

Range

(AC4.1)
- The policy on maintenance documentation signatures
- 1st signature responsibilities
- 2nd signature responsibilities
- 3rd signature responsibilities

(AC4.2)
- Regulations
- Advantages
- Problems
- Copies

(AC4.3)
- Management responsibility
- Purpose of documentation
- Uses of documentation
- Effects on safety
- Controlled forms
- Reasons for and meaning of different signatures
- Penmanship
- Different fields

(AC4.4)
- All relevant fields and blocks

(AC4.5)
- Similarities and differences with on-aircraft documentation
- All relevant fields and blocks

(AC4.6)
- Manual compilation
- Relevant fields

(AC4.7)
- Electronic engineering management
- Asset management
- Relevant systems in current use
- Accurate data input

(AC4.8)
- Topics for inclusion
- Shift handover
- Task handover

(AC4.9)
- Purpose of aircraft modification
- Designer modification
- Service modification
- Configuration management
- Technical instructions

(AC4.10)
- Purpose
- When they should be carried out
- Where they are defined
- Basic process

Unit 304 Military Aviation Engineering (MAE) policy and regulation

Supporting Information

Unit guidance

This unit has been produced to meet military aviation training requirements.

On completion of this unit the learner will be able to show a comprehensive knowledge of the aviation policy and regulation relating to the servicing of military aircraft.

Assessment is to be designed to demonstrate underpinning knowledge across the Unit. This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for the following functional skills:

Communication

Information and communication technology

Improving own learning and performance

Problem solving

Working with others.

Unit 305 Military aircraft avionics system principles

Unit level:	Level 3
GLH:	110
Unit aim:	This unit aims to give a working knowledge of military aircraft communications and RADAR systems.
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 2 NOS Units 001, 002 etc.
Endorsed by	This unit is endorsed by SEMTA.

Learning outcome

The learner will:

1 Understand the basic theory of communication systems

Assessment criteria

The learner can:

1.1 describe the basic principles of RF transmission lines
1.2 explain the basic theory of transmitters
1.3 explain the basic theory of receivers
1.4 describe aerial systems

Range

(AC1.1)
- Purpose
- Construction
- Impedance
- Matched/mismatched
- Standing Wave Ratio (SWR)
- Resonant/non-resonant lines
- Balanced/unbalanced lines

(AC1.2)
- AM transmitters
- FM transmitters
- Carrier wave modulation
- Single side band

(AC1.3)
- AM superhet receiver
- SSB receiver
- FM receiver

(AC1.4)
- Half wave dipole

- Quarter wave dipole
- Slot or notch aerials
- Matching
- Tuning

Learning outcome

The learner will:

2 Know the operation of the main different types of communication equipment in current use

Assessment criteria

The learner can:

2.1 describe V/UHF communication
2.2 describe HF communication
2.3 describe aircraft secure communication systems
2.4 identify the properties of typical tactical communication systems

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Range

(AC2.1)
- Basic operation
- UHF & VHF ranges and applications
- Principles of operation of a V/UHF transmitter
- Safety precautions

(AC2.2)
- Basic operation
- HF ranges and applications
- Principles of operation of an HF transmitter
- Transmission precautions

(AC2.3)
- Operation and signal flow of a typical system
- Common types of military secure communications system, and their properties
- Operation of a frequency agile system to block schematic level
- Properties and advantages of digital signals

(AC2.4)
- Relevant operational systems
- Telebrief systems
- SATCOM systems

Learning outcome

The learner will:

3 Know aircraft RADAR fundamentals

Assessment criteria

The learner can:

3.1 explain the basic theory of RADAR
3.2 describe RADAR microwave production

3.3 describe RADAR waveguides
3.4 describe the principles and techniques of RADAR transmission
3.5 describe factors affecting RADAR performance
3.6 describe the principles and techniques of RADAR reception

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Range

(AC3.1)
- Uses
- Primary
- Secondary
- Frequency bands
- Transmission characteristics
- Angular position and slant range
- Doppler system
- Pulse modulated system
- Frequency modulated continuous wave system

(AC3.2)
- Resonant cavity microwave oscillators
- Microwave oscillator and amplifier devices
- Cavity magnetron
- Travelling wave tube
- Gunn diode

(AC3.3)
- Uses
- Construction
- Coupling
- Pressurisation
- Components

(AC3.4)
- Main forms of transmission
- Relevant transmitter types
- High power modulator

(AC3.5)
- External factors
  - clutter
  - external noise
  - atmospheric attenuation
  - target characteristics
- Internal factors
  - design factors
  - transmitter peak power
  - receiver sensitivity
  - noise factor
  - frequency of operation
  - beam shape
  - pulse repetition frequency
  - pulse width

(AC3.6)
- Airborne RADAR superheterodyne receiver:
  - RF amplifier
  - mixer
  - local oscillator
  - AFC

- IF amplifier
- detector
- video amplifier
- Clutter and noise reduction

Learning outcome

The learner will:

4 Understand the operation of aircraft RADAR systems

Assessment criteria

The learner can:

4.1 describe the Radar Altimeter (RADALT) system

4.2 describe airborne interception system

4.3 describe the electrical aspects of the airborne radar scanners to LRU level

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Range

(AC4.1)
- Frequency modulated RADALT systems:
  - modulator
  - CW transmitter
  - mixer
  - receiver
  - display
- Pulse modulated RADALT systems
  - transmitter chain
  - aerials
  - the range computer
- Advantages over air data derived altitude

(AC4.3)
- Aerials
  - beam width
  - gain
  - polarisation
- Beam shapes
- Transmitter and Receiver (T/R) Switching

Learning outcome

The learner will:

5 Understand the basic theory of aircraft navigation systems

Assessment criteria

The learner can:

5.1 describe the basic operation of the pitot / static system

5.2 describe the layout and operation of a typical aircraft navigation system

5.3 describe the basic operation of a Head-Up-Display (HUD) system

5.4 describe the basic operation of the Horizontal Situation Indicator (HSI)

Range

(AC5.1)
- Requirement
- Pitot head
- Static vents
- Pressure heads
- Pipes / unions
- Drain traps
- Switches
- Safety precautions
- Servicing

(AC5.2)
- Layout
- Schematic
- Heading
- Groundspeed
- Airspeed
- Velocity
- Compass heading
- Lat / Long
- Polar/Cartesian Coordinates

(AC5.3)
- Waveforem generator
- Pilot's Display Unit
  - CRT
  - combiner glass
  - control unit
  - sensor inputs
- Principles of operation
- Safety precautions of HUD maintenance

Learning outcome

The learner will:

6 Understand the operation of aircraft dependant and independent positioning systems

Assessment criteria

The learner can:

6.1 describe the basic principles employed in dependent navigation aids

6.2 describe the basic operation of a compass system

6.3 describe the basic operation of a gyroscopic flight instruments

6.4 describe the basic operation of a Doppler system

Range

(AC6.1)
- For example, TACAN, ILS
- Purpose

- Transmissions patterns
- Indications to the pilot

(AC6.2)
- Requirement
- Magnetic fields and magnetic pole
- Variation
- Properties of system
- Deviation
- Compass swing procedures

(AC6.3)
- Advantages
- Inputs/output of a typical system
- Ring laser gyros
- Digital IN System
- Strapdown IN Platform

(AC6.4)
- Description of Doppler Effect
- Definition of:
  - heading
  - track
  - drift
- Can be used to determine:
  - groundspeed:
  - aircraft track
  - drift angle
- Factors that affect Doppler Shift

Learning outcome

The learner will:

7 Know the principles of aircraft flight management computing

Assessment criteria

The learner can:

7.1 describe the electronic display system

7.2 describe the Ground Proximity Warning System (GPWS)

Range

(AC7.1)
- Operation of LCD/LED display
- Multifunction display

(AC7.2)
- Requirement for a GPWS
- Predictive / non-predictive
- Operation
- Warnings
- Failures

Unit 305 Military aircraft avionics system principles

Supporting Information

Unit guidance

This unit has been produced to meet military aviation training requirements. On completion of this unit the learner will be able to show a comprehensive knowledge of the aviation policy and regulation relating to the servicing of military aircraft.

Assessment is to be designed to demonstrate underpinning knowledge across the unit.

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Functional Skills:

- Communication
- Information and Communication Technology
- Improving Own Learning and Performance
- Problem Solving
- Working with Others

Unit 306 Military aviation engineering trade knowledge

Unit level:	Level 3
GLH:	100
Unit aim:	This unit aims to give a working knowledge of military aircraft trade skills.
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 2 NOS Units 001, 002 etc.
Endorsed by	This unit is endorsed by SEMTA

Learning outcome

The learner will:

1 Know Aircraft Electrical Wiring Interconnection Systems (EWIS) husbandry

Assessment criteria

The learner can:

1.1 describe Aircraft EWIS
1.2 describe Aircraft EWIS defects
1.3 describe methods of cable support and protection
1.4 describe typical methods used to prevent erosion to avionic
1.5 understand aircraft earthing and bonding requirements
1.6 understand the need for EWIS installation inspection

Range

(AC1.1)
- Current relevant publications
- Aircraft wires, types and characteristics
- Cleaning of electrical wiring installations
- Theory of wire and cable stripping
- Wire and cable storage, handling and examination
- Role of wiring husbandry co-ordinator

(AC1.2)
- Cable Damage
- Cadmium Corrosion:
  - identification
  - health and safety precautions
- Expedient repair

(AC1.3)
- Cable support and protection, including:

- capping and stowage
- lacing cords
- cable ties
- woven wrap
- spiral wrap

(AC1.4)
- Means of avoiding erosion to avionic components:
  - correct routing
  - P clips
  - anti-erosion tape fitted to aerials
  - heat shrink

(AC1.5)
- Aircraft earthing
  - Bonding leads: requirement, inspection

(AC1.6)
- Inspection requirement:
  - tools
  - extent of inspection
  - EWIS system survey guide
- Inspect EWIS installations for:
  - serviceability
  - corrosion/erosion
  - damage
  - correct cable support / protection

Learning outcome

The learner will:

2 Know techniques for soldering on military aircraft equipment

Assessment criteria

The learner can:

2.1 describe the relevant health and safety aspects of soldering on military aircraft equipment

2.2 demonstrate soldering techniques used on military aircraft equipment

2.3 identify soldering defects

Range

(AC2.1)
- Safety and hazards to be observed when using soldering techniques:
  - solder and flux
  - soldering techniques
  - de-soldering techniques
  - inspection of soldering joints and standards

(AC2.2)
- Soldering techniques to be utilised:
  - hook joints
  - bucket joints
  - aircraft long leads
  - through hole soldering (basic CCT board, wire and resister soldering)

(AC2.3)
- Soldering techniques to be utilised:
  - hook joints
  - bucket joints

- aircraft long leads
- through hole soldering (basic CCT board, wire and resister soldering)

Learning outcome

The learner will:

3 Know the precision termination process for military aircraft cables

Assessment criteria

The learner can:

3.1 describe standards for crimping and Precision Terminating Tools (PTT)

3.2 identify termination defects

3.3 demonstrate EWIS precision termination

Range

(AC3.1)
- PTT Management
- Current relevant standards and tooling for Precision Termination.
- Modern electronic manuals for Electrical Termination

(AC3.2)
- Students to use relevant documentation to identify tooling, defects, and inspection of:
  - AMP terminals
  - CCCC75201 (602 Pattern)
  - splice
  - BNC Connector
  - Data Bus Connector
  - Knit Mesh

(AC3.3)
- Correct termination of:
  - AMP Terminal
  - CCCC75201 (602 Pattern)
  - splice
  - BNC connector
  - data bus connector
  - knit mesh
- Cable testing using DMM
- Precision termination using:
  - hydraulic crimping
  - jiffy terminal
  - solder sleeve

Learning outcome

The learner will:

4 Know the process to remove fasteners using a standard screw extractor

Assessment criteria

The learner can:

4.1 explain the use of a manual drill to carry out aircraft maintenance and repairs

4.2 explain the correct use of screw extractor tools

Range

(AC4.1)

- Aspects of safe working practices
- Precautions when working with:
  - electricity
  - gases
  - oxygen
  - oils
  - chemicals
- The need for drilling accurately positioned holes in components and structure:
  - safety precautions for personnel and general workshop safety
  - consequences of holes positioned incorrectly in components and panels
  - consequences of correctly positioned but incorrectly sized holes
- The features of a twist drill and their purpose:
  - shank
  - land
  - flute
  - point
- Drill grade:
  - CS and HSS
  - cobalt
- Drill sizes:
  - fractional imperial range
  - metric range
  - drill gauge
- Preparing material for drilling:
  - purpose
  - scribing
  - punching
- Definition of, and when to pilot drill:
  - drill size selection
  - correct execution
- Drilling lubricants

(AC4.2)

- Explain the correct method of use for a screw extractor to remove broken aircraft threaded fastener:
  - personal and workshop safety precautions
  - correct method to centre punch damaged fastener
  - drill depth
  - drilling health and safety precautions
  - fastener removal
- FOD prevention

Learning outcome

The learner will:

5 Know the process of aircraft structural examination for damage

Assessment criteria

The learner can:

5.1 describe how to check for corrosion in aircraft structure and components
5.2 describe how to check for erosion damage in aircraft structure and components
5.3 describe how to replace aircraft anti erosion materials
5.4 describe how to check for damage to aircraft surface finish
5.5 describe how to check for damage to aircraft composite materials

Range

(AC5.1)
- Corrosion on aircraft avionic components:
  - the need for corrosion checks
  - issues caused with corrosion
  - means of avoiding corrosion
  - remedial action on discovering corrosion
- Remedial action of corrosion to avionic components

(AC5.2)
- Erosion on aircraft avionic components:
  - issues caused with erosion
  - remedial action on discovering erosion
- Damage to aircraft transparencies, including:
  - means of avoiding damage
  - results of damage
  - remedial action on suspected damage
- Damage to aircraft ducts and connectors. Including:
  - means of avoiding damage
  - results of damage
  - remedial action on suspected damage

(AC5.3)
- Methods of replacing aircraft anti erosion materials

(AC5.4)
- Identifying damage
- Damage reporting processes
- Resultant problems if not corrected

(AC5.5)
- Composite material damage:
  - an understanding of Barely Visible Impact Damage (BVID)
  - means of avoiding damage
  - results of damage
  - remedial action on suspected damage

Learning outcome

The learner will:

6 Know techniques used in aircraft fibre optic systems maintenance

Assessment criteria

The learner can:

6.1 explain the safety precautions particular to fibre optic systems
6.2 describe the basic theory of optical data transmission
6.3 describe the basic construction of various FO cables and connectors
6.4 explain the principle components that comprise a typical FO Data bus
6.5 explain the current airborne FO installation and husbandry regulations
6.6 explain FO cable testing using typical aircraft test equipment
6.7 describe fusion splice techniques on FO cable

Range

(AC6.1)
- Health and Safety at Work (HSW) Act 1974 and Environmental Protection (EP) Act relevant to operating fibre optic equipment and substances.
- Safety precautions particular to fibre optic systems:
  - lasers
  - COFFEE
  - curing ovens
  - safety data sheets

(AC6.2)
- Electro-magnetic spectrum
- Glass purity
- Refractive index
- Snell's law
- Cone of acceptance
- Modal and pulse dispersion
- Types of index
- Mode
- Advantages/disadvantages

(AC6.3)
- Construction of cables, including:
  - core & cladding
  - primary coated fibre cables
  - secondary coated fibre cables
  - single ruggedized fibre cables
- Construction of in-service connectors:
  - basics
  - ST hot melt connectors
  - current military specification connectors
  - in-line couplers

(AC6.4)
- Function and operation of fibre optic transmission system:
  - transmitters
  - receivers
  - FO cable and connectors

- Bi-directional Reflective Star Coupler

(AC6.5)
- Requirement
- Husbandry to current relevant standards
- Characteristics of FO cable
- Fragility
- Routing
- Bend radius
- Cable security
- Damage and repair

(AC6.6)
- Attenuation within prescribed limits
- Measurement of attenuation
- Performance requirements to current relevant standards
- Test equipment:
  - Visible Fault Locator
  - fibre optic and face viewer
  - light source and power meter
  - OTDR
  - computer diagnostic software

(AC6.7)
- Importance of cleaning and inspection
- Techniques:
  - termination disconnection
  - inspection
  - cleaning
  - storage
  - re-connection

Unit 306 Military aviation engineering trade knowledge

Supporting Information

Unit guidance

This unit has been produced to meet military aviation training requirements.

On completion of this unit the learner will be able to show a comprehensive knowledge of the aviation policy and regulation relating to the servicing of military aircraft.

Assessment is to be designed to demonstrate underpinning knowledge across the Unit.

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Functional Skills:

Communication

Information and Communication Technology

Improving Own Learning and Performance

Problem Solving

Working with Others

Unit 307 Military aviation electrical principles

Unit level:	Level 3
GLH:	85
Unit aim:	This unit aims to give the learner the electrical systems knowledge in a military aviation context to allow further study of aircraft maintenance practices.
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS
Endorsed by	This unit is endorsed by SEMTA.

