QUALIFICATION HANDBOOK

Level 3 Diploma in Aircraft Maintenance (Military Aircraft Weapons Maintenance) (2675-03)

February 2019 Version 2

City & Guilds

Qualification at a glance

Subject area	Aeronautical Engineering
City & Guilds number	2675
Age group approved	16-18, 19+
Entry requirements	City & Guilds does not set a minimum requirement for entry to this qualification. The apprenticeship framework **suggests** the following: Employers would be interested in candidates that: • Are keen and motivated to work in an engineering environment • Are willing to undertake a course of training both on-the-job and off-the-job and apply this learning in the workplace • Have previous work experience or employment in the sector • Have completed a 14 to 19 Diploma in Engineering or Manufacturing • Have completed a Young Apprenticeship in Engineering or other related area • Have GCSEs in English, Maths and Science • Have completed tests in basic numeracy, literacy and communication skills and have spatial awareness As a guide, the Engineering Manufacturing framework is suitable for applicants who have five GCSEs grades D to E in English, Maths and Science.
Assessment	Assignment, Multiple Choice test
Fast track	Available
Support materials	Centre handbook
Registration and certification	Consult the City & Guilds website for information

Title and level	GLH	TQT	City & Guilds number	Accreditation number
Level 3 Diploma in Aircraft Maintenance (Military Aircraft Weapons Maintenance)	720	800	2675-03	600/1973/6

Version and date	Change detail	Section
1.1 March 2014	Correction in unit 203 - Density: kgm^{-2} to Density: kgm^{-3}	Units
1.2 June 2014	Test Spec amended	Assessment
1.3 September 2017	Added TQT details Deleted QCF	**Qualification at a glance and Structure** **Throughout**
V2 February 2019	Removed range from Unit 203 Outcome 1 List 3 Corrected layout and numbering	**Unit 203** **All units**

Contents

1 Introduction

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

Area	Description
Who is the qualification for?	For candidates who work or want to work in the aeronautical engineering sector across a range of roles and career routes.
What does the qualification cover?	Allows candidates to learn, develop and practise the skills required for employment and/or career progression in the aeronautical engineering sector.
Is the qualification part of a framework or initiative?	This qualification is recognised as a technical certificate in the Engineering Manufacture apprenticeship framework.
What opportunities for progression are there?	Further opportunities for candidates include: • Level 2 NVQ Diploma in Aeronautical Engineering (City & Guilds 1789) • Level 3 Diploma in Aircraft Engineering (City & Guilds 2675) • Level 3 Certificate/Diploma in Aircraft Manufacturing (City & Guilds 4597) • Level 3 Diploma in Survival Equipment (City & Guilds 5412)

Structure

Learners require **80 credits** to achieve the Level 3 Diploma in Aircraft Maintenance (Military Aircraft Weapons Maintenance).

Learners can obtain a further 5 credits from the Elective Unit 111. However, these credits do not contribute to the required minimum for the qualification.

Mandatory Units

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
M/503/1263	Unit 035	Human factors in aviation	5
A/503/0956	Unit 201	Fundamentals of electronics and avionics	10
L/503/0959	Unit 202	Military policy and regulation in aviation	4
D/503/0965	Unit 203	Aerodynamics and control in a fixed-wing aircraft	5
L/503/1111	Unit 211	Maintaining aircraft armament expendable stores	18
L/503/1139	Unit 212	Maintaining aircraft assisted escape systems	12
R/503/1112	Unit 213	Maintaining aircraft gun systems	10
Y/503/1113	Unit 214	Maintaining aircraft weapons electrical systems	8
D/503/1128	Unit 215	Aviation mathematics and science for technicians	8

Elective Unit

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
D/503/0951	Unit 111	Working safely with aircraft armament systems	5

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
Level 3 Diploma in Aircraft Maintenance (Military Aircraft Weapons Maintenance)	720	800

2 Centre requirements

Approval

For Level 2, centres already delivering the Level 2 City & Guilds Certificate in Aeronautical Engineering (2597) will be automatically approved to run the Level 2 routes in this qualification.

For Level 3, centres already delivering the City & Guilds Certificate in aeronautical Engineering (2661) will be automatically approved to run this new qualification at both levels 2 and 3.

To offer this qualification, 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 qualification before designing a course programme.

Resource requirements

Physical resources and site agreements

Centres can use specially designated areas within a centre to assess, for example, the installation of specialised electrical systems, alignment and setting up of electric motors and driven devices (pumps, compressors, and generators). The equipment, systems and machinery must meet industrial standards and be capable of being used under normal working conditions, for example electric motors must have a method of applying sufficient power and not be connected up to show movement.

Please note that to gather the requisite evidence, access to flight worthy aircraft is required on a regular basis.

Centre staffing

Centre staff must satisfy the requirements for occupational expertise for this qualification. These requirements are as follows:

Staff should be technically competent in the areas for which they are delivering training and/ or should also have experience of providing training.

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 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.

Assessors and internal verifiers

While the Assessor/Verifier (A/V) units are valued as qualifications for centre staff, they are not currently a requirement for the qualification.