Learning outcome

The learner will:

1 Know basic electrical components

Assessment criteria

The learner can:

1.1 describe basic electronic terms
1.2 describe resistors
1.3 describe Kirchhoff's laws
1.4 describe power dissipation in a DC circuit
1.5 describe common electronic components

Range

(AC1.1)
- Current
- Voltage
- Ohm's Law
- Electromotive force
- Resistance
- Resistivity
- Resistance/ temperature relationships

(AC1.2)
- Identification of value
- Power rating
- Circuit symbols
- Ohm's Law
- Voltage drops in circuits

(AC1.3)
- First and Second Law

- Examples using resistor networks
- Calculations

(AC1.4)
- Energy
- Power
- P=IV
- Internal resistance

(AC1.5)
- Capacitors
- Inductors
- Protection devices
- Relays
- Solenoids
- Switches
- Actuators

Learning outcome

The learner will:

2 Understand 3 phase electrical power generation and distribution

Assessment criteria

The learner can:

2.1 explain AC circuit theory

2.2 explain 3 phase electrical power generation and distribution

2.3 explain parallel operation of AC generators

Range

(AC2.1)
- Generation of a sinusoidal waveform
- Amplitude
- Average value
- Peak and peak to peak
- RMS
- Periodic time
- Frequency
- Cycle
- Phase
- Effect of resistors
- Power dissipated
- Effect of capacitors
- Single phase generation
- Losses
- Wound field v permanent magnet
- Multipole rotors
- Load characteristics

(AC2.2)
- Brushed 3 phase generator
- 3 stage brushless 3 phase generator

- Generator control
- 3 phase characteristics
- 3 phase distribution
- STAR connection
- Delta connection
- Phase voltages and currents
- Line voltages and currents

(AC2.3)
- Synchronising 3 phase generators:
  - equal line voltage
  - same frequency
  - in phase
  - same phase rotation
- Load sharing
- Static inverters

Learning outcome

The learner will:

3 Understand the operation of electrical machines

Assessment criteria

The learner can:

3.1 explain transformers, rectifiers and filters
3.2 explain the operation of DC generators
3.3 explain the operation of DC motors
3.4 explain the operation of AC motors

Range

(AC3.1)
- Modern aircraft transformers:
  - mutual inductance
  - transformer action
  - voltage and current ratios
- Types of transformer and their uses:
  - single phase
  - multiple windings and multi-tap
  - centre-tapped transformer
  - three phase transformer
  - auto-transformer
  - circuit symbols
- Semiconductor diodes
- Stabilizing circuits
- Filtering

(AC3.2)
- DC generation, shunt connected/series connected/ brushless
- TRU:
  - voltage conversion

- supply power to DC equipment
- advantages
- construction and operation

(AC3.3)
- Construction and operation of a permanent magnet DC motor
- VS=EB +IARA
- Effects of back EMF
- Speed control
- Torque
- Connection types
- DC shunt/ compound motors
- Compound motors

(AC3.4)
- Principles of rotating magnetic field
- Synchronous speed
- Frequency
- Number of pole pairs per phase
- Synchronous rotor construction
- Cage rotor construction

Learning outcome

The learner will:

4 Know the principles of aircraft information transfer

Assessment criteria

The learner can:

4.1 define the characteristics of number systems used by computers

4.2 explain aircraft integrated avionic suites

Range

(AC4.1)
- Requirement
- Decimal
- Binary
- Hexadecimal
- Conversion

(AC4.2)
- Requirements of a databus:
  - interconnections
  - ADC/DAC conversion
- Latest military standards
- Data transmission
- Shielded twisted pair
- Transformer coupling
- Redundancy
- Bus controller
- Bus monitor
- Remote terminal

Unit 307 Military aviation electrical principles

Supporting Information

Unit guidance

This unit has been produced to meet military aviation training requirements.

On completion of this unit the learner will be able to show a comprehensive knowledge of the aviation policy and regulation relating to the servicing of military aircraft.

Assessment is to be designed to demonstrate underpinning knowledge across the Unit.

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Functional Skills:

Communication

Information and Communication Technology

Improving Own Learning and Performance

Problem Solving

Working with Others

Unit 308 Maintaining military aircraft electrical systems

Unit level:	Level 3
GLH:	75
Unit aim:	This unit aims to give a working knowledge of electrical systems for avionics technicians.
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 2 NOS Units 001, 002 etc.
Endorsed by	This unit is endorsed by SEMTA

Learning outcome

The learner will:

1 Describe power generation and distribution

Assessment criteria

The learner can:

1.1 describe the types and uses of aircraft batteries
1.2 describe aircraft battery power supply systems
1.3 describe AC power supply system
1.4 describe power distribution system
1.5 explain the electrical aspects of the APU electrical generator system
1.6 describe the DC power supply system
1.7 describe emergency battery power systems

Range

(AC1.1)
- Charging
- Theory of battery operation
- Need for aircraft batteries
- Primary/ secondary cell
- Construction
- Safety precautions
- Thermal runaway

(AC1.2)
- Battery installation
- Battery bus bar
- Essential buses
- Emergency power supply

- Routine maintenance

(AC1.3)
- Requirement
- Layout
- Typical system schematic
- Voltage regulation
- Power distribution
- Circuit protection
- Interaction with other systems

(AC1.4)
- Requirement
- Layout
- System schematic
- Interaction with other systems

(AC1.5)
- Requirement
- Layout
- System schematic
- Interaction with other systems

(AC1.6)
- Requirement
- Layout
- TRU's
- External/Ground Power
- Circuit protection
- Interaction with other systems

(AC1.7)
- Requirement
- Layout
- System schematic
- Interaction with other systems

Learning outcome

The learner will:

2 Understand electrical power monitoring and protection

Assessment criteria

The learner can:

2.1 describe auxiliary power supply system

2.2 explain the aircraft earth bonding system

Range

(AC2.1)
- Requirement
- Layout
- Switching to Aux supply
- Under voltage
- Overvoltage
- Interaction with other systems

(AC2.2)
- Requirement

- Factors that produce electrostatic charges
- Metal airframes
- Risks associated with charges producing electrical arcs
- Electrical bonding
- Maintenance of earth joints and bonding systems

Learning outcome

The learner will:

3 Understand the electrical operation of the landing and egress systems

Assessment criteria

The learner can:

3.1 describe electrical aspects of the landing gear and door system
3.2 describe electrical aspects of aircraft brakes
3.3 describe electrical aspects of aircraft steering
3.4 describe electrical aspects of landing assist systems
3.5 describe electrical aspects of aircraft doors

Range

(AC3.1) Requirements:

- Construction:
  - Oleo
  - Shock absorbing
  - Pins
  - Actuators
  - Solenoids
  - Controls
- Indications and Warnings
- Pneumatic emergency systems:
  - system layout
  - power sources
  - control
- Operation of generic gear and door system
- Interfaces with other systems
- Safety precautions

(AC3.2)
- Requirements
- Wheels/tyres
- Anti skid
- Auto braking
- Controls
- Sensors
- Hydraulics
- Indications and warnings
- Safety precautions

(AC3.3) Requirements:

- Steering motor:
  - highgear
  - low gear
  - free to castor
- Amplifiers
- Switches
- Safety precautions

(AC3.4) Requirements:

- Arrestor hook
- Drag shute
- Operation of landing assist
- Safety precautions

(AC3.5)

- Passenger doors
- Cargo doors
- Ramp system
- Canopy system

Learning outcome

The learner will:

4 Understand the electrical operation of engine control systems

Assessment criteria

The learner can:

4.1 describe the basic principles of gas turbine engines

4.2 describe engine indication systems

4.3 explain the electrical aspects of engine control

Range

(AC4.1)

- Component parts and their function:
  - intake
  - compressor
  - combustion chamber
  - High Energy Ignition Unit (HEIU)
  - fuel spray nozzle
  - turbine
  - exhaust
- Operation of a basic aircraft turbine engine system:
  - working cycle
  - induction
  - compression
  - ignition
  - exhaust reheat
  - reverse thrust
- Engine gearboxes

(AC4.2)

- Requirements

- Pressure indications
- Remote (electrical indication)
- Direct reading Indication (Skin Gauges)
- Position indicating system
- Temperature
- Flow
- Engine speed
- Tachogenerator
- Torque
- Thrust Indication

(AC4.3)
- Requirement:
  - engine control
  - APU control
- DECU
- FADEC
- EEC
- Fuel metering
- APU
- Transducers
- Sensors
- Parameters for calculations

Learning outcome

The learner will:

5 Understand the electrical operation of the aircraft fuel and lubrication system

Assessment criteria

The learner can:

5.1 describe the electrical aspects of the aircraft fuel storage and vent systems
5.2 describe the electrical aspects of the aircraft fuel tank inerting systems
5.3 identify the electrical aspects of the aircraft fuel gauging systems
5.4 explain the electrical aspects of the aircraft engine fuel feed systems
5.5 describe the electrical aspects of the aircraft refuelling system
5.6 describe the electrical aspects of the aircraft fuel jettison and dump system
5.7 describe electrical aspects of aircraft engine oil system
5.8 describe electrical aspects of aircraft APU oil system

Range

(AC5.1)
- Types of tank
- Management control sensors
- Float switches

(AC5.2)
- Requirements
- System layout
- Components and operation

- OBIGGS

(AC5.3)
- Requirements
- Components and their operation
- Tank units
- Bridge amplifier
- Indicators
- Cables and connectors
- Hazards
- Safety precautions

(AC5.4)
- Fuel pumps
- Booster pumps
- Pressure switches
- Fuel cocks and valves
- X feed and transfer
- Trim transfer
- Safety precautions

(AC5.5)
- Uses
- Open line refuelling
- Defueling
- Components and operation:
  - indication
  - control panel
  - refuel panel
  - valves
  - relays
  - level sensors
- Implications of fuel movement on the ground
- Process:
  - fuel x feed and transfer
  - trim transfer
  - emergency transfer
- Controls
- Level switches
- Indication
- Pumps
- Valves

(AC5.6) Requirements:
- Components:
  - control unit
  - refuel panel
  - boost pumps
  - dump valves
  - relays
  - sensors
  - Indications

(AC5.7)
- Filters
- Signals and Indications
- Pumps

- Heat Exchangers
- Pressure transmitters
- Switches

(AC5.8)
- Differential pressure switches
- Pressure transducers
- Temperature switches

Learning outcome

The learner will:

6 Understand the electrical operation of the aircraft ignition and exhaust systems

Assessment criteria

The learner can:

6.1 describe the electrical aspects of the engine ignition system

6.2 describe the electrical aspects of aircraft thrust augmentation

6.3 describe the electrical aspects of aircraft thrust reversers

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Range

(AC6.1)
- Requirement
- Component parts and function
- Starter motor
- APU
- Air starter
- Electronic Control Unit (ECU)
- High energy Ignition unit (HEIU)
- Igniter plugs
- Transducers
- Indication
- Safety interlocks
- Safety precautions

(AC6.2)
- Requirements:
  - selection
  - automatic sequencing
  - fuel supply
  - core engine operation
  - fail-safe
- Functions necessary for successful operation
- Components and their operation:
  - selection, co-ordination and control
  - fuel flow metering and ignition
  - nozzle operation

(AC6.3)
- Control:
  - weight-on-wheels
  - throttles
  - over-ride switch

- valves
- microswitches

- Indication
  - magnetic indicators
  - CWS

Learning outcome

The learner will:

7 Understand the electrical aspects of military aircraft hydraulic systems

Assessment criteria

The learner can:

7.1 describe hydraulic pump systems

7.2 explain the factors to consider when maintaining the engine driven hydraulic pump electrical systems

7.3 explain the factors to consider when maintaining the air turbine motor hydraulic pump electrical systems

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Range

(AC7.1)
- The need for a Hydraulic pump system
- Warnings and Indications
- Data feeds to other systems ie CWS
- Hydraulic monitoring systems
- Construction
- Principles of operation
- System layout
- Emergency pressure generation
- Safety precautions when maintaining an aircraft Hydraulic Pump System

(AC7.2)
- Indications
- Warnings
- Safety precautions to be observed when maintaining an engine driven pump system

(AC7.3)
- Indications
- Warnings
- Safety precautions to be observed when maintaining an air turbine motor hydraulic pump system

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Learning outcome

The learner will:

8 Understand the electrical operation of military aircraft environmental control systems

Assessment criteria

The learner can:

8.1 explain operation of systems in a serviceable state
8.2 describe the electrical aspects of the aircraft cabin air conditioning system
8.3 describe aircraft oxygen system
8.4 describe the electrical aspects of the aircraft zone temperature control system
8.5 describe the electrical aspects of the aircraft cabin pressurisation system
8.6 describe the electrical aspects of the aircraft equipment bay conditioning system
8.7 describe the electrical aspects of the aircraft anti-G system
8.8 describe the electrical aspects of the aircraft liquid and gaseous pressure measurement system

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Range

(AC8.1)
- Signal flow at schematic level
- Outputs to dependant systems
- Inputs from associated systems
- System safety precautions

(AC8.2)
- Need for air conditioning system
- Sources of air supply
- Air cycle and vapour cycle machines
- Distributions systems
- Sensors
- The operation of the following temperature sensing transducers:
- Temperature cabin air
- Control
- Indications and warnings
- Interfaces with other systems
- Principle of operation of a generic aircraft air conditioning system

(AC8.3)
- Need for an aircraft Oxygen system
- System Layout
- Passenger/troop drop down oxygen masks
- Sources
- Storage
- Charging
- Distribution Control
- Supply regulation
- The principle of operation of a representative Oxygen system
- Indications and Warnings
- Interfaces with other system

(AC8.4)
- Sensors
- Need for an aircraft zone temperature system
- Indications and warnings
- Interfaces with other systems
- Operation of zone temperature system

(AC8.5)
- Need for an aircraft pressurisation system

- System layout
- Safety valves
- Outflow valve / dump valve
- Pressure sensing transducer
- Control
- Indications and warnings
- Interfaces with other systems
- Principle of operation of a generic aircraft cabin pressurisation system

(AC8.7)
- Need for an aircraft equipment bay conditioning system
- System layout
- Components
- Sensors
- Control
- Indications and warnings
- Interfaces with other systems
- Principle of operation of a generic aircraft equipment bay conditioning

(AC8.8)
- Need for an aircraft anti-G system
- System layout
- Components
- Sensors
- Control
- Indications and warnings
- Interfaces with other systems
- Principle of operation of a generic anti-G system
- Safety precautions when maintaining an anti-G system

Learning outcome

The learner will:

9 Understand the electrical operation of military aircraft ancillary systems

Assessment criteria

The learner can:

9.1 explain the electrical aspects of the engine fire detection system
9.2 explain aircraft fire extinguishing systems
9.3 describe the electrical aspects of the ice detection system
9.4 describe the electrical aspects of aircraft windows ice and rain protection
9.5 describe the electrical aspects of the airfoil anti-ice system

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Range

(AC9.1)
- Fire wire fire detection system
- Warning Conditions
- Single point fire detection system
- Fire detectors situated in fire zones
- Pneumatic thermal detectors

- Displayed warnings
- Interactions with other systems
- Safety precautions to be observed when maintaining a fire detection system

(AC9.2)
- The need for a fire extinguishing / suppression system
- Fire bottles
- Fire bottles indication
- Audio warnings
- Pressure relief valves
- Crash switches
- Safety precautions
- Portable fire extinguisher
- APU fire extinguishers
- Cargo compartment fire extinguishing
- Fire detection indication
- Basic layout and operation of fire detection systems

(AC9.3)
- Visual detectors
- Automatic ice detectors
- Ice formation
- Classification
- System layout
- Sources
- Pressure control
- Distribution
- Indications and warnings
- Interfaces with other systems
- The operation of an ice detection system and its components

(AC9.4)
- Electrically heated windscreens
- Associated power supply inputs / origin
- Temperature controllers
- Visual indication of operation
- Windscreen sensors
- The operation of a representative windscreen anti-icing system
- Indications and Warning

(AC9.5)
- Spray mats
- Engine intakes
- Propeller blades
- Bleed air systems
- Pneumatic systems

Learning outcome

The learner will:

10 Know the basic operation of military information and recording systems

Assessment criteria

The learner can:

10.1 describe the operation of aircraft information systems

10.2 describe the operation of aircraft indication systems

10.3 describe the operation of aircraft recording systems

Range

(AC10.1)
- Redundancy
- Bus controller
- Bus monitor
- Remote terminal
- Purpose of software
- Types of programs:
  - operational flight programs
  - mission data
  - map definition data
  - weapons data
- Test programs
- System schematic
- Interaction with other systems

(AC10.2)
- Classification
- Terminology
- Pressure systems and devices
- Associated data and display
- Alert systems
- Air data computers
- Safety precautions
- Stall warning
- Angle of attack indicating
- Instrument warning systems
- Vibration measurement and indication
- Maintenance indication/ Panels

(AC10.3)
- Components of a typical centralised warning system
  - centralised warning panel
  - attention getters
  - voice warnings
  - tranducers
  - audio warnings
- Different data recorder systems
- Cockpit voice recorder
- Flight data recorder
- Accident data recorder
- Data acquisition unit
- Signals recorded
- Health Usage Monitoring System (HUMS)
- Structural Health Monitoring system (SHM)

Unit 308 Maintaining military aircraft electrical systems

Supporting Information

Unit guidance

This unit has been produced to meet military aviation training requirements.

On completion of this unit the learner will be able to show a comprehensive knowledge of the aviation policy and regulation relating to the servicing of military aircraft.

Assessment is to be designed to demonstrate underpinning knowledge across the Unit.

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Functional Skills:

Communication

Information and Communication Technology

Improving Own Learning and Performance

Problem Solving

Working with Others

Unit 309 Maintaining Military Gas Turbine Engines

Unit level:	Level 3
GLH:	90
Unit aim:	This unit aims to provide learners with a detailed understanding of Gas Turbine Engines fitted to military aircraft.
Endorsed by	This unit is endorsed by SEMTA

Learning outcome

The learner will:

1 Understand the fundamentals of gas turbine engine theory

Assessment criteria

The learner can:

1.1 explain energy and Newton's Laws of Motion
1.2 explain the Brayton cycle
1.3 explain the relationship between force, work, power, energy, velocity, and acceleration
1.4 explain terms relating to gas turbine engine performance
1.5 explain engine efficiencies
1.6 explain by-pass and engine pressure ratio
1.7 explain engine ratings
1.8 describe the features of bearings and seals used in gas turbine engines.

Range

(AC1.1)
- Force
- Mass
- Acceleration
- Inertia
- Momentum

(AC1.2)
- Compression
- Combustion
- Expansion
- Expulsion (heat rejection

(AC1.3)
- Newton's Laws of motion
- Work done
- Thrust equations
- Factors affecting thrust

(AC1.4)
- Thrust forces such as: choked nozzle thrust, thrust distribution, resultant thrust
- Specific fuel consumption
- International Standard Atmosphere
- Thrust equations
- Thrust in flight: effect of Airspeed, Altitude
- Momentum, thrust and drag forces
- Power to weight ratio
- Nozzle Convergent-divergent nozzles

(AC1.5)
  - Propulsive efficiency
  - Thermal efficiency
  - Mass airflow

(AC1.6)
- Mass airflow
- Bypass airflow
- Core flow
- Cold and Hot gas flow
- Pressure ratio

(AC1.7)
- Static thrust
- Influence of speed, altitude climate on performance
- Altitude; fall in ambient air pressure/density
- Temperature: increase/reduction in air density
- Flat rating and limitations
- ISA correction
- RPM/Temperature limitation
- Factors affecting thrust:-
- Fuel consumption and power to weight ratio

(AC1.8)
- Construction and performance of e.g.:
  - Ball/Roller/Squeeze film bearings
  - Axial loadings
  - Ring seals
  - Brush seals
  - Labyrinth seals (e.g. Air Blown seals)
  - Bearing chambers
  - Carbon seals

Learning outcome

The learner will:

2 Understand the types of aircraft gas turbine engine and their installations

Assessment criteria

The learner can:

2.1 describe the variations of the gas turbine engine
2.2 explain the constructional arrangement of turbo-jet and turbofan engines
2.3 explain the basic operation of turboprop engines
2.4 describe the types of gearbox utilised on gas turbine engines
2.5 describe the types of drive systems utilised on gas turbine engines
2.6 explain the operation of an APU

2.7 describe the configuration of typical engine installations.

Range

(AC2.1)
- Modular engine construction
- Thrust producing engines
- Torque producing engines

(AC2.2)
- Thrust producing engines – Turbojet/turbofan:
- Single and twin spool engines
- Low and high bypass turbofan

(AC2.3)
- Torque producing engines – Turbo Prop/Turbo shaft:
- coupled power turbine
- free power turbine
- compounded

(AC2.4)
- Purpose
  - Types of gearbox: Internal
  - External/Auxiliary
  - Reduction
- Engine accessory gearbox component parts
- Secondary Power System
- Types of gear:
  - Spur
  - Epicyclic

(AC2.5)
- Drive shaft purpose
- Types of drive shafts e.g. cross drive, PTO
- Drive Train clutches:
  - freewheeling
  - Selectable

(AC2.6)
- Description
- APU Drive Transfer
- Over-speed
- Under-speed
- Over-load
- Low oil pressure
- Fire detection

(AC2.7)
- Power Unit/Engine Change Unit/ Power Plant
- Firewalls, cowlings, acoustic panels, engine mounts, anti-vibration mounts, hoses, pipes, feeders, control cables and rods, lifting points
- V Band Clamps
- Drains
- Electrical cables, connectors and looms

Learning outcome

The learner will:

3 Understanding Inlets and Compressors

Assessment criteria

The learner can:

3.1 describe compressor inlet ducts
3.2 explain the effects of various inlet configurations
3.3 describe inlet ice protection
3.4 explain axial and centrifugal compressors
3.5 explain compressors
3.6 explain how a compressor operates
3.7 explain compressor stall and surge
3.8 explain methods of air flow control

Range

(AC3.1)
- Ram effect
- Diffuser
- Kinetic energy
- Pressure energy

(AC3.2)
- Subsonic, supersonic
- Shock waves
- Boundary layer devices

(AC3.3)
- Electrical heating system
- Hot air system

(AC3.4)
- Purpose
- Requirements
- Types:- e.g Single, twin and multi-spool compressors

(AC3.5) Constructional features, operating principles of axial compressors and applications:
- Construction
- Operation
- Rotors, Rotor blades, Stator vanes
- Blade attachment methods
- Materials
- Kinetic energy

Constructional features, operating principles of centrifugal compressors and applications:
- Construction
- Operation,
- Impeller, diffuser, casing
- Materials
- Kinetic energy

(AC3.6)
- Airflow
- Temperature
- Pressure
- Velocity
- Optimum efficiency/Design point
- Compressor characteristics

(AC3.7)
- Causes and effects of:

- Blade stall
- Engine surge

(AC3.8)
- Including:
  - Bleed valve systems
  - Variable inlet guide vanes
  - Variable stator vanes

Learning outcome

The learner will:

4 Understand combustion, turbine and exhaust sections

Assessment criteria

The learner can:

4.1 describe the construction of a typical combustion section
4.2 explain the principle of operation of a typical combustion section
4.3 explain the principle operation of a typical turbine used on gas turbine engine
4.4 describe blade to disk attachment
4.5 describe nozzle guide vanes
4.6 explain the process of turbine blade stress and creep
4.7 describe the constructional features of a typical exhaust section
4.8 describe the principle of operation of a typical exhaust section
4.9 describe engine noise reduction methods
4.10 describe thrust reversers

Range

(AC4.1)
- Purpose/requirements
- Materials
- Combustion chamber inner and outer cases
- Multiple, tubo-annular or cannular, annular and reverse flow annular chambers

(AC4.2)
- Fuel/Air ratio
- Primary, secondary and tertiary air
- Fuel Spray Burners, Vaporisers
- Duplex and spray nozzle atomisers
- Drain/dump valves

(AC4.3)
- Construction, operation and characteristics:
- Materials and manufacture
- Impulse/Reaction
- Impulse/reaction/radial inflow
- Shrouds, Blade twist

(AC4.4)
- Fir tree root
- BLISK bonding

(AC4.5)
- Purpose
- Shrouded vanes

(AC4.6)
- Causes and effects:

- Temperature
- Extended high power
- Erosion
- Rate of acceleration
- Run down times
- Performance loss

(AC4.7)
- Materials
- Jet pipe/Exhaust unit/Propelling nozzle

(AC4.8)
- Velocity
- Mass airflow
- Temperature
- Low and high by-pass ratio
- Convergent, divergent and variable area nozzles
- Thrust vectoring

(AC4.9)
- Noise suppression:
  - Exhaust gas noise reduction
  - Fan noise reduction
  - Acoustic liners

(AC4.10)
- Purpose/requirements
- High by-pass ratio fan engine (Cold Stream Reverser)
- Clamshell deflector doors
- Bucket target system

Learning outcome

The learner will:

5 Understand engine lubrication and engine fuel systems

Assessment criteria

The learner can:

5.1 explain the properties of gas turbine lubricants
5.2 describe the layout, operation and components in a typical lubrication system
5.3 explain the properties of fuel used in gas turbine engines
5.4 describe the operation of electronic fuel control and fuel metering systems
5.5 describe typical fuel system components and layout
5.6 describe safety precautions applicable to lubricants and fuels

---

Range

(AC5.1)
- Viscosity
- Specification/Classification
- Synthetic oil

(AC5.2)
- Sump
- Pressure relief valve system
- Scavenge system
- Full flow system
- Loss system

- Oil tanks
- Oil filters
- Oil pumps - pressure, scavenge
- Oil coolers - air cooled, fuel cooled
- Venting/Centrifugal breather
- Contamination/Debris detection

(AC5.3)
- Types of fuel
- Fuel system Icing Inhibitor (FSII)
- General Requirements eg: pumpability, calorific value, combustion by-products, lubricity, non-corrosive
- Contamination:
  - Solid Matter
  - Water
  - Microorganisms (Cladisporium Resinae)
  - Quality and contamination checks

(AC5.4)
- Typical systems eg:
  - Hydro-mechanical flow control
  - Hydro-mechanical/electronic
  - Electronic flow control
  - FADEC
  - Low pressure element – LP cock, LP pump, LP filter
  - High pressure element – HP cock, HP pump
  - Fuel control unit (FCU)
  - Fuel metering unit

(AC5.5)
- Fuel pumps/Filters
- Fuel and flow control
- Throttle Valve
- Fuel spray nozzles

(AC5.6)
- Fire
- Contamination

Learning outcome

The learner will:

6 Understand engine control and instrumentation systems

Assessment criteria

The learner can:

6.1 describe the requirements of a gas turbine engine control
6.2 describe the types of control systems used on gas turbine engines
6.3 describe engine systems indication
6.4 describe the types of sensors and transmitters used on gas turbine engines
6.5 describe oil pressure and temperature indication
6.6 describe fuel pressure and flow indication
6.7 describe vibration measurement and indication
6.8 explain the need for automatic and manual corrections

Range

(AC6.1)
- Fuel control system
- Starter system
- Lubrication system
- Air system
- Airflow control system
- Reheat system
- Thrust Reverse system

(AC6.2)
- Purpose
- Supervisory control
- Full authority control

(AC6.3)
- Mechanical
- Multi Function Display
- Head Up Display
- Centralised Warning system
- Indicated information e.g. RPM, EGT, Nozzle position, Fuel Flow, Oil Pressure

(AC6.4)
- Engine Spool Speed:
  - Tachogenerator
  - Speed Probe
- Exhaust Gas Temperature (EGT):
  - Thermocouples
  - Pyrometers
  - Sensing areas
  - Indication

(AC6.5)
- Pressure/Temperature sensors and transmitters

(AC6.6)
- Fuel flow meters:
  - Flow transmitter
  - Flow Indicator

(AC6.7)
- Vibration transmitter/transducers
- Indicator

(AC6.8)
- ISA corrected performance data (Placard)
- Performance ground runs

Learning outcome

The learner will:

7 Understand starting, ignition, air and power augmentation systems

Assessment criteria

The learner can:

7.1 describe engine start systems
7.2 describe ignition systems and components
7.3 describe maintenance safety requirements
7.4 describe failed start indications
7.5 describe the operation of engine air distribution and anti-icing
7.6 explain the need for power augmentation

7.7 describe afterburner systems.

Range

(AC7.1)
- Purpose/requirements and components
- Electric
- Air turbine
- Gas turbine starter/APU
- Secondary power system
- Hydraulic

(AC7.2)
- High energy ignition unit
- Igniter plug

(AC7.3)
- High energy ignition units
- Electrical systems safe
- Systems isolation
- Oil and fuel contact and spillage
- Air intake and exhaust checks

(AC7.4)
- Hung start
- Hot start
- Emergency below/above self-sustaining

(AC7.5)
- Compressor/shaft cooling
- Turbine cooling
- Combustion cooling
- Bearing chamber cooling/sealing
- Accessory cooling
- Exhaust cooling
- Regulated/unregulated anti icing

(AC7.6)
- Including typical applications
- Purpose of thrust augmentation
- When it might be used

(AC7.7)
- Principle of operation
- Construction
- Requirements
- Methods of ignition
- Methods of control

Learning outcome

The learner will:

8 Know engine health monitoring and engine protection systems

Assessment criteria

The learner can:

8.1 explain the need for engine health monitoring systems

8.2 describe health monitoring

8.3 describe usage monitoring

8.4 describe procedures and techniques used to identify contamination

8.5 explain vibration and frequency analysis

8.6 explain relationship between usage and life

8.7 describe the operation of engine fire detection and extinguishing systems

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Range

(AC8.1)
- Subjected stresses:
  - Gravity
  - Aerodynamic loads
  - Heat
  - Pressure
  - Centrifugal force
  - Vibration

(AC8.2)
- Sampling
- Debris analysis
- Vibration analysis
- Performance monitoring

(AC8.3)
- RPM
- Heat
- Pressure

(AC8.4)
- Aero engine lubrication system health monitoring:
  - Magnetic Chip detectors
  - Spectrometric Oil Analysis Programme (SOAP)
  - Viscosity comparator

(AC8.5)
- Thresholds
- Sensors

(AC8.6)
- Low cycle fatigue monitoring
- Turbine blade creep
- Usage rates
- Exceeding predetermined limits
- Records

(AC8.7)
- Fire detectors and sensors
- Fire extinguishants

Learning outcome

The learner will:

9 Understand Routine servicing, Inspection, Preservation and Packing

Assessment criteria

The learner can:

9.1 describe the assessment and repair method used on a compressor blade

9.2 describe the types of Remote Viewing Aids (RVA) and explain their uses

9.3 describe trend monitoring processes

9.4 describe the principles and process of preservation and packing

9.5 describe the overall process for carrying out an engine change

9.6 describe engine ground runs

Range

(AC9.1)
- Requirement for repair: FOD, Time & Expense
- Assessment of damage
- Blade blending
- Balancing

(AC9.2)
- Boroscope
- Videoscope
- Mirror
- Internal Engine Inspection:
  - Compressor
  - Combustion section
  - Turbine
  - Bypass ducts
  - Corrosion

(AC9.3)
- Magnetic Chip Detectors:
  - Colour coded
  - Seals
  - Handling e.g. Debris displacement
  - Component change
  - Increased sampling
  - Hot drain/flush
- Oil Sampling:
  - Hot within 30 minutes
  - Prior to replenishment
  - Viscosity comparator

(AC9.4)
- Purpose
- External
- Internal
- Short term storage
- Long term storage
- Bungs, blanks and covers
- Liquid protective barrier
- Protective wraps
- Pressurised container e.g. STC
- Water vapour resistant bags
- Fuel system inhibiting

(AC9.5)
- Preparation:
  - Personnel
  - Fuel level
  - Cockpit/flight deck switches
  - Aircraft configuration
  - Circuit Breakers/fuses
  - Ground equipment
- Engine Removal:
  - Disconnections
  - Housekeeping

- Fitting of Blanks
- Control rod and cables secured
- Correct storage of removed ancillary components

- Engine Fitment Preparation:
  - Dressing
  - Engine compartment inspection, e.g. firewire.
- Engine Fitment:
  - Personnel
  - Procedure
- Testing:
  - Leaks: e.g. Fluid, gas or hot air
  - Control adjustment
  - Performance e.g. NH, TGT

(AC9.6)
- Anti-deterioration
- Conventional

Unit 309 Maintaining Military Gas Turbine Engines

Supporting Information

Unit guidance

This unit has been produced to meet military aviation training requirements.

On completion of this unit the learner will be able to show a comprehensive knowledge of Gas Turbine engines fitted to rotary and fixed wing military aircraft.

Assessment is to be designed to demonstrate underpinning knowledge across the Unit

Unit 310 Military Aircraft Materials Components and Structural Maintenance

Unit level:	Level 3
GLH:	140
Unit aim:	This unit aims to provide learners with a detailed understanding of military aircraft structures and maintenance practices.
Endorsed by	This unit is endorsed by SEMTA

Learning outcome

The learner will:

1 Understand tools and working practices used on aircraft and in aircraft related work places

Assessment criteria

The learner can:

1.1 explain safe working practices used when working in aircraft-related workplaces
1.2 describe common maintenance hand tools used on aircraft and in the workshop
1.3 describe common maintenance pneumatic power tools used on aircraft and in the workshop
1.4 explain accurate measurement requirements when producing and maintaining aircraft components
1.5 describe the use of non-adjustable gauges
1.6 explain the care and control of tools
1.7 describe the procedure to calibrate tools and to ensure tools are maintained to a satisfactory standard
1.8 explain lubrication practices and methods used on aircraft mechanisms

Range

(AC1.1)
- Relevant safe working practices such as:
  - Aircraft external checks e.g chocks, undercarriage locks
  - Aircraft internal checks e.g AAES, switches, levers (safe, off position)
  - Aircraft Jacking
  - Non Destructive Testing
  - Mechanical Drive Systems
  - Hazards e.g. working at height
  - High pressure gases including Oxygen
  - Liquid gases e.g. Oxygen, Nitrogen

- Pressurised systems e.g. Hydraulic
- Electricity
- Ground Power
- Fuels
- Drilling procedures
- Hand riveting

(AC1.2)
- Hand operated such as:
  - Spanner Types: Size, British Standard, American, Unified, Metric, Ring, Flared Nut
  - Special Spanners e.g. 'C', Peg,
  - Sockets: hexagonal, bi-hexagonal
  - Ratchet handle
  - Speed Brace
  - Step up & down adaptors
  - Drive bars
  - Wrench
  - Hexagonal Keys e.g. allen
  - Screwdriver Types: Bladed, Cruciform (cross point), posidrive
  - Hi-torque drivers
  - Pliers: Side-cutting, flat nosed, round nosed, wire-locking, circlip
  - Hammers
  - Torches

(AC1.3)
- Pistol grip drill
- Offset/angled drills
- Straight drills
- Riveting hammers
- Type specific tools e.g. Cherry pneumatic hydraulic tool

(AC1.4)
- Need/Purpose
- Pre Use checks e.g. Zero Checks, Calibration
- Handling and Storage
- Torque loading

(AC1.5)
- Purpose
- Types

(AC1.6)
- Permanent marking of tools
- Storage
- Tool Tallies including: Master tool tallies, Aircraft tool tallies, Individual tool tallies
- Tool control documentation
- 100% Checks
- Lost tool action

(AC1.7)
- Types of tools subject to calibration/periodic checks
- Test and Measuring Equipment (TME), and other measuring tools
- Responsibilities

(AC1.8)
- Need/Purpose
- Viscosity & Temperature
- Grades
- Cleanliness/contamination
- Handling
- Excessive/insufficient
- Lubricated mechanism methods:

- Pre-packed bearings
- Injection
- Manual application
- Spray
- Surface coating

- Lubrication equipment:
  - Grease gun
  - Oil can
  - Syringe
  - Brush
  - Pressurised can
  - Lubrication Procedure

Learning outcome

The learner will:

2 Understand engineering drawings, diagrams and standards used on aircraft

Assessment criteria

The learner can:

2.1 explain engineering drawings

2.2 describe title block and associated information

2.3 explain how engineering drawings are utilised in aircraft related environments

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Range

(AC2.1)
- Purpose
- Standards organisations e.g. ISO, NAS, ATA, MIL
- Isometric
- Orthographic
- Type of projection (First Angle, Third angle)
- Views
- Line types, symbols and dimensions

(AC2.2)
- Line types
- Symbols
- Dimensions
- Title Block contents
- Scale

(AC2.3)
- Assembly drawing
- Servicing drawing
- Manufacturing drawing

Learning outcome

The learner will:

3 Understand the system of fits and clearances used on aircraft

Assessment criteria

The learner can:

3.1 explain the common system of fits and clearances
3.2 explain tolerance
3.3 Explain the need for drilling accurately
3.4 Explain bow, twist and wear
3.5 Explain standard methods for checking shaft assemblies

Range

(AC3.1)
- British Standard
- ISO
- For aircraft and engines
- Clearance fit, interference fit, transition fit

(AC3.2)
- Definition
- Unilateral
- Bilateral

(AC3.3)
- Consequences
- Pilot holes
- Twist Drill features: shank, Land, Flute, point, point angle
- Twist Drill grade: CS and HSS Drills, Cobalt Drill
- Twist Drill size: Marking, Fraction (inch), Metric, Drill gauge
- Lubrication
- Centre Punch

(AC3.4)
- Distortion: Ovality
  - Bowing

(AC3.5)
- Distortion Check: Dial Test Indicator (DTI), Vee Block, surface table
- Shafts, bearings and other associated parts for e.g.
  - Concentricity/Trueness
  - Wear

Learning outcome

The learner will:

4 Understand the properties of aircraft ferrous and non-ferrous materials

Assessment criteria

The learner can:

4.1 describe the principle properties of materials
4.2 describe how ferrous metals are identified
4.3 describe changes in properties of plain carbon steel during heat treatment and mechanical working processes
4.4 describe methods of testing ferrous metals
4.5 describe how the composition and quality of metals are controlled

4.6 describe how non-ferrous metals are identified

4.7 describe heat treatment processes applicable to non-ferrous materials

4.8 describe methods of testing non-ferrous materials

Range

(AC4.1)
- Mechanical Properties e.g.
- Strength
- Stress
- Strain
- Elasticity
- Ductility
- Malleability
- Toughness
- Hardness
- Brittleness
- Creep
- Fatigue
- Work hardening

Physical properties e.g.
- Density
- Melting point
- Magnetism
- Electrical Conductivity
- Thermal Conductivity
- Colour

Chemical properties e.g.
- Corrosion resistance
- Acids
- Alkali Metals

(AC4.2)
- Grain Structure
- Composition
- Alloying elements: Carbon, Chromium, Nickel, Vanadium

(AC4.3)
- Heat treatment processes:
  - Annealing
  - Normalising
  - Quench hardening
  - Tempering
  - Surface hardening: Carburising, Nitriding, Flame hardening, Induction hardening
- Mechanical working processes:
  - Hot working
  - Cold working

(AC4.4)
- Hardness testing
- Tensile testing
- Impact testing
- Fatigue testing
- Creep testing

(AC4.5)
- British Standards Institutions (BSI)
- Director of Development (DTD)
- Defence Standard (Def Stans)
- Aircraft Specifications (Aerospace series)
- Specification Markings M0
- British Standards Institutions (BSI)
- Wire Gauges e.g. SWG

(AC4.6)
- Aluminium alloying elements e.g.: Copper, Zinc, lithium
- Number & lettering systems

(AC4.7)
- Solution treatment
- Precipitation hardening
- Age hardening

(AC4.8)
- Hardness testing
- Tensile testing
- Impact testing
- Fatigue testing
- Creep testing

Learning outcome

The learner will:

5 Understand corrosion in aircraft materials

Assessment criteria

The learner can:

5.1 describe the chemical fundamentals of corrosion
5.2 describe the contributory factors to corrosion
5.3 describe the types of corrosion and their Identification
5.4 describe corrosion protection design factors
5.5 identify and describe the purpose of corrosion treatments
5.6 identify the products of corrosion
5.7 identify and describe the use and application of visual aids
5.8 describe corrosion removal, assessment and re-protection

Range

(AC5.1)
- Define Corrosion
- Dry Oxidation/direct chemical action
- Electro-chemical/Galvanic

(AC5.2)
- Oxygen
- Moisture
- Contaminates
- Environments

(AC5.3)
- Surface
- Pitting

- Crevice
- Fretting
- Filiform
- Inter-granular
- Exfoliation
- Stress corrosion cracking
- Fatigue

(AC5.4)
- Water and dirt traps
- Flanges
- Sharp changes in profile
- D6rain Holes
- Ribs and Stringers

(AC5.6)
- Ferrous metals
- Metal alloys
- Sacrificial coating
- Excluder coatings

(AC5.7)
- Purpose of Visual examination
- Types e.g. Magnifiers, Microscopes, Endoprobe
- Limitations

(AC5.8)
- Types of Corrosion
- Detecting
- Removing methods e.g. Abrasion, Chemical
- Abrasive equipment
- Safety precautions
- Restoration of protective finish

Learning outcome

The learner will:

6 Understand the properties of advanced, composite and other non-metallic materials

Assessment criteria

The learner can:

6.1 describe ‘advanced’ aircraft materials
6.2 describe the characteristics of aircraft composite materials
6.3 explain the detection of typical defects/deterioration in composite material
6.4 explain repair techniques for composite materials
6.5 describe the characteristics of sealants and bonding agents
6.6 describe the characteristics of non-metallic materials
6.7 describe the characteristics of aircraft Transparencies?

Range

(AC6.1)
- Titanium alloy
- Magnesium alloy
- Super alloys

(AC6.2)
- Properties
- Handling composites
- Identification
- Usage

(AC6.3)
- Cracks
- Scratches
- Gouges
- Twists
- Barely Visible Impact Damage (BVID)
- Delamination
- Moisture ingress
- Burn/lightning strikes

(AC6.4)
- Requirement
- Safety Precautions
- Storage
- Disposal of Waste
- Dry Fibre: Wet layup
- Pre-impregnated
- Fibre orientation

(AC6.5)
- Properties and identification of eg:
  - Sealants
  - Bonding Agents

(AC6.6)
- Properties and identification of eg:
  - Polymers: Thermoplastics, Thermosets, Elastomers

(AC6.7)
- Materials
- Construction techniques
- Common types of damage:
  - Distortion
  - Crazing
  - Scratches
  - Delamination
  - Contamination

Learning outcome

The learner will:

7 Understand airframe structures

Assessment criteria

The learner can:

7.1 describe structural strength requirements for airframes
7.2 describe the varying types of airframe loading
7.3 describe the different classifications of aircraft structure
7.4 identify the location and function of major aircraft assemblies
7.5 describe structural husbandry

Range

(AC7.1)
- Structural integrity
- Strength and stiffness
- Mass
- Mechanical properties e.g. toughness, fatigue resistance
- Aerodynamic shape
- Safety factor
- Aerodynamic loads
- Structural loads e.g. Landing, Localised vertical loads
- Pressurisation loads
- Ground handling loads

(AC7.2)
- Stress
- Strain
- Bending
- Compression
- Torsion
- Tension
- Hoop Stress
- Fatigue

(AC7.3)
- Primary
- Secondary
- Tertiary

(AC7.4)
- Frames: Light, Medium, Heavy
- Ribs
- Stringers
- Spars
- Intercostals
- Longerons
- Bulkheads
- Aircraft Skin: Aerodynamic shaping & Load Bearing
- Struts and Ties

(AC7.5)
- Purpose
- Cleanliness
- Debris removal & prevention
- Surface Finish
- Husbandry Fault Recording

Learning outcome

The learner will:

8 Understand techniques for the assembly and repair of airframe structures

Assessment criteria

The learner can:

8.1 describe the constructional techniques used in aircraft construction

8.2 describe the conventional fastening methods used in aircraft construction

8.3 describe how to locate and identify structural items
8.4 describe the constructional features of major aircraft assemblies
8.5 explain the classification of damage to aircraft materials
8.6 explain visual inspection techniques
8.7 explain Non Destructive Testing

Range

(AC8.1)
- Monocoque
- Semi-Monocoque
- Stressed Skin
- Truss Construction
- Advantages/Disadvantages

(AC8.2)
- Riveting
- Bolts

(AC8.3)
- Aircraft Document Sets
- Frame positions
- Rib Positions
- Datum Points/ C of G position
- Structural Significant Item (SSI)

(AC8.4)
- Mainplane construction
- Fin/Tail plane construction
- Flying Control Surfaces Construction
- Faying surfaces
- Sealing Aircraft Structures
- Bonding Methods
- Integral construction
- Honeycomb construction

(AC8.5)
- Damage Assessment
- Negligible
- Repairable
- Non-repairable
- Primary Damage
- Secondary Damage

(AC8.6)
- Visual Inspection tools and equipment eg:
  - Torch/ Probe Illuminator
  - Mirror
  - Magnifier
  - Remote Viewing Aid
  - Straight Edge/Feeler Gauges
  - Scratch depth dial indicator (DTI)
  - Modelling Clay

(AC8.7)
- Purpose
- Preparation
- Detection Methods e.g.
  - Tap testing

- Ultrasonic
- Penetrant
- Magnetic
- Eddy Current
- Radiography

Learning outcome

The learner will:

9 Understand general purpose aircraft components

Assessment criteria

The learner can:

9.1 explain the nomenclature of screw threads
9.2 explain thread profiles
9.3 explain the specification and identification system for aircraft bolts
9.4 describe nuts, screws, studs, and locking devices used on aircraft
9.5 describe rivet systems
9.6 describe Taper Pins
9.7 explain wire thread inserts
9.8 describe aircraft springs
9.9 describe types of seal used in aircraft applications
9.10 describe types of aircraft bearings

Range

(AC9.1)
- Crest
- Form
- Root
- Thread Angle
- Pitch
- Lead
- Major and minor diameters
- Depth
- Threads per Inch
- Single and multi-start threads
- Right and left hand threads

(AC9.2)
- Vee Threads
- BSF
- BSW
- BA
- ANF
- ANC
- UNF
- UNC
- Metric

- ACME
- Square
- Buttress

(AC9.3)
- Nuts
- Bolts
- Screws
- Studs
- Washers
- ISO: BS, AS, Director of Technical Developments

(AC9.4)
- Threaded fasteners and washers
- Plain nuts
- Thin nuts
- Slotted nuts
- Castellated nuts
- Self-locking nuts
- Bolt and screw heads: External and Internal drive forms
- Tab & Spring washers
- Split pins
- Locking plates
- Circlips
- Cotter pins
- Locking Wire
- Quick Release Fasteners (QRF)

(AC9.5)
- Solid & Blind Rivet Advantages/disadvantages
- Rivet Head types e.g. Snap, Mushroom, Flat, Countersunk
- Rivet identification: Colour and markings, rivet coding, rivet length & diameter
- Heat treatments
- Rivet joint types e.g. single/double chain, Lap, Butt
- Gripping pins
- Riveting tools
- Common riveting faults

(AC9.6)
- Purpose
- Types: Plain, Split, Threaded
- Fitment
- Removal

(AC9.7)
- Purpose
- Wire thread inserts
- Helicoil
- Tools
- Fitment & removal
- Run down torque

(AC9.8)
- Types: Compression, tension, leaf, torsion
- Materials
- Applications
- Common reasons for failure

(AC9.9)
- Types e.g. ‘O’ ring, Labyrinth

- Applications e.g. oil seals, pipe seals

(AC9.10)
- Purpose
- Types and their applications
- Bearing load characteristics
- Bearing faults and failures
- Bushes

Learning outcome

The learner will:

10 Understand the maintenance procedures for the safe and effective operation of aircraft

Assessment criteria

The learner can:

10.1 describe mechanical control and operating systems
10.2 describe the construction and operation of manual flying control system
10.3 explain the maintenance of manual flying control system
10.4 describe airframe symmetry and alignment checks
10.5 explain fastener replacement
10.6 explain the procedures for removing damaged studs, bolts, screws
10.7 explain how to ream holes
10.8 explain screw thread manufacture and repair
10.9 describe jacking and trestling
10.10 explain how to undertake hydraulic flushing and sampling
10.11 describe fault diagnosis techniques and aides

Range

(AC10.1)
- Requirement/application
- Construction, operation and maintenance of typical systems e.g.
  - Shaft drive system
  - Screw Jack
  - Geared drive
  - Bowden Cable

(AC10.2)
- Cable operated
- Cable construction e.g. SWG, CWT, Bowden
- Tie rods
- Tension, Backlash, thermal expansion
- Turnbuckles
- Tensiometer
- Faults e.g. kinks, fraying, corrosion, wear
- Push-pull rod operated
- Bell Crank
- Material
- Fittings e.g. fork end, eye end
- Idle lever

- Torque tubes
- Faults e.g. corrosion, wear, bowing
- Purpose

(AC10.3)
- Range of Movement
- Adjustments/limits
- Testing
- Independents

(AC10.4)
- Purpose
- Symmetry & Rigging
- Angular & Linear Measurement
- Clinometer
- Positioning (Longitudinal and Horizontal axis)
- Datum Points
- Recording & reporting action post checks
- Rivet formation

(AC10.5)
- Rivet formation errors
- Insertion and setting tools
- Blind rivets
- Fasteners e.g. Quick release, Hi-Loc, Visu- Loc
- Broken/damaged fasteners
- Removal tools

(AC10.6)
- Damaged heads
- Broken above surface
- Broken flush with or below surface

(AC10.7)
- Requirement
- Parallel Reamer
- Tapered Reamer
- Expanding Reamer

(AC10.8)
- Limitations
- Tooling e.g. Taps and Dies
- Method:
  - Internal screw thread
  - External screw thread

(AC10.9)
- Purpose
- Jacking operation safety precautions
- Aircraft jack types e.g. Pillar jack, Tripod jack, Quadruped Jack
- Aircraft jack components:
  - Reservoir
  - Pump
  - Valves: Release, Pressure release, Breather
  - Locking Collar
  - Adjustable Legs/feet
  - Safe Working Load (SWL)
- Jacking operations: Incremental lift, Vertical Lift, Arc Lift
- Stress Jacking
- Jacking and trestle positioning symbols

(AC10.10)
- Replenishment points

- Flushing:
  - Need
  - Equipment
  - Components
  - Procedure
- Sampling:
  - Routine
  - Unscheduled
  - Procedure

(AC10.11)
- Automated Test Equipment (ATE)
- Built in Test Equipment (BITE)
- Proceduralisation
- Decision Tree
- Diagnostic procedural analysis

Unit 310 Military Aircraft Materials Components and Structural Maintenance

Supporting Information

Unit guidance

This unit has been produced to meet military aviation training requirements.

On completion of this unit the learner will be able to show a comprehensive knowledge of the aircraft materials, components and structures, relating to the servicing of military aircraft.

Assessment is to be designed to demonstrate underpinning knowledge across the unit

Unit 311 Understanding Military Aircraft Electrical and Avionic Fundamentals

Unit level:	Level 3
GLH:	60
Unit aim:	This unit aims to give the learner an understanding of the electrical and avionic systems knowledge in a military aviation context to allow further study of aircraft maintenance practices for the maintenance fitter (mechanic).
Endorsed by	SEMTA

Learning outcome

The learner will:

1 Understand basic electrical theory

Assessment criteria

The learner can:

1.1 understand basic electrical terms and identify relevant symbols
1.2 explain Alternating and Direct current
1.3 describe the construction and operation of AC and DC motors and generators
1.4 describe the theory of Resistance
1.5 explain capacitors and capacitance
1.6 describe Transducers
1.7 understand servomechanisms and servo motors

Range

(AC1.1)

- Electrical Terms:
  - Coulomb
  - Charge
  - Current
  - Resistance
  - Potential Difference
  - Electromotive force
  - Electrical power
  - Conductors and insulators
- Electrical symbols:
  - Resistor, Capacitor
  - Ammeter, voltmeter, motor
  - Inductor, transformer

- Switch
- Lamp
- Ground
- DC Voltage source

(AC1.2)
- Free electron flow
- Ohms Law
- Resistors: Series, Parallel

(AC1.3)
- Direct current:
  - Electron flow
- Alternating current:
  - Electron flow
  - Voltage polarity

(AC1.4)
- Definition
- Uses
- Construction
- Electric field
- Capacitor safety

(AC1.5)
- Aircraft DC Generators
- DC Motors
- AC Generators
- AC Motors: Synchronous, Induction

(AC1.6)
- Definition
- Uses

(AC1.7)
- Purpose
- Components
- Operation
- Control systems
- Open Loop
- Closed Loop
- Uses

Learning outcome

The learner will:

2 Understand Electrical Wiring Interconnection Systems (EWIS)

Assessment criteria

The learner can:

2.1 explain aircraft bonding and earthing
2.2 identify causes of aircraft wiring stressors
2.3 identify type & characteristics of aircraft wire and cables
2.4 describe EWIS components, standards and husbandry

Range

(AC2.1)
- Requirement/static electricity

- Earth Systems
- Earth Points
- Bonding

(AC2.2)
- Typical causes e.g.:
  - Handling, Bending, securing
  - Chafing, vibration
  - During removal and installation operations
  - Lightning strike
  - Climate
  - Contamination
- Avoidance

(AC2.3)
- Type of aircraft wire and cables:
  - As used in aerospace applications eg: Co-axial, Data-bus, Fibre -Optic
  - Manufacturers Markings
  - System and circuit markings
- Characteristics of aircraft wire and cables eg:
  - Problems associated with Polymide products

(AC2.4)
- Purpose
- Relevance of correct maintenance
- Cable damage:
  - Precautions
  - Assessment
  - Recognising/identifying
  - Causes
  - Repair criteria
- Cleaning
- Wire and cable storage, handling and examination
- Capping and stowage of electrical connectors
- Support eg: Lacing, cable ties, P Clips, Heat shrink, woven and spiral wrap
- Inspection of circuit breaker (thermal)

Learning outcome

The learner will:

3 Understand aircraft avionic and electrical systems

Assessment criteria

The learner can:

3.1 describe aircraft avionic systems interaction

3.2 describe aircraft power provision and distribution

3.3 understand mechanical trade interaction with avionic systems

---

Range

(AC3.1)
- Basic architecture
- Voting
- Redundancy
- Mechanical systems

- Weapons systems

(AC3.2) Requirements

- AC and DC power generation:
  - AC & DC usage
  - Aircraft batteries
  - Ground power units (GPU)
  - Auxiliary Power Units (APU)
  - Bus bar utilisation
- Distribution and power switching Inc. electrical failure
- Hazards associated with the application of power to aircraft

(AC3.3)

- Sensors
- Lighting
- Navigational aids
- Communication
- Automatic flight control systems (AFCS)
- Cockpit/flight deck controls, interfaces and display configurations

---

Learning outcome

The learner will:

4 Know the principles of aircraft information transfer

Assessment criteria

The learner can:

4.1 define the characteristics of numbering systems used by aircraft systems

4.2 explain how aircraft communicate, control monitor and display the status of Mechanical trade systems

4.3 explain how mechanical system airworthiness data is captured and exploited

---

Range

(AC4.1)

- Requirement
- Decimal
- Binary
- Hexadecimal

(AC4.2)

- Information transfer:
  - Digital
  - Analogue
  - Databus including advantages
- Mechanical systems e.g.
  - Flying control
  - Undercarriage
  - Propulsion
  - Environmental Control Systems (ECS)

(AC4.3)

- Purpose
- On-board Maintenance System (OBMS)
- Health monitoring

- Data acquisition and Recording systems
- Advisory, caution and warning systems

Unit 311 Understanding Military Aircraft Electrical and Avionic Fundamentals

Supporting Information

Unit guidance

This unit has been produced to meet military aviation training requirements.

On completion of this unit the learner will be able to show a broad understanding in the knowledge of aircraft electrical and avionic principles in relation to the servicing of military aircraft.

Assessment is to be designed to demonstrate underpinning knowledge across the Unit.

Unit 312 Maintaining Military Aircraft Mechanical Systems

Unit level:	Level 3
GLH:	110
Unit aim:	This unit aims to provide learners with a detailed understanding of military aircraft mechanical systems for technicians of the mechanical trade.
Endorsed by	SEMTA

Learning outcome

The learner will:

1 Understand Aircraft Hydraulic Power supply system and its components

Assessment criteria

The learner can:

1.1 explain hydraulic actuation
1.2 describe a basic hydraulic system
1.3 describe hydraulic reservoirs
1.4 describe hydraulic pumps
1.5 describe hydraulic system accumulators
1.6 explain typical hydraulic valves
1.7 describe hydraulic filters
1.8 describe supply system indications and warnings
1.9 describe typical hydraulic redundancy

Range

(AC1.1)
- Principles
- Advantages

(AC1.2)
- Components
- Actuator/jack
- Reservoir
- Pump
- Valves

(AC1.3)
- Purpose
- Pressurised
- Non-pressurised
- Reservoir components

(AC1.4)
- Purpose
- Pump types:
  - Constant Displacement
  - Self-regulating
  - Hand pumps

(AC1.5)
- Purpose
- Operation
- Maintenance

(AC1.6)
- Non-return valves (NRV)
- Pressure control valves: Relief, Release, ACOV
- Priority valves

(AC1.7)
- Purpose
- Operation
- Filter bypass valve

(AC1.8)
- Pressure switch
- Pressure Transducer
- Temperature warning system: Switch, transducer
- Cockpit Indication e.g. gauges, warning panel
- Skin gauges e.g. accumulator pressure gauge

(AC1.9)
- Purpose
- Ram Air Turbine
- Electro Hydraulic Pump
- Power Transfer Unit
- Auxiliary Power Units e.g. APU, AAPU
- Hydraulic Power Pack System

Learning outcome

The learner will:

2 Understand hydraulic fluid distribution and operating circuits

Assessment criteria

The learner can:

2.1 describe the characteristics of hydraulic fluid
2.2 describe the materials used in hydraulic pipe manufacture
2.3 explain how to install hydraulic fluid lines
2.4 describe hydraulic seals
2.5 explain why certain hydraulic operating circuits require sequenced/synchronised operation
2.6 describe a typical sequenced circuit and its components
2.7 describe a typical synchronised circuit and its components

---

Range

(AC2.1)
- Properties: Viscosity, Stability, Flash point
- Types: Mineral, Synthetic

- Contamination

(AC2.2)
- Rigid Fluid lines
- Aluminium Alloy Tubing
- Steel
- Titanium
- Flexible hose fluid lines
- Hydraulic pipe identification
- Fluid end Fittings:
  - Flared
  - Flareless

(AC2.3)
- Rigid tubing
- Flexible hose assemblies

(AC2.4)
- Seals e.g. Dynamic Seals, Bonded Seals, Duplex, O ring
- V-Ring packings
- U Ring
- Back up rings
- Gaskets
- Wipers
- Materials
- Need

(AC2.5)
- Typical operating circuits eg:
  - Undercarriage
  - Ramps and doors
  - Refuel probe
  - Blade Folding
  - Airbrakes
  - Flaps

(AC2.6)
- Typical sequenced operating circuit eg:
  - Undercarriage
- Typical synchronised operating circuit eg: Airbrake

(AC2.7)
- Flow Divider, 2 way restrictor, blow back valves

Learning outcome

The learner will:

3 Understand the operation of hydraulic Flight Control Systems

Assessment criteria

The learner can:

3.1 describe the basic requirements of powered flying control systems

3.2 describe the stages of Hydraulic Control Power Augmentation

3.3 describe the operation of a powered flying control unit

3.4 describe additional control inputs

3.5 explain the way in which automatic flight control is achieved in a manually articulated flight control system

3.6 describe methods of power failure provision

3.7 describe fly by wire/fly by light control systems

3.8 describe the types of aircraft abnormal flying characteristics

Range

(AC3.1)
- Performance
- Feedback
- Accuracy
- Stability
- Irreversibility: Off-loading aerodynamic forces
- Safety & reliability
- Need
- Hydro-Mechanical

(AC3.2)
- Power Assisted control
- Fully powered control
- Application

(AC3.3)
- Powered Flying Control Unit
- Fixed Ram Moving Body
- Fixed Body moving Ram

(AC3.4)
- Artificial Feel devices:
  - Purpose
  - Spring Feel
  - Q' Feel
- Trim adjustment

(AC3.5)
- Need
- Auto stabilisation operation

(AC3.6)
- Manual
- Multiplication:
  - Parallel
  - Tandem

(AC3.7)
- Principles
- Operation
- Advantages

(AC3.8)
- Un-commanded Flying Control Movements (UFCM)
- Control Restriction

Learning outcome

The learner will:

4 Understand aircraft undercarriage, retraction and aircraft steering systems

Assessment criteria

The learner can:

4.1 describe aircraft landing gear

4.2 explain the operation of a shock absorber

4.3 describe undercarriage retraction systems

4.4 explain the operation of a typical undercarriage retraction system

4.5 describe undercarriage emergency extension systems

4.6 describe aircraft landing gear safety devices

4.7 describe landing gear inspection, rigging and adjustment

4.8 describe how to carry out undercarriage functional tests

4.9 describe aircraft steering systems

4.10 describe the operation and components of a typical mechanical/hydraulic aircraft nose wheel steering systems

4.11 describe the operation and components of a typical electro/hydraulic aircraft nose wheel steering systems

4.12 explain the operation of nose wheel centering

Range

(AC4.1)
- Configuration:
  - Tail wheel
  - Bicycle
  - Tricycle
  - Wheel arrangements

(AC4.2)
- Purpose
- Ole-pneumatic
- With/without Separator
- Shock absorber states: Airborne, Landing, Recoil, Static

(AC4.3)
- Need
- Requirements
- Components:
  - Side-stays
  - Drag struts
  - Mechanical Locks
  - Geometric locks
  - Indication
  - Sensors
  - Micro-switches

(AC4.4)
- Sequencing
- Aircraft braking

(AC4.5)
- Secondary/independent hydraulic system
- Mechanical cranking
- Free fall
- Blow down

(AC4.6)
- Throttle warning
- Weight on wheels
- Airspeed switch
- Emergency override
- Ground locks

(AC4.7)
- Requirement
- Latches
- Door clearances
- Components to be inspected
- Lubrication
- Shock absorber replenishment

(AC4.8)
- Retraction Test

(AC4.9)
- Purpose
- Types

(AC4.10)
- Typical Mechanical/hydraulic e.g.
  - Steering Jack/motor
  - Servo valve
  - Selector valve
  - Linkages: Input, feedback

(AC4.11)
- Typical electro/hydraulic e.g.
  - Selector valve
  - Command transducer/potentiometer
  - Shimmy damping/centring
  - Weight on wheels
  - Hi-Lo ratio

(AC4.12)
- Purpose
- On retraction
- On failure
- Deselecting
- Failsafe devices

Learning outcome

The learner will:

5 Understand aircraft wheels and braking systems

Assessment criteria

The learner can:

5.1 explain the purpose and construction of aircraft wheels
5.2 explain aircraft wheel installation
5.3 describe aircraft braking systems
5.4 explain servo assisted brake systems
5.5 describe the types and construction of aircraft brake units
5.6 explain the operation aircraft anti-skid systems
5.7 describe aircraft auxiliary braking

Range

(AC5.1)
- Requirement
- Brake half hub
- Valve half hub
- Wheel Bearings

(AC5.2)
- Inspection
- Correct installation: End Float

(AC5.3)
- Purpose
- Operation
- Brake fade
- Types:

- Normal
- Emergency
- Parking

(AC5.4)
- Purpose
- Components e.g. Foot motors, Hydraulic circuit, accumulators, indication, control and relief valves
- Types of braking: Progressive, Simultaneous, Differential
- System protection

(AC5.5)
- Calliper disk
- Multiple disc
- Torque plate
- Torque tube
- Pistons
- Pressure plate
- Rotor and Stator assemblies
- Thrust ring
- Wear: Indication and compensation
- Carbon brakes

(AC5.6)
- Requirement
- Operation
- Wheel speed sensors
- Control units
- Control valves
- Fail safe
- Touchdown and lock wheel protection
- Auto brake

(AC5.7)
- Types
- Aerodynamic:
  - Flying control configuration
  - Reverse thrust
  - Reverse pitch
  - Brake Chute
- Emergency:
  - Arrestor hook/Rotary Hydraulic Arrestor Gear (RHAG)
  - Crash barrier
  - Safety Precautions

Learning outcome

The learner will:

6 Understand aircraft fuel systems

Assessment criteria

The learner can:

6.1 explain the requirements of an aircraft fuel system

6.2 explain fuel storage systems utilised by aircraft

6.3 describe the typical removal and installation procedure for an aircraft flexible fuel tank

6.4 explain the operation of fuel supply sub-system components

6.5 explain aircraft fuel transfer
6.6 explain the purpose and operation of fuel tank pressurisation and venting
6.7 explain aircraft fuel management systems
6.8 describe a typical aircraft flight refuelling system
6.9 explain the purpose and operation of a typical aircraft fuel contents gauging system

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Range

(AC6.1)
- Purpose
- Aircraft Centre of Gravity
- Safe
- Fuel Sub systems e.g.: storage, supply, transfer, pressure and vent, contents and gauging

(AC6.2)
- Purpose
- Internal tanks:
  - Rigid
  - Flexible
  - integral
- External tanks:
  - Jettisonable
  - fixed
- Fuel tank construction and materials
- Grouping
- Leak categorisation and path analysis
- Fuel tank defects

(AC6.3)
- Fuel tank maintenance safety precautions
- Preparation: defuel, drain, documentation, restricted access
- Removal: de-panel, detect gases, residual liquid, fixings, handling and storage, cavity checks
- Installation: Pre-installation checks, fixings, post installation checks

(AC6.4)
- Purpose
- Location
- Booster pump
- Pressure switch
- Non-return valve (NRV)
- Firewall shut-off valve (FWSOV)
- Filters
- Cross-feed
- Negative G devices
- Oil coolers e.g. (Fuel Cooled Oil Cooler)
- Fuel cooler e.g. (Air Cooled Fuel Cooler or jet pump)
- Temperature sensor

(AC6.5)
- Purpose
- Methods
- CofG balancing
- Fuel level sense and control
- Pipeline couplings:

    - Types
    - Bonding
    - Assembly and locking

(AC6.6)
- Requirement
- Pressurised tanks
- Unpressurised tanks
- Ascent and descent
- Components:
    - Non-return valves (NRV)
    - Pressure reducing valves
    - Inward relief valve
    - Vent valve
    - Switches
    - Other valves e.g. Air/no fuel, fuel/ no air
    - Inert tank pressurisation

(AC6.7)
- Purpose
- Methods:
    - Automatic
    - Manual
- Fuel flow proportioners
- Cockpit indications
- Fuel dump
- Low level fuel warning

(AC6.8)
- Purpose
- Methods
- Flight refuel probe
- Fuselage mounted hose drum unit
- Flight refuel pod
- Flight refuel drogue
- Breakaway (e.g. nozzle body riveted joint)
- Routine maintenance

(AC6.9)
- Gauge types: Analogue, Digital
- Gauging unit
- Compensator
- Densitometers (or Cadensicons)
- Reed switches and Magnetic Indicators
- Thermistor
- Manual methods of checking fuel contents
- Fuel Flow Transmitter (meter)
- Gauging/discrepancy checks

Learning outcome

The learner will:

7 Understand aircraft oxygen storage and delivery

Assessment criteria

The learner can:

7.1 describe oxygen storage and generation on aircraft
7.2 describe the operation of an oxygen pressure regulator
7.3 describe a typical layout of a gaseous oxygen system
7.4 explain the operation of a stabilised liquid oxygen (LOX) system
7.5 explain the operation of an aircraft Molecular Sieve Generation system
7.6 describe the operation of passenger oxygen systems
7.7 identify oxygen hoses, pipes and connectors

Range

(AC7.1)
- Gaseous Oxygen system
- Liquid Oxygen system (LOX)
- On-board Oxygen Generating system (OBOGS)
- Chemical

(AC7.2)
- Purpose
- Automatic functions e.g. Air mix, safety pressure, pressure breathing
- Pressure demand systems
- Regulator features e.g. Electro-magnetic flow indicator (dolls eye), pressure gauge, supply, shutter and emergency switches, inflation adaptor

(AC7.3)
- Storage cylinders
- Typical valves e.g. cylinder, charging, pressure reducing, non – return (check),
- Contents gauge
- Filters
- Low and high pressure pipelines
- Regulator

(AC7.4)
- Typical LOX system:
  - Fill, build up, vent and relief valve (FBVR)
  - Stabilising container
  - Automatic change over valve (ACOV)
  - Heat exchanger
  - Lox container including contents gauge and bursting disc
  - Differential check valves
  - Pressure raising coil
  - Temperature raising coil
- Valve-less system:
  - LOX package units

(AC7.5)
- Advantages
- Components e.g. filters, concentrator, valves, monitors

(AC7.6)
- Purpose
- Components e.g. pressure reducing valve, pressure closing valve, control panel, ring main

(AC7.7)
- Purpose
- Personal Equipment Connectors (PEC)
- Oxygen pipelines: High pressure, low pressure
- Hoses: Low pressure, anti-kink

- Identification labelling e.g. NATO

Learning outcome

The learner will:

8 Understand aircraft air conditioning and pressurisation systems

Assessment criteria

The learner can:

8.1 describe methods of supplying air for aircraft air conditioning systems
8.2 explain the operation of a typical aircraft air conditioning system
8.3 explain the operation of a typical aircraft pressurisation system
8.4 describe a simple bleed air distribution system

Range

(AC8.1)
- Engine bleed air
- APU
- ECU driven compressor
- External ground source

(AC8.2)
- Purpose
- Air cooling systems e.g. Primary and secondary heat exchangers, cold air unit
- Water extraction
- Ram and bleed Air
- Valves e.g. Temperature control, regulating/shut off, NRV

(AC8.3)
- Purpose
- Cabin pressure control
- Cabin air distribution

(AC8.4)
- Purpose
- Operation (Modes)
- Components e.g. ducting, valves, regulators
- V flange couplings
- Sealing requirements:
  - Metal joints e.g. rolled sheet and solid
  - Clamping devices e.g. Rigid, Segmented band (V band)
- Flange and clamp Faults
- Torque loading

Learning outcome

The learner will:

9 Understand aircraft protection systems (Fire, Ice, Rain)

Assessment criteria

The learner can:

9.1 describe aircraft fire protection systems

9.2 describe fire warnings on aircraft

9.3 explain the principle of operation of fire extinguisher and flame suppression systems

9.4 explain the principle of operation of crash switches

9.5 describe the purpose and operation of aircraft ice protection systems

9.6 describe aircraft windshield rain protection

Range

(AC9.1)
- Purpose
- Fire zones
- Fire detection
- Smoke detectors

(AC9.2)
- Attention Getters
- Centralised Warning Panel (CWP)
- Audible alerts
- Fire button illumination

(AC9.3)
- Purpose
- Fire Button
- Indicator fuses
- Extinguishers
- Single/dual head operation
- Pressure relief indicators e.g. Bursting disc
- Inert Gas
- Explosive suppressants

(AC9.4)
- Purpose
- Manual Crash switches
- Inertia Crash switches

(AC9.5)
- Areas sensitive to ice formation
- Icing effects
- Ice detection
- Ice protection

(AC9.6)
- Rain control systems e.g. wipers, repellent, pneumatic

Unit 312 Maintaining Military Aircraft Mechanical Systems

Supporting Information

Unit guidance

This unit has been produced to meet military aviation training requirements.
On completion of this unit the learner will be able to show a comprehensive knowledge of military mechanical systems relating to the servicing of military aircraft.

Assessment is to be designed to demonstrate underpinning knowledge across the Unit.

Unit 313 Armament Trade Electrical Principles

Unit level:	Level 3
GLH:	80
Unit aim:	This unit aims to give the learner knowledge of electrical principles in a military armourer context to allow further study of aircraft maintenance practices.
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS
Endorsed by	This unit is endorsed by SEMTA.

Learning outcome

The learner will:

1 Know basic electrical theory

Assessment criteria

The learner can:

1.1 understand basic electrical terms
1.2 understand basic AC and DC theory
1.3 describe Capacitance, Inductance and Reactance
1.4 describe the theory of resistors, resistance and relays
1.5 describe the construction and operation of motors and generators

Range

(AC1.1)
- Electron theory
- Conductors and insulators
- Resistance, Resistors
- Ohm's Law
- Potential Difference
- Reactance
- Temperature Co-efficient of Resistance
- Energy and Power
- Static electricity
- Electrical circuit symbols

(AC1.2)
- Direct Current theory and principles
- Alternating Current theory and principles

(AC1.3)
- Free electrons
- Series
- Parallel
- Relays
  - Purpose
  - Operation

(AC1.4)
- Capacitance:
  - Units
  - Characteristics
  - Construction
  - Associated hazards
- Induction:
  - Magnetism as a source of Electricity
- Reactance

(AC1.5)
- Basic Motor and Generator theory
- AC Generators:
  - Construction
  - Principle of operation
  - Characteristics
  - Waveforms produced
- AC Motors:
  - Types
  - Construction
  - Principles of rotating magnetic field
  - Characteristics
  - Speed control
  - rotational direction

Learning outcome

The learner will:

2 Understand the basic principles of binary and hexadecimal number systems

Assessment criteria

The learner can:

2.1 explain binary and hexadecimal number systems

2.2 explain digital fundamentals in relation to aircraft armament systems

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Range

(AC2.1)
- Signal categories
- Binary
- Hexadecimal
- Use in aircraft:
  - Data transmission
  - Fault codes
  - Software

(AC2.2)
- Principles of digital systems
- Uses in aircraft
- Principles of data bus systems
  - Unidirectional
  - Bidirectional
  - Serial
- Test techniques

Learning outcome

The learner will:

3 Understand Aircraft Electrical Wiring Interconnection Systems (EWIS)

Assessment criteria

The learner can:

3.1 explain the need for aircraft electrical wiring
3.2 know the constitute parts included under the term EWIS
3.3 explain correct cable identification
3.4 explain wire and cable husbandry
3.5 describe cadmium corrosion on aircraft cables
3.6 explain the typical termination techniques utilised on aircraft electrical wiring
3.7 describe soldering in an aircraft environment
3.8 explain aircraft electrical bonding

Range

(AC3.1)
- evolution of EWIS
- explain EWIS publications
- wiring husbandry coordinator role

(AC3.2)
- EWIS definition
  - Conductors
  - Insulators
  - Connectors

(AC3.3)
- Cable by type
- Cable connections by type
- Cable terminations by type
- Cable markings
  - Manufacturer
  - System and circuit

(AC3.4)
- Storage
- Handling
- Inspection
- Connectors and terminations
  - Capping
  - Stowage
- Cleaning
  - Contamination e.g. dry, fluid

- Cable support e.g.
  - Lacing
  - Cable ties
  - Wrap
- Erosion prevention e.g.
  - Routing
  - P clips
  - Heat shrink
  - Loops e.g. drip, service

(AC3.5)
- Cadmium plating
- Environmental factors
- Appearance
- hazards

(AC3.6)
- Precision terminations
  - Policy
  - Standards
  - Publications
  - Tooling
  - Purpose
  - Need
  - Advantages/disadvantages
  - PTT servicing requirements
  - Types of termination (connector)

(AC3.7)
- Soldering
  - Health & safety
  - Preparation
  - Utilisation
  - Solderable materials
  - Joint types e.g. hook, bucket
  - Soldering equipment
  - Types of solder
  - Defects

(AC3.8)
- Requirement
- Electrostatic charges (Static electricity)
- Aircraft skin
- Earth points

Learning outcome

The learner will:

4 Know the principles of testing and fault finding on aircraft armament systems

Assessment criteria

The learner can:

4.1 Explain aircraft armament related systems

4.2 Describe the principles and basic methods of circuit testing

4.3 Explain basic fault finding techniques

4.4 Describe the management of Test & Measuring equipment (TME)

4.5 Describe the function and use of typical, in use, trade specific TME

Range

(AC4.1)
- Automatic Navigation and Aiming Complex (ANAC)
- Armament Control System (ACS)
- Aircraft Armament Electrical Installation (AAEI)
- Function
- Testing
- Weapon system control e.g. Stores Management System (SMS)

(AC4.2)
- types and function of typical equipment
- Safety precautions
- Pre-use inspection
- Safety precautions

(AC4.3)
- Power on/ off
- Short circuits
- Open circuits
- Half split technique
- Continuity testing
- Correct equipment

(AC4.4)
- TME Handbook
- Categories of TME
- Typical management organisation
- Storage and handling
- Maintenance
- Calibration
- Training
- Paperwork

(AC4.5)
- Typical in-use TME: e.g.
  - Digital multi-meter
  - Safety ohmmeter
  - Insulation tester
- Function
- Pre and post use inspection
- Hazards associated with use
- Safety precautions to be observed
- Actions to be taken if unserviceable

Unit 314 Maintaining Aircraft Weapons Systems

Unit level:	Level 3
GLH:	100
Unit aim:	This unit aims to give the learner the knowledge of the aircraft weapons and associated equipment in a military armourer context to allow further study of aircraft maintenance practices.
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS
Endorsed by	This unit is endorsed by SEMTA.

Learning outcome

The learner will:

1 Understand the maintenance of missiles

Assessment criteria

The learner can:

1.1 describe the maintenance of typical, in-use air-to-air missile systems

1.2 describe the maintenance of typical, in-use air-to-ground missile systems

Range

(AC1.1)
- Definition
- Normal operation
- Component parts
- Identifying features and markings
- Potential hazards of inadvertent operations
- Permitted damage limits
- Maintenance tasks permitted
- Current, relevant DAPs
- Current, relevant documentation

(AC1.2)
- Definition
- Normal operation
- Component parts
- Identifying features and markings
- Potential hazards of inadvertent operations
- Telemetry system
- Container system
- Specific test equipment

- Handling and moving requirements
- Security classifications
- Maintenance tasks permitted
- Lifing details
- Current, relevant DAPs
- Current, relevant documentation

Learning outcome

The learner will:

2 Understand the maintenance of missile launchers

Assessment criteria

The learner can:

2.1 explain the orders and instructions applicable to, and the requirement for Aircraft Armament Suspension Equipment (AASE)

2.2 describe the construction, operation and maintenance of a typical, in-service, standard air-to-air missile launcher

2.3 describe the construction, operation and maintenance of a typical, in-service, counter measure inclusive, air-to-air missile launcher

2.4 describe the construction and operation of a typical, in-service, air-to-ground missile launcher

2.5 explain the processes involved in AASE hang-up investigations

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Range

(AC2.1)
- definition
- categories
- purpose
- security aspects
- scheduled maintenance periodicities
- limitations of on-aircraft corrective maintenance
- storage
- typical, in-service, AASE
- AASE support equipment
- hazards
- Relevant, in-use, publications

(AC2.2)
- hazards
- major assemblies and their function, e.g.:
  - housing assembly
  - gas receiver assembly
  - mechanism assembly
  - power supply
- sequence of operation
- scheduled maintenance
- current, in-use, publications

- specialist maintenance equipment
- relevant, in-use documentation

(AC2.3)
- hazards
- component parts and their function
- sequence of operation
- scheduled maintenance
- current, in-use, publications
- specialist maintenance equipment
- relevant, in-use documentation

(AC2.4)
- hazards
- component parts and their function
- basic operation
- current, in-use, publications

(AC2.5)
- hazards
- safety precautions
- types of failure
- responsibilities
- current, in-use, publications
- relevant, in-use documentation

Learning outcome

The learner will:

3 Understand the maintenance procedures associated with armament release equipment

Assessment criteria

The learner can:

3.1 explain the orders and instructions applicable to, and the requirement for Ejection Release Unit (ERU)

3.2 describe the construction, operation and maintenance of a typical, in-service, Heavy Duty ERU

3.3 describe the construction and operation of a typical, in-service, Light Duty ERU.

Range

(AC3.1)
- Definition
- Categories
- Purpose
- Security aspects
- Scheduled maintenance
- Limitations of on-aircraft corrective maintenance
- Storage
- Typical, in-service, ERUs
- Associated terms, e.g.:
  - Positive cocking
  - Physical safety devices
  - Crutching
  - Explosively operated
  - Micro switch indications
- Hazards and associated safety precautions

- Relevant, in-use, publications

(AC3.2)
- Hazards, eg:
  - lethal voltages
  - explosive cartridges
  - cadmium
  - oils and lubricants
- Component parts and their function
- Basic operation
- Current, in-use, publications
- Specialist maintenance equipment
- Relevant, in-use documentation

(AC3.3)
- Hazards, eg:
  - lethal voltages
  - explosive cartridges
  - cadmium
  - beryllium-oxide
- Component parts and their function
- Basic operation
- Current, in-use, publications
- Relevant, in-use documentation

Learning outcome

The learner will:

4 Understand the types of aircraft explosive munitions used by military aircraft and how they operate.

Assessment criteria

The learner can:

4.1 describe the identification, handling and maintenance of typical, in service, unguided bombs

4.2 describe the identification, handling and maintenance of typical, in service, precision attack bombs

4.3 describe the identification, handling and maintenance of a typical, in service, bomb fuze

Range

(AC4.1)
- safety precautions
- definitions
- identification
- component parts
- features
- storage
- lines, depth and frequency of maintenance
- current, in-use, publications
- relevant, in-use documentation

(AC4.2)
- safety aspects
- makeup
- component parts

- operation
- lines, depth and frequency of maintenance
- current, in-use, publications

(AC4.3)
- safety precautions
- identification
- component parts
- features
- lifing and storage
- lines, depth and frequency of maintenance
- current, in-use, publications

Learning outcome

The learner will:

5 Know the principles of on aircraft ordinance

Assessment criteria

The learner can:

5.1 describe aircraft chaff and flare countermeasures

5.2 explain the maintenance tasks associated with aircraft flares and their magazines

5.3 describe the maintenance of Electro Explosive Devices (EEDs)

Range

(AC5.1)
- Safety precautions
- Potential hazards
- Transportation
- Actions in dealing with a misfire
- Chaff Cartridges
- Squibs
- Flares
  - Types
  - Identifying features
  - Normal operation
  - Component parts

(AC5.2)
- Safe working practices
- Hazards
- Permitted checks
- Lifing details
- Relevant Work recording
- Inspect/ examine
- Prepare and load
- Unload
- Purpose

(AC5.3)
- Current, in-use Emergency Operated Fire Extinguishers (EOFE)
  - Potential hazards
  - Appropriate safety precautions
  - Identification
  - Normal operation

- Current, in-use, publications
- Relevant documentation

Unit 315 Explosive Storage and Handling

Unit level:	Level 3
GLH:	85
Unit aim:	This unit aims to give the learner the knowledge of the storage and handling of explosives, weapon components along with the appropriate regulatory and mandatory processes in a military armourer context to allow further study of aircraft maintenance practices.
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS
Endorsed by	This unit is endorsed by SEMTA.

Learning outcome

The learner will:

1 Know the common properties of current, in-service explosives

Assessment criteria

The learner can:

1.1 describe the history and development of explosives
1.2 explain explosive terminology
1.3 explain the basic chemistry of explosives and relate it to Weapons, Ordinance Munitions and Explosive (WOME)
1.4 describe the toxicological hazards associated with explosives
1.5 explain the purpose of common, in use, explosive components

Range

(AC1.1)

- Early explosives, eg:
  - Gun powder
  - Nitro-glycerine
  - Dynamite
- Commercial explosives
- Military explosives, eg:
  - TNT
  - RDX
  - Shaped charges
- Primary explosives`
- Manufacturing techniques

- Development of UK legislation

(AC1.2)
- Explosion
- Primary high explosives
- Secondary high explosives
- Propellants
- Pyrotechnics
- Deflagration
- Detonation
- Stability
- Explosive train

(AC1.3)
- Elements
- Compounds
- Change in state
- Explosions eg: Physical, Chemical, Atomic
- Release of energy
    - Blast wave
    - Radiation
        - Thermal
        - Ionising
- Propagation of detonation shock wave

(AC1.4)
- Exudation
- Extrusion
- Explosive
- Flammable
- Toxic
- Safety precautions
- Protective measures

(AC1.5)

Offensive, eg:
- Bombs
- Missiles

- Defensive, eg:
    - Cartridge counter measures
- Constructive, eg:
    - Aircraft Assisted Escape Systems (AAES)
    - Power cartridges

Learning outcome

The learner will:

2 Understand the fundamental principles of Explosive Regulations

Assessment criteria

The learner can:

2.1 state Explosive Regulation definitions

2.2 describe the locations and responsibilities of Explosive Regulation posts

2.3 describe the Publications used in Explosive Regulations

2.4 explain the Lifing of Explosives

2.5 describe the Joint Service Munitions Constraints Register (JSMCR)

2.6 explain Potential Explosive Site (PES) licensing

Range

(AC2.1)
- define relevant terms/ abbreviations
  - Ordinance
  - Munitions
  - Explosives
  - ALARP
  - AMANDA
  - HERO

(AC2.2)
- Explosive Safety Rep
- Technical Explosive authorities

(AC2.3)
- Current, in use, publications, eg:
  - JSP 482
  - JSP 762
  - JSP 440
  - JSP 375
  - AP110A-0102-1D

(AC2.4)
- Initial Determination
- Service life
- Storage life
- Air carriage life
- Operational life
- Publication of lifing changes
- Recording life consumption
- Disposal of life expired explosives

(AC2.5)
- Munitions ban
- Munitions constraint
- Limitations in the use of missiles and ammunitions (LUMATS)
- Air drop codes
- AMANDA

(AC2.6)
- Responsibilities
- Principles
- Permits
- Forms
- Constraints
- Quantities
- Checks
- Inspections

Learning outcome

The learner will:

3 Understand the identification, handling and transportation of Explosives

Assessment criteria

The learner can:

3.1 describe explosive classifications

3.2 describe the markings on Explosive Stores and Packaging

3.3 describe the safe handling and transportation of explosives

3.4 explain the principles and regulations governing explosive storage buildings

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Range

(AC3.1)
- Dangerous Goods e.g:
  - Explosives
  - Gases
  - Flammable liquids
  - Flammable Solids
  - Radioactive material
- Hazard Divisions
- Compatibility Groups
- Hazard Classification Codes
- UN Number
- Regulations
- Responsible organizations

(AC3.2)
- Purpose
- Relevant Standard
- Markings:
  - Colours
  - Role colour codes
  - Hazard colour codes
  - Descriptive markings
  - Symbols
- Principles of marking:
  - Clarity
  - Uniformity
  - Simplicity
  - Position
- Identification
- Stencilling
- Application
- Labels
- Ammunition marking drawings

(AC3.3)
- Hazards
  - Explosive Hazard Data Sheet
  - Safety Certificates
  - Occupational Exposure limits
  - Current, in-service, publications
  - COSSH assessment
- Precautions
- Treatments

- Safety principles
- Explosive processing
- Sealing of explosive packages
- Investigation and reporting of accidents involving munitions
  - H&S at Work Regulations
  - Service Inquiry
  - Records
  - Timescales
- Weapons preparation
- Current transport regulations
- Responsibilities of Authorised representatives
- Use of Container Transport Units

(AC3.4)
- Terms
  - Potential Explosive Site (PES)
  - Exposed site
  - Process building
  - A Traverse
- Factors affecting siting of a PES
- Current, relevant publications
- Regulatory requirements
- Categories of vehicles permitted
- Explosive Safety Brief
- Protection of personnel
- Disclosure of Risk Assessments (DRES)
- Permit to work
- Regulations for Electrical installations
- Mitigation of ESD hazards
- HERO
- Security of OME
- Stacking of explosives
- Certification free from Explosives (CFFE) regime
- Documentation

Learning outcome

The learner will:

4 Know the principles of ESA safe working practices.

Assessment criteria

The learner can:

4.1 describe the safe working practices required in an ESA
4.2 describe the regulations governing the issue of explosives
4.3 describe the regulations governing the receipt of explosives
4.4 describe the regulations governing the CFFE process

Range

(AC4.1)
- Entering and exiting

- Receiving explosives
  - Location
  - Quantities
  - Correct PES
  - Stacking
  - Palletisation
  - Documentation

(AC4.2)
- Consignee identification
- Location
- Stock selection
- Marking and sealing of Ammunition Container assembly (ACA)
- Transit ACAs
- JSMCR update and subsequent actions
  - Ban
  - Constraint
- Documentation

(AC4.3)
- Correct location
- Repacking
- Marking and Sealing of ACA
- Documentation

(AC4.4)
- Current, in use, publications covering CFFE processes:
  - Empty ACAs
  - Expended pyrotechnics
  - Fired Brass
- Documentation

Learning outcome

The learner will:

5 Know the principles of off aircraft pyrotechnics and ammunition

Assessment criteria

The learner can:

5.1 describe the policy governing pyrotechnics associated with survival equipment

5.2 describe the maintenance tasks on pyrotechnics associated with survival equipment

5.3 describe off aircraft ammunition

5.4 describe off aircraft pyrotechnics and specialist kits

Range

(AC5.1)
- Safety precautions
- Procedures for safe storage
- Procedures for safe transportation
- Lifing policy
- Disposal of Life-Ex or unserviceable pyrotechnics
- Disposal of packaging
- Fault reporting

- Documentation

(AC5.2)
- Flare distress signal
- Signal pistol
- Rocket distress signal
- Waterproof matches
- Relevant, in-use, publications
- Relevant documentation

(AC5.3)
- Current, in-use small arms ammunition
  - Potential hazards
  - Appropriate fire precautions
  - Identification
  - Normal operation
- Current, in-use, publications
- Relevant documentation

(AC5.4)
- Potential hazards, appropriate fire precautions, Identification, component parts and normal operation of current, in-use eg:
  - Explosive cartridges
  - Hand fired signal rockets
  - Parachutists signal smoke
  - Specialist kits
  - Anti-tank guided weapon (ATGW)
  - Mortar rounds
  - Grenades
- Pyrotechnics issued to ATC and MRT vehicles
- Current, in-use, publications
- Relevant documentation

Learning outcome

The learner will:

6 Understand armoury regulations and mandatory requirements

Assessment criteria

The learner can:

6.1 identify the policy and regulations relevant to working within an armoury

6.2 explain the Army Equipment Support Publication (AESP) structure

6.3 explain light weapons policy

6.4 explain the generic principles of operation for in service light weapons

6.5 understand level 1 maintenance of in service light weapons

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Range

(AC6.1)
- Terminology
  - ammunition and explosives
  - arms/firearms and firearm components
  - ACTO store categories
  - Establishment Armament Officer
- Mandatory Requirements
  - security of arms
  - ammunition

- explosives
- Control of access
- relevant documentation
  - mandatory arms checks
  - in use documentation e.g: weapon management logs, maintenance records, custody register, issue & receipt
  - recipient checks pre-issue
- discrepancy action

(AC6.2)
- scope
- referencing system
- levels of information
- amendment instigation
- location and access

(AC6.3)
- equipment covered
- Current, in-use, publications
- Security classification
- Different classes of Armourer
  - Responsibilities
  - Capabilities
- Safe custody

(AC6.4)
- cycle of operation
- mechanical safety
- applied safety
- principles of operation
- internal ballistics e.g obturation, pressure and time, misfires, recoil

(AC6.5)
- hazards.
- tool control
- work recording and documentation
- Complete Equipment Schedule (CES)
- test firing/zeroing terminology
- responsibilities
- relevant publications

Unit 316 Aircraft Avionic and Armament Systems

Unit level:	Level 3
GLH:	100
Unit aim:	This unit aims to give the learner knowledge of aircraft avionic and armament systems in a military armourer context, as well to allow further study of aircraft maintenance practices.
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS
Endorsed by	This unit is endorsed by SEMTA.

Learning outcome

The learner will:

1 Understand how aircraft systems interact with the aircraft avionic systems

Assessment criteria

The learner can:

1.1 describe a typical military aircraft avionics system
1.2 describe how aircraft avionic systems interact with other aircraft systems
1.3 explain the types of data collected by aircraft sensors and its application
1.4 demonstrate fault finding skills from a weapons trade perspective on Avionic related systems

Range

(AC1.1)
- history & evolution
- structure/architecture
  - system
  - sub-system
  - equipment
- categories
  - mission
  - air vehicle
  - munitions

(AC1.2)
- control & monitor
  - Inputs & outputs
  - processing
  - voting
  - redundancy
- integration

- mechanical systems
- weapon systems

(AC1.3)
- sensor requirement and purpose
- types of sensors:
  - transmitter sensors e.g.: RADAR, range-finding, communication and EW
  - environmental
  - positional
- sensor datatypes e.g.:
  - altitude
  - height
  - speed - air, ground, vertical, wind
  - Mach number
  - angle of attack
  - outside air temp
- Critical system data
- Sensor technology e.g.:
  - micro-switches
  - proximity switches
  - solenoids
  - synchro's
  - sensors – temperature, pressure
  - flow rate
  - strain gauge
  - accelerometers
- flight and navigation sensors eg:
  - air data sensors
  - accelerometers
  - GPS
  - RADAR altimeter
  - mission sensors eg:
  - Primary RADAR
  - Secondary RADAR
  - Defensive Aids
  - electro-optics

(AC1.4)
- fault finding using a simple block diagram
  - identification of systems affected
  - what the effect on the system would be
  - fault indications including cockpit warnings

Learning outcome

The learner will:

2 Understand the operation of an aircraft electrical power distribution system

Assessment criteria

The learner can:

2.1 explain the requirement and how the generation of AC and DC power is achieved

2.2 explain how power is distributed

2.3 explain the distribution of power under various fault conditions

2.4 know the potential hazards associated with the application of power to aircraft and equipment

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Range

(AC2.1)
- aircraft electrical power requirement e.g.
  - mission and flight systems
  - control surface movement
  - engine starting/control
  - pumps - fuel, hydraulic etc.
  - explosive devices
- types of power utilised by aircraft
  - AC and DC
  - 3 phase
  - advantages/disadvantages
- categories e.g.:
  - primary
  - secondary
  - emergency
- Ground Power Unit (GPU)
- Auxiliary Power Unit (APU)
- aircraft batteries
- generators
  - generator drives e.g: CSDU, IDG, VSCF
  - generator control
- Transformer Rectifier Units (TRU)
- inverter
- emergency power generation

(AC2.2)
- busbars
  - vital
  - essential
  - non-essential
- relays
- circuit protection
  - fuses
  - circuit breakers

(AC2.3)
- power switching and distribution:
  - partial electrical failure
  - complete electrical failure
  - aircraft crash

(AC2.4)
- connecting and disconnecting ground power
- earthing and bonding
- electrically safe for maintenance operations
- aircraft batteries
- high voltages
- aircraft document set e.g. Air Publications

Learning outcome

The learner will:

3 Know the principles of aircraft monitoring and information systems

Assessment criteria

The learner can:

3.1 explain how aircraft communicate, control, monitor and display the status of aircraft systems

3.2 explain how necessary aircraft systems airworthiness data is captured and utilised

Range

(AC3.1)

- terminology
  - Electronic Control and Monitoring (ECAM)
  - serial
  - multiplexed
  - cross checking and voting
  - data fusion
  - topology
- signal types
  - analogue
  - digital
- typical Databus system
  - advantages
  - transmission mediums

(AC3.2)

- purpose of data loading
- purpose of an on-board maintenance system (OBMS)
- components of an OBMS
- interpretation of monitoring systems
- data acquisition methods
  - Cockpit Voice Recorder (CVR)
  - Flight Data Recorder (FDR)
  - Data Acquisition Unit (ASU)
- warning systems
  - attention getters
  - Centralised Warning Panel (CWP)
  - audible
- alerts
  - advisory
  - caution
  - warning

Learning outcome

The learner will:

4 Understand the basic functions of communication, navigation and identification systems

Assessment criteria

The learner can:

4.1 know the principles of aircraft communication systems
4.2 know the principles of aircraft navigation systems
4.3 know the principles of aircraft identification systems
4.4 describe the various cockpit controls and display configurations

Range

(AC4.1)
- purpose
- communication eg:
  - VHF
  - UHF
  - HF
  - intercom
- radio signals
- radio safety

(AC4.2)
- terminology
- navigation methods
- navigation aids e.g.:
  - Automatic Direction Finding (ADF)
  - VHF Omnidirectional Ranging (VOR)
  - Distance Measuring Equipment (DME)
  - Tactical Air Navigation (TACAN)
- Landing aids
  - Instrument Landing System (ILS)
  - localiser
  - glideslope
- Inertial Navigation System
- Sat Nav
- flight management systems
  - inputs and outputs

(AC4.3)
- requirement
- interrogation
- transponder
- safety/hazards

(AC4.4)
- purpose
- cockpit displays & layouts
- flight Instruments
  - analogue
  - digital

- engine instruments
- monitoring systems e.g.:
  - Engine Indicating and Crew Alerting System (EICAS)
  - Electronic Centralised Aircraft Monitoring (ECAM)
- Types of Display
  - Head Down Displays (HDD)
  - Head Up Display (HUD)
  - Helmet Mounted Displays (HMD)
- Controls
  - HOTAS
  - voice
  - analogue switches

Learning outcome

The learner will:

5 Understand the dependence of air vehicle systems on avionics and electronic control

Assessment criteria

The learner can:

5.1 know the air vehicle systems and associated sub-systems found on an aircraft

5.2 identify typical aircraft actuated equipment

5.3 explain the principles of flight control

Range

(AC5.1)
- flight control
- landing gear
  - extension/retraction
  - braking
  - nose wheel steering
- hydraulic
- propulsion
- fuel
- fire protection
  - detection
  - suppression
- lighting
  - external
  - internal
  - emergency

(AC5.2)
- systems requiring actuation e.g.:
  - undercarriage
  - flying controls
  - canopy
  - nozzles
  - intakes

- gun bay
- electric
- hydraulic

(AC5.3)
- pneumatic axis of control
- stability
- primary flying controls
- secondary flying controls
- thrust vectoring
- open & closed loop systems
- redundancy
- technologies
  - mechanical
  - fly by wire
  - fly by light

Learning outcome

The learner will:

6 Understand the principles of aircraft munition systems

Assessment criteria

The learner can:

6.1 describe in broad terms aircraft armament control systems (ACS)
6.2 explain in simple terms aircraft weapon release systems
6.3 describe aircraft counter measures/defensive aids

(AC6.1)
- purpose
- operation/processes
- safety
- integration
- inputs/outputs
- Master Armament Safety Switch (MASS)
- late arm switch

(AC6.2)
- purpose
- stations & pylons
- stores
- target acquisition
- weapons release process

(AC6.3)
- requirement
- purpose
- types

Learning outcome

The learner will:

7 Understand Aircraft Armament Systems (AAS) and the associated safety implications

Assessment criteria

The learner can:

7.1 Explain the hazards to personnel from aircraft explosive systems and components
7.2 Explain Aircraft Assisted Escape System cockpit access
7.3 Describe the removal and installation of a typical aircraft ejection seat
7.4 Explain aircraft Ejector Release Units (ERU)
7.5 Describe in service role equipment
7.6 Explain the regulations relating to aircraft weapon loading
7.7 Explain the components utilised in weapon loading

Range

(AC7.1)
- armed aircraft safety precautions
  - signage
  - regulation & publications
  - armed states
  - safety devices
  - environmental e.g. Thunderstorms
  - division e.g. aircraft parking, other activities

(AC7.2)
- symbols/markings
- AAES responsibility for appropriate position
- documentary requirements
- four conditions
  - safe for maintenance
  - safe for parking
  - safe condition
  - flight condition

(AC7.3)
actions required on discovery of incorrectly positioned devices
- canopy removal and fitting
- seat removal/installation
  - EO2 cylinder
  - restraint lines
  - canopy jettison system
  - canopy unlocking jack
- seat
- documentation

(AC7.4)
- safety precautions
- hazards
- publications
- 'holdfire' condition and actions to be taken

Stores Management System (SMS)

(AC7.5)
- rationale
- role equipment e.g. aircraft fuel tanks, weapon carriers, missile launchers, coolant bottles, pods/dispensers
  - purpose
  - hazards

loading/unloading

(AC7.6)
- regulatory publications

- authorisations
- training periodicity
- terminology
- work recording requirements

(AC7.7)
- terminology
- Purpose & function of:
  - Master Armament Switch (MASS)
  - late Arm Switch
  - landing gear Weight on Wheels switches (WOW)
  - override switch (e.g. BUTTS Switch)
  - trigger weapon release
  - connecting leads e.g. lanyards, arming leads
- Aircraft Armament System Aviation Support Equipment (ASE)

Learning outcome

The learner will:

8 Know the principles of Aircraft Gun systems

Assessment criteria

The learner can:

8.1 Explain a typical aircraft gun system

8.2 Describe the general orders and special instructions that apply to aircraft guns

8.3 Describe the component parts of an aircraft gun

8.4 Describe the specialist cleaning equipment used in armament equipment maintenance

8.5 Explain the processes involved in Aircraft gun stoppage investigations

Range

(AC8.1)
- purpose
- development
- harmonisation

(AC8.2)
- depths of maintenance
- Main Operating Base (MOB) repair tasks
- maintenance periodicities
- limitations
- documentation

(AC8.3)
- major assemblies
- function
- lifing
- major assemblies
- sequence of operation
  - electrical
  - first cycle
  - second cycle
- loading
- safety arrangements
  - mechanical

- electrical

(A8.4)
- aqueous component cleaning
- vacu-blast
- oven

(A8.5)
- definition
- causes
- stoppage report
- key personnel

Unit 317 Military Helicopter Aerodynamics

Unit level:	3
GLH:	32
Unit aim:	This unit aims to give the learner knowledge of rotary wing aerodynamics in a military aviation context to allow further study of aircraft maintenance practices.

Learning outcome

The learner will:

1 Understand the basic fundamentals of helicopters and types of military helicopter in current use

Assessment criteria

The learner can:

1.1 describe important stages in the history of vertical flight
1.2 describe how rotary flight is achieved
1.3 describe the main military helicopter types
1.4 describe different helicopter configurations
1.5 describe the basic helicopter flight controls
1.6 describe helicopter power control

Range

(AC1.1)

- Vertical flight pre-19th century
- Vertical flight 19th and 20th centuries
- Key historical dates of vertical flight

(AC1.2)

- Lifting force
- Variation of lift
- Tail rotor (torque reaction)

(AC1.3)

- Gyroplane; pure helicopter
- Compound helicopter
- Convertible helicopter (e.g. Osprey)

(AC1.4)

- Single rotor with tail rotor
- Two rotors in tandem
- Coaxial or contra-rotating rotors
- No tail rotor (NOTAR)

(AC1.5)

- Collective pitch
- Cyclic pitch
- Yaw pedals
- Throttle

(AC1.6)

- Engine and rotor rpm (Nr) control
- Union end fittings

Learning outcome

The learner will:

2 Understand different types of military helicopter rotor and associated aerodynamic characteristics

Assessment criteria

The learner can:

2.1 state the main types of rotor
2.2 describe a teetering rotor
2.3 describe a fully articulated rotor
2.4 describe a semi-rigid rotor
2.5 explain rotor lifting force
2.6 describe blade pitch and washout
2.7 describe relative airflow
2.8 describe a rotor disc
2.9 describe the ‘coning angle’
2.10 describe the operating limits of a semi-rigid rotor
2.11 describe overpitching

Range

(AC2.2)

- Simple teetering rotor

(AC2.3)

- Purpose of the articulation

(AC2.5)

- Rotor blade lift calculation
- Drag force produced

(AC2.6)

- Rotor blade pitch
- Washout
- Tailored lift characteristics

(AC2.7)

- Induced Airflow (IAF)
- Relative Airflow (RAF)
- Angle of Attack (AoA)

(AC2.8)

- Rotor disc area:
    - tip path plane
    - rotor disc
    - axis of rotation
    - coning angle

(AC2.9)

- Rotor thrust raises the blades
- Coning angle measurement
- Varying coning angle using rotor thrust and rpm

(AC2.10)

- Safe operating limits
- Upper limit
- Compressibility

Learning outcome

The learner will:

3 Understand military helicopter manoeuvrability

Assessment criteria

The learner can:

3.1 describe how vertical movement is achieved
3.2 describe ground effect
3.3 describe how horizontal movement is achieved
3.4 describe the function of the tail rotor
3.5 describe how tail directional control is achieved
3.6 describe tail rotor drift and roll
3.7 describe the function of a fenestron
3.8 describe how a no tail rotor helicopter (NOTAR) counteracts torque

Range

(AC3.1)

- Vertical climb
- Vertical descent

(AC3.2)

- Ground effect phenomenon
- Factors affecting ground effect

(AC3.3)

- Vertical component
- Horizontal component

(AC3.6)

- Tail Rotor drift
    - balancing torque reaction
    - correct tail rotor drift
- Tail rotor roll

(AC3.8)

- Use of an engine-driven fan
- Use of the Coanda effect

Learning outcome

The learner will:

4 Understand military helicopter rotor blade movement

Assessment criteria

The learner can:

4.1 describe blade feathering
4.2 describe blade flapping
4.3 describe blade dragging
4.4 describe the function of a swash plate
4.5 describe phase lag
4.6 describe advance angle

Range

No range.

Learning outcome

The learner will:

5 Understand military helicopter aerodynamics in forward flight

Assessment criteria

The learner can:

5.1 describe dissymmetry of lift
5.2 describe flap-back
5.3 describe factors affecting forward speed
5.4 describe the function of British Experimental Rotor Programme (BERP) blades

Range

(AC5.1)

- Considerations in forward flight
- Advance/retreating blades
- Lift dissymmetry calculation

(AC5.2)

- Dissymmetry flap up/flap down
- Flap to equality
- Flap back
- Cyclic feathering

(AC5.3)

- Reversal of airflow on retreating blade
- Retreating blade stall
- Compressibility effect on advancing blade
- Design factors
- Methods of increasing forward speed

Learning outcome

The learner will:

6 Understand transition in flight in military helicopters

Assessment criteria

The learner can:

6.1 describe the term ’transition’
6.2 describe the forces in the hover
6.3 describe the forces in forward flight
6.4 describe transitional lift
6.5 describe the transition sequence from hover to forward flight
6.6 describe the transition sequence from forward flight to hover
6.7 explain the term ‘flare’

Range

(AC6.2)

- Perfect hover – Centre of Gravity (CG)
- Change of CG – aircraft pitch

(AC6.4)

- Hover in still air
- Horizontal air flow over tilted disc
- Reduction of IAF
- Maintain level flight
- Power required to climb

(AC6.7)

- Execute a flare
- Flare effects

Learning outcome

The learner will:

7 Understand military helicopter in-flight stability

Assessment criteria

The learner can:

7.1 describe stability in the hover
7.2 describe stability in forward flight
7.3 describe longitudinal stability aids
7.4 describe control power

Range

(AC7.1)

- Static and dynamic stability
- Pitching/rolling planes
- Yawing plane

(AC7.2)

- Effect of wind gust from ahead
- Effect of wind gust from side

(AC7.3)

- Horizontal stabiliser
- Synchronised elevator
- Lateral stability aids
- Directional stability aids
- Synthetic stabilisation:
    - auto stabilisation equipment (ASE)
    - automatic flight control system (AFCS)
    - flight control system

(AC7.4)

- Main factors
- Types to be considered:
    - semi-rigid

    - fully articulated
    - teetering head
- Comparison of control forces

Learning outcome

The learner will:

8 Understand military helicopter hazardous conditions and recovery

Assessment criteria

The learner can:

8.1 define auto-rotation
8.2 describe descending autorotation
8.3 describe landing following autorotation
8.4 describe the avoid curve (area) for autorotation
8.5 describe the vortex ring
8.6 describe ground resonance
8.7 describe ground resonance recovery
8.8 describe causes of rotor head vibration
8.9 describe causes of fuselage vibration

Range

(AC8.2)

- Consider autorotation vertically downwards:
  - calculations for each blade
- Three sections of a rotor blade
- Blade section producing autorotative force
- Propeller region
- Adjustment of speed
- Autorotation used in normal flight

(AC8.3)

- Use of flare to cushion touchdown

(AC8.5)

- Condition of powered flight
- Conditions conducive to settling with power
- Descent
- Helicopter experiences
- Conditions likely to cause Vortex ring
- Recovery actions from Vortex ring

(AC8.6)

- Definition
- Cause of ground resonance

(AC8.7)

- Appropriate actions taken if aircraft serviceabl
- Appropriate actions taken if aircraft not serviceable

(AC8.8)

- Vibration causes:
    - blade imbalance
    - faulty dampers
    - faulty tracking
    - the NR effect

Learning outcome

The learner will:

9 Understand military helicopter power requirements

Assessment criteria

The learner can:

9.1 describe the different types of power
9.2 describe Rotor Profile Power (RPP)
9.3 describe Induced Power (IP)
9.4 describe available power
9.5 describe significant speeds
9.6 describe the effect of limited power
9.7 describe the effects of altitude on helicopter handling and performance
9.8 describe helicopter endurance
9.9 describe helicopter range
9.10 describe the effects of altitude on helicopter performance

Range

(AC9.1)

- Requirement differs from hover to forward flight
- Power required to maintain flight:
    - rotor profile power – type of form drag
    - induced power – lift dependent drag
    - parasite power – form drag

(AC9.3)

- Induced power required to induce a flow through the rotor
- Parasite power required to overcome form drag

(AC9.4)

- Performance of helicopter made up from:
    - power available
    - power required

(AC9.6)

- Power available and power required, effected by changes in:
    - air density
    - weight
    - altitude

(AC9.7)

- Effects of density on handling and performance
- Densities lower than ISA at sea level
- Effects will combine to limit helicopter performance

(AC9.8)

- Principle for range and endurance
- Endurance definition
- Range definition
- Criterion – fuel consumption

(AC9.10)

- Increase weight requires more power
- Engine efficiency:
- All up weight
- Combined effects
- Wind

Learning outcome

The learner will:

10 Understand helicopter weight and balance in military helicopters

Assessment criteria

The learner can:

10.1 describe weight limitations
10.2 describe longitudinal balance
10.3 describe the effects of forward and aft centres of gravity (CG)
10.4 describe lateral balance
10.5 describe how CG is calculated

Range

(AC10.1)

- Maximum All Up Weight (MAUW)
- Basic Weight
- Disposable Load
- Total load of cargo and passengers
- Operating Weight:
    - sum of basic weight and variable load
    - operating weight subtracted from MAUW – lifting capacity
- Max permitted AUW
- Further effects of exceeding MAUW conditions

(AC10.3)

- Excessive forward CG
- Excessive aft CG

Unit 318 Military Helicopter Transmission Systems

Unit level:	Level 3
GLH:	38
Unit aim:	This unit aims to give the learner knowledge of helicopter aerodynamics in a military aviation context to allow further study of aircraft maintenance practices.

Learning outcome

The learner will:

1 Understand basic helicopter transmission systems

Assessment criteria

The learner can:

1.1 describe the requirement for power transmission
1.2 describe the capabilities of the transmission system
1.3 describe the location of the transmission system
1.4 describe the main helicopter transmission components

Range

(AC1.1)

- Power Transfer
  - main rotor
  - tail rotor
  - auxiliary services
- Revs Per Minute (RPM)
  - relationship between the engine and the rotors
  - reduction/optimisation
- Change the direction (axis) of the drive

(AC1.2)

- Auto Rotation
- Engine failure
- Tail Rotor Failure
- Auxiliary services

(AC1.3)

- Rotors and engine positioning

(AC1.4)

- Engine Output Shaft (EOS)
- Clutch
- Freewheel
- Main Rotor Gearbox (MRGB)
- Rotor Brake
- Tail Rotor Drive Shafts (TRDS)
- Intermediate Gearbox (IGB)
- Tail Rotor Gearbox (TRGB)

Learning outcome

The learner will:

2 Understand the Engine Output Shaft (EOS), clutch and free-wheel

Assessment criteria

The learner can:

2.1 describe the purpose of the EOS
2.2 describe the construction of the EOS
2.3 describe the purpose of different types of clutch
2.4 explain the operation of a clutch
2.5 describe the purpose of a free-wheeling unit
2.6 describe a ramp and roller free-wheeling unit
2.7 describe an over-running sprag clutch

Range

(AC2.3)

- Types
  - Centrifugal
  - Belt-driven
  - Free power turbine engines (air clutch)
- Purpose
  - start up loading
  - rotor speed build up
  - blade sailing

(AC2.4)

- Centrifugal clutch
  - inner assembly
  - outer drum
  - low engine speeds
  - increasing engine speeds
- Belt driven clutch
  - pulleys, upper & lower
  - v belts
  - belt tension
  - advantages – maintenance, vibration, engine/rotor independence
- Free power turbine engines
  - air coupling (air clutch)

(AC2.6)

- Construction

- Operation

(AC2.7)

- Construction
- Operation

Learning outcome

The learner will:

3 Understand the operation of a Main Rotor Gearbox (MRGB)

Assessment criteria

The learner can:

3.1 state the purpose of an MRGB
3.2 describe the construction of a MRGB
3.3 describe the MRGB drive path
3.4 describe how the drive is transferred
3.5 describe the operation of a MRGB lubrication system
3.6 describe the operation of a MRGB pressure system
3.7 describe MRGB maintenance requirements

Range

(AC3.3)

- Route of the transmission force
- Engine connection
    - input pinion
    - gearing
- Main Rotor Head (MRH)
- Tail rotor transmission system
- Accessory gear train

Learning outcome

The learner will:

4 Understand the operation of a main rotor brake

Assessment criteria

The learner can:

4.1 state the purpose of a main rotor brake
4.2 describe the location of a rotor brake unit
4.3 explain the operation of a rotor brake
4.4 explain rotor brake control and indication
4.5 describe rotor brake maintenance requirements

Range

(AC4.3)

- Aircraft hydraulic system
- Rotor brake control-lever
- brake disc and pads movement
    - hydraulic pressure applied
    - hydraulic pressure released

(AC4.4)

- Control:
    - rotor brake operating lever; mechanical or hydraulic
- Inadvertent application -positive OFF position
- Brake on indication:
    - red warning light
    - centralised warning panel (CWP)
    - red rotor brake operating lever; location

(AC4.5)

- Fault diagnosis
- Routine maintenance:

Learning outcome

The learner will:

5 Understand the operation of a Tail Rotor Drive Shaft (TRDS)

Assessment criteria

The learner can:

5.1 state the purpose of a TRDS
5.2 describe the construction of a TRDS
5.3 describe TRDS attachments
5.4 describe TRDS maintenance requirements
5.5 state typical effects of TRDS misalignment and defective bearings

Range

(AC5.3)

- Support bearings
- Splined couplings
- Universal or flexible joints (shim packs)
- Hub attachments

Learning outcome

The learner will:

6 Understand the operation of an Intermediate Gearbox (IGB)

Assessment criteria

The learner can:

6.1 state the purpose of an IGB
6.2 describe the construction of an IGB
6.3 describe the operation of an IGB
6.4 describe the lubrication of an IGB
6.5 describe IGB maintenance requirements

Range

No range.

Learning outcome

The learner will:

7 Understand the operation of a Tail Rotor Gearbox (TRGB) and drive shafts

Assessment criteria

The learner can:

7.1 state the purpose of a TRGB
7.2 describe the construction of a TRGB
7.3 describe the operation of a TRGB
7.4 describe the lubrication of a TRGB
7.5 describe the maintenance requirements for a TRGB
7.6 state the purpose of torque measuring on a drive shaft
7.7 describe the principles of torque measuring
7.8 explain the methods of torque measuring

Range

(AC7.8)

- Basic methods employed to measure the torque (power) of the engine:
    - phase displacement – detailed description
    - angular displacement – detailed description
    - axial gear – detailed description

Learning outcome

The learner will:

8 Understand Health and Usage Monitoring (HUM) and Wear Debris Monitoring (WDM)

Assessment criteria

The learner can:

8.1 define the term HUM
8.2 state the purpose of HUM
8.3 describe HUM techniques
8.4 describe HUM sampling
8.5 state the purpose of WDM
8.6 describe the uses of WDM
8.7 explain the methods of WDM
8.8 state the health and safety implications of WDM methods

Range

(AC8.3)

- Load Monitoring – including:
    - stress metering
    - accelerometers
    - ‘G’ meters
- Vibration Analysis
- Vibration Control (VC)
- Vibration Analysis (VA)

(AC8.4)

- Importance of reliability of samples
- Recommendations based on samples analysis
- Validity
- Cost
- Factors affecting reliability

Unit 319 Maintaining Military Helicopter Flight Control Systems

Unit level:	3
GLH:	25
Unit aim:	This unit aims to give the learner the helicopter flight control systems knowledge in a military aviation context to allow further study of aircraft maintenance practices.

Learning outcome

The learner will:

1 Understand the operation of main rotor head (MRH) assemblies

Assessment criteria

The learner can:

1.1 state the functions of an MRH
1.2 state the three main types of MRH
1.3 describe the blade attachments on a fully articulated rotor head
1.4 describe the operation and characteristics of a semi-rigid rotor head
1.5 describe the operation and characteristics of a rigid rotor head
1.6 state the requirements of a MRH design
1.7 describe the operation of hinges and blade damping devices
1.8 describe the purpose and operation of a main rotor blade sleeve

Range

(AC1.7)

- Drag hinge
- Flapping hinge
- Feathering hinge
- Drag damper
- Ground resonance damping

(AC1.8)

- Purpose
- Operation

- Mounting
- Main rotor blade sleeves (extension arms)
- Pitch Bearings
- Tie Bar
- Damper support / attachment

Learning outcome

The learner will:

2 Understand the construction and operation of helicopter main rotor blades

Assessment criteria

The learner can:

2.1 state the purpose of helicopter main rotor blades
2.2 describe the operation of main rotor blades
2.3 describe main rotor blade design
2.4 describe main rotor blade construction
2.5 describe main rotor blade attachment
2.6 describe the Lift Load Path
2.7 describe vibration control devices

Range

(AC2.2)

- Lift generation
- Blade lift distribution
- Total rotor thrust

(AC2.3)

- Basic requirements
- Refinements
- BERP blade design
- Blade camber
- Blade tip design

(AC2.4)

- Materials
- Main areas
- Blade sections
- Non-linear twist

- Non-parallel planform
- Static/dynamic balance weights
- Blade identification

(AC2.5)

- Attachment pins and bushes:
- Doubler plates
- Bonding leads

(AC2.7)

- Mass/spring main rotor head vibration absorber (MRHVA)
- Bifilar vibration absorber
- Active vibration cancellation

Learning outcome

The learner will:

3 Understand helicopter tail rotors

Assessment criteria

The learner can:

3.1 describe the purpose of a helicopter tail rotor
3.2 describe the operation of a tail rotor in flight
3.3 describe the features of Free and Shrouded Tail Rotor
3.4 describe tail rotor blade construction
3.5 describe tail rotor control

Range

(AC 3.2)

- Anti-torque pedals control tail rotor pitch
- Straight and level flight
- Pilot operation
- Direction of flight
- Forward flight

(AC 3.3)

- Free
- Shrouded (fenestron)

(AC 3.4)

- Material
- Typical construction

(AC 3.5)

- Tail rotor control mechanism:
    - collective pitch control activator shaft
        - location
    - inputs – route to output
- Pitch Vernier tail rotor
    - visual marks for reference
        - purpose
        - position and use

Learning outcome

The learner will:

4 Understand the maintenance requirements of rotor heads and blades

Assessment criteria

The learner can:

4.1 describe the maintenance procedures for main rotor heads
4.2 describe the maintenance procedures for main rotor blades
4.3 describe the maintenance procedures for tail rotor hubs and blades

Range

No range.

Learning outcome

The learner will:

5 Understand helicopter flight controls

Assessment criteria

The learner can:

5.1 state the three main controls, their position and their purpose
5.2 state the three main requirements for flight controls
5.3 describe main rotor pitch change
5.4 describe the collective and throttle control
5.5 describe the cyclic control
5.6 describe the yaw control
5.7 describe control trim
5.8 describe the Interlink system
5.9 describe powered flying controls
5.10 describe fly-by-wire (FBW)

Range

(AC5.3)

- Swash plate system:
- Spider system
- Main rotor pitch Vernier
- Vertical movement

(AC5.4)

- Operation
- Effect
- Throttle twist grip where fitted
    - operation when no throttle control fitted

(AC5.5)

- Operation
- Effect

(AC5.6)

- Yaw pedals
    - operation
    - movement transmission
    - effect on tail rotor

(AC5.7)

- Operation
- Control movement

(AC5.8)

- Purpose
- Interlink assemblies
    - operation
- Constant rotor speed
    - throttle control link
    - sensors
    - fuel control

(AC5.9)

- Purpose
- Servo jacks
    - position
    - operation
        - input
        - output
- Failure mode

(AC5.10)

- Philosophy
- FBW system
    - purpose
    - components
    - layout
- Operating principles
    - pilot input
    - redundancy
    - failure mode

Learning outcome

The learner will:

6 Understand helicopter flying controls maintenance

Assessment criteria

The learner can:

6.1 state the main criteria checked during flying control inspection
6.2 describe control rod maintenance
6.3 describe cable maintenance
6.4 describe pulley maintenance
6.5 describe fairlead maintenance
6.6 describe rigging procedures
6.7 describe blade tracking and balancing
6.8 describe independent inspection

Range

(AC 6.3)

- Warnings on cable handling
- Working on cables
- Examining in- situ cables
- Cable faults
- Examination techniques
- Rejection criteria – replace cable
- Replacement cables

(AC 6.4)

- Pulleys and bearings

(AC 6.5)

- Definition
- Examine for:
    - worn cable guide holes
    - corrosion
    - damage

(AC 6.6)

- Definition of rigging
- Purpose
- Pre-rigging checks
- Rigging pins
- Check using setting gauges

(AC 6.7)

- Explain term
- Measurement devices
- Pre-balance checks
- Basic tracking carried out
- Balancing

Unit 320 Military Helicopter Integrity Monitoring

Unit level:	3
GLH:	48
Unit aim:	This unit aims to give the learner a thorough grounding in the theory and practice of military helicopter integrity monitoring.

Learning outcome

The learner will:

1 Understand Health and Usage Monitoring Systems (HUMS) in Military Helicopters

Assessment criteria

The learner can:

1.1 describe the types of HUMS used in aircraft
1.2 describe Wear Debris Monitoring (WDM)
1.3 describe hydraulic oil monitoring
1.4 describe the basics of vibration in machines
1.5 describe vibration control (VC)
1.6 describe the fundamental characteristics of vibration
1.7 explain origins of vibration in helicopters
1.8 describe the causes of vibration in helicopters

Range

(AC1.1)

- HUMS
- Electrical Health and Usage Monitoring System (EHUMS)
- Cockpit Voice Recorder/Flight Data Recorder (CVR/FDR)

(AC1.2)

- Applications
- Uses
- Spectrometric Oil Analysis Programme (SOAP)
- Magnetic detector plug (MDP)
    - filter debris assessment

(AC1.3)

- Purpose
- Main aims
- Methods

(AC1.4)

- Vibration in machines
    - induced vibration
    - sources
    - elimination

(AC1.5)

- Vibration control – definition
- Vibration analysis
    - meaning
    - monitoring
    - corrective maintenance
    - organisations
        - manufacturer
        - operator

(AC1.6)

- Definition
- Main parameters
- Operation of a simple vibratory system

(AC1.7)

- Aerodynamic
- Mechanical

(AC1.8)

- Common causes

Learning outcome

The learner will:

2 Understand the types and effects of vibration in military helicopters

Assessment criteria

The learner can:

2.1 describe the vibratory waveform
2.2 describe types of vibration
2.3 describe information provided by vibration amplitude
2.4 describe information provided by vibration frequency
2.5 describe frequency spectrum and its measurement
2.6 describe stress and fatigue in mechanical components
2.7 describe resonance and damping
2.8 describe the effects of vibration
2.9 describe information provided by vibration phase

Range

(AC2.2)

- Types to include:
  - Different frequency ranges
  - Different amplitude ranges

(AC2.4)

- Reason for using frequency data
- Formulae in terms of:
  - period
  - cycles
  - time
  - Hz
- Importance of vibration frequency in machines:
  - fundamental frequency
  - dominant frequency

(AC2.6)

- Cyclic stress – definition
- Use of stress and fatigue when describing the effects of vibration on humans
- Effect of stress and fatigue on components

(AC2.7)

- Resonant frequency
- Reasons for early component failure
- Susceptibility of components to failure
- Shock

- Damping

Learning outcome

The learner will:

3 Understand rotor balance equipment used with military helicopters

Assessment criteria

The learner can:

3.1 state the purpose of vibration measuring equipment
3.2 describe piezo-electric accelerometers
3.3 describe operating conditions of piezo-electric accelerometers
3.4 describe speed transducers and phase locking devices
3.5 describe a rotor track, balance, and vibration diagnostic system
3.6 describe the logical sequence for rotor track, balance, and vibration analysis

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Range

(AC3.2)

- Piezo-electric effect – description
- Accelerometer – definition
- Accelerometers – function
- Mounting
- Advantages
- Disadvantages

(AC3.3)

- Swamping - definition
- Operating in:
  - humidity
  - heat

(AC3.4)

- Speed sensor - purpose
- Additional information from speed sensors
- Importance of correct positioning
- Magnetic pickup (MPU)
- Optical pickup (OPU)

Learning outcome

The learner will:

4 Understand time and frequency domains when monitoring health and usage in military helicopters

Assessment criteria

The learner can:

4.1 explain the term ‘time domain’

4.2 state Fourier’s theorem

4.3 explain how the use of Fast Fourier transform (FFT) can be used to analyse vibration data

4.4 explain the term ‘frequency domain’

4.5 describe the function of electronic filters used in frequency analysis

Range

(AC4.1)

- Definition
- Explain graphical representation

(AC4.2)

- State Fourier’s theorem

(AC4.4)

- Graphical representation of filter output

Learning outcome

The learner will:

5 Understand vibration in military helicopters

Assessment criteria

The learner can:

5.1 describe how vibration is detected in helicopter assemblies
5.2 state the reason for the susceptibility of helicopters to vibration
5.3 describe the relationship between frequency of vibration and speed
5.4 describe the classification of vibration frequency ranges
5.5 describe the significance of the plane of vibration of a rotor
5.6 describe vibration levels
5.7 describe how excess vibration is corrected
5.8 describe the correctable vibrations
5.9 describe causes of non-correctable vibrations

Range

(AC5.3)

- Calculation of the vibration order alphanumeric
- Vibration order table

(AC5.4)

- Frequency range – examples in helicopters:
  - low
  - medium
  - high

(AC5.7)

- examination of components
- remedial action

Learning outcome

The learner will:

6 understand the effects of military helicopter vibration on human beings

Assessment criteria

The learner can:

6.1 describe human susceptibility to vibration
6.2 describe the mechanical model of a human being
6.3 state vibration frequency ranges from aircraft related sources
6.4 describe low frequency effects on the human body
6.5 describe specific effects of higher frequencies
6.6 describe the effects of a combination of frequencies on aircrew

Range

(AC6.1)

- Different simultaneous frequencies
- Different sensitivities of the body to vibration frequencies

(AC6.2)

- Basic diagrams to illustrate the model
- Complications with the model
- Degrees of discomfort

(AC6.3)

- E.g.:
  - Turbulence and gusts
  - Helicopter rotor
  - Structural distortion

Learning outcome

The learner will:

7 Understand the dynamic balancing of shafts in military helicopters

Assessment criteria

The learner can:

7.1 describe the basic principles of shaft (rotor) balance correction

7.2 describe the relationship between unbalance and vibration in a rotor

7.3 describe the process of shaft balancing

Range

(AC7.2)

- Unbalance forces
- Additional vibration sources
- Reasons for identifying all vibration causes
- Sources of information for each aircraft type
- Vibration due to unbalance
- Vibration due to misalignment
- Vibration due to mass

(AC7.3)

- Definition of ‘dynamic balance’:
- Additional definition of unbalance
- Types of unbalance in shafts
- Balance planes
- Multi-plane balancing

Appendix 1 Relationships to other qualifications

Links to other qualifications

Centres are responsible for checking the different requirements of all qualifications they are delivering and ensuring that candidates meet requirements of all units/qualifications.

Literacy, language, numeracy and ICT skills development

This [these] qualification[s] can develop skills that can be used in the following qualifications:

- Functional Skills (England) – see www.cityandguilds.com/functionalskills
- Essential Skills (Northern Ireland) – see www.cityandguilds.com/essentialskillsni
- Essential Skills Wales – see www.cityandguilds.com/esw

Appendix 2 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the Centres and Training Providers homepage on www.cityandguilds.com.

Centre Manual - Supporting Customer Excellence contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification, as well as updates and good practice exemplars for City & Guilds assessment and policy issues.

Specifically, the document includes sections on:

- The centre and qualification approval process
- Assessment, internal quality assurance and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Management systems
- Maintaining records
- Assessment
- Internal quality assurance
- External quality assurance.

Our Quality Assurance Requirements encompasses all of the relevant requirements of key regulatory documents such as:

- SQA Awarding Body Criteria (2007)
- NVQ Code of Practice (2006)

and sets out the criteria that centres should adhere to pre and post centre and qualification approval.

Access to Assessment & Qualifications provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment.

The **centre homepage** section of the City & Guilds website also contains useful information on such things as:

- **Walled Garden**: how to register and certificate candidates on line
- **Events:** dates and information on the latest Centre events
- **Online assessment**: how to register for e-assessments.

Centre Guide – Delivering International Qualifications contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification.

Specifically, the document includes sections on:

- The centre and qualification approval process and forms
- Assessment, verification and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Frequently asked questions.

Appendix 3 Useful contacts

UK learners General qualification information	**E: learnersupport@cityandguilds.com**
International learners General qualification information	F: +44 (0)20 7294 2413 **E: intcg@cityandguilds.com**
Centres Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results	F: +44 (0)20 7294 2413 **E: centresupport@cityandguilds.com**
Single subject qualifications Exam entries, Results, Certification, Missing or late exam materials, Incorrect exam papers, Forms request (BB, results entry), Exam date and time change	F: +44 (0)20 7294 2413 F: +44 (0)20 7294 2404 (BB forms) **E: singlesubjects@cityandguilds.com**
International awards Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports	F: +44 (0)20 7294 2413 **E: intops@cityandguilds.com**
Walled Garden Re-issue of password or username, Technical problems, Entries, Results, e-assessment, Navigation, User/menu option, Problems	F: +44 (0)20 7294 2413 **E: walledgarden@cityandguilds.com**
Employer Employer solutions, Mapping, Accreditation, Development Skills, Consultancy	T: +44 (0)121 503 8993 **E: business@cityandguilds.com**
Publications Logbooks, Centre documents, Forms, Free literature	F: +44 (0)20 7294 2413

If you have a complaint, or any suggestions for improvement about any of the services that we provide, email: feedbackandcomplaints@cityandguilds.com

About City & Guilds

As the UK's leading vocational education organisation, City & Guilds is leading the talent revolution by inspiring people to unlock their potential and develop their skills. We offer over 500 qualifications across 28 industries through 8500 centres worldwide and award around two million certificates every year. City & Guilds is recognised and respected by employers across the world as a sign of quality and exceptional training.

City & Guilds Group

The City & Guilds Group is a leader in global skills development. Our purpose is to help people and organisations to develop their skills for personal and economic growth. Made up of City & Guilds, City & Guilds Kineo, The Oxford Group and ILM, we work with education providers, businesses and governments in over 100 countries.

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