Continuing professional development (CPD)

Centres must support their staff to ensure that they have current knowledge of the occupational area, that delivery, mentoring, training, assessment and verification

Verifier Requirements (internal and external)

Internal quality assurance (Internal Verification) must be carried out by competent Verifiers that as a minimum must hold the Level 4 Award in the Internal Quality Assurance of Assessment Processes and Practices. Current and operational Internal Verifiers that hold internal verification units V1 or D34 will not be required to achieve the Level 4 Award as they are still appropriate for the verification requirements set out in this Unit Assessment Strategy. Verifiers must be familiar with, and preferably hold, either the nationally recognised Assessor units D32 and/or D33 or A1 and/or A2 or the Level 3 Award in Assessing Competence in the Work Environment.

External quality assurance **(External Verification)** must be carried out by competent External Verifiers that as a minimum must hold the Level 4 Award in the External Quality Assurance of Assessment Processes and Practices**.** Current and operational External Verifiers that hold external verification units V2 or D35 will not be required to achieve the Level 4 Award as they are still appropriate for the verification requirements set out in this Unit Assessment Strategy. Verifiers must be familiar with, and preferably hold, either the nationally recognised Assessor units D32 and/or D33 or A1 and/or A2 or the Level 3 Award in Assessing Competence in the Work Environment

External and Internal Verifiers will be expected to regularly review their skills, knowledge and understanding and where applicable undertake continuing professional development to ensure that they are carrying out workplace Quality Assurance (verification) of Assessment Processes and Practices to the most up to date National Occupational Standards (NOS) Verifiers, both Internal and External, will also be expected to be fully conversant with the terminology used in the NVQ units against which the assessments and verification are to be carried out, the appropriate Regulatory Body's systems and procedures and the relevant Awarding Organisation's documentation.

Candidate entry requirements

City & Guilds does not set entry requirements for this qualification. However, centres must ensure that candidates have the potential and opportunity to gain the qualification successfully so should have the opportunity to gather work based evidence.

The SEMTA Engineering Manufacture apprenticeship framework suggests that:

Employers would be interested in candidates that:

- Are keen and motivated to work in an engineering environment
- Are willing to undertake a course of training both on-the-job and off-the-job and apply this learning in the workplace
- Have previous work experience or employment in the sector

- Have completed a 14 to 19 Diploma in Engineering or Manufacturing
- Have completed a Young Apprenticeship in Engineering or other related area
- Have GCSEs in English, Maths and Science
- Have completed tests in basic numeracy, literacy and communication skills and have spatial awareness.

As a guide, the Engineering Manufacturing framework is suitable for applicants who have five GCSEs grades D to E in English, Maths and Science. The selection process on behalf of employers may include initial assessment where applicants will be asked if they have any qualifications or experience that can be accredited against the requirements of the apprenticeship. They may also be required to take tests in basic numeracy and literacy, communications skills and spatial awareness. There may also be an interview to ensure applicants have selected the right occupational sector and are motivated to become an apprentice, as undertaking an apprenticeship is a major commitment for both the individual and the employer.

Recognition of prior learning

Without evidence of formal qualifications, candidates must demonstrate adequate prior knowledge and experience to ensure they have the potential to gain the qualification. It is recognised that learners come from a wealth of applicable backgrounds and in these cases it is recommended that the centre assess learner competence against their claims.

Age restrictions

There is no age restriction for this qualification unless this is a legal requirement of the process or the environment.

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 qualification.
- any units they have already completed, or credit they have accumulated which is relevant to the qualification.
- 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, their responsibilities as a candidate, and the responsibilities of the centre. This information can be recorded on a learning contract.

Support materials

The following resources are available for these qualifications:

Description	How to access
Centre devised forms	**www.cityandguilds.com**, 2675 qualification pages
Centre devised generic guidance: • Centre guidance • Generic grading criteria	**www.cityandguilds.com**, 2675 qualification pages
Guidance for producing centre devised tasks (specific guidance for each unit within a pathway)	**www.cityandguilds.com**, 2675 qualification pages
Example assignments (for selected units only)	**www.cityandguilds.com**, 2675 qualification pages

4 Assessment

Assessment of the qualification

This qualification is assessed by a combination of e-assessments (multiple choice tests) and centre devised assignments covering practical skills and underpinning knowledge. The table below provides details on the assessment methods for each unit.

Mandatory Units

City & Guilds unit number	Unit title	Assessment method
2675-035	Human factors in aviation	e-assessments
2675-201	Fundamentals of electronics and avionics	e-assessments
2675-202	Military policy and regulation in aviation	Centre Devised Assignment
2675-203	Aerodynamics and control in a fixed-wing aircraft	e-assessments
2675-211	Maintaining aircraft armament expendable stores	Centre Devised Assignment
2675-212	Maintaining aircraft assisted escape systems	Centre Devised Assignment
2675-213	Maintaining aircraft gun systems	Centre Devised Assignment
2675-214	Maintaining aircraft weapons electrical systems	Centre Devised Assignment
2675-215	Aviation mathematics and science for technicians	e-assessments

Elective Unit

City & Guilds unit number	Unit title	Assessment method
Unit 111	Working safely with aircraft armament systems	Centre Devised Assignment

Online multiple-choice assessments

The online multiple-choice assessments for this qualification will be in the form of a question with three options to choose from (a, b, c) and calculators are **not** permitted. This is to bring it in line with the CAA exams and the expectation from industry that candidates can do basic mathematics (including long division) without a calculator. Please refer to the 2675-001 sample questions to understand the level of maths required of candidates – this will be available to download from the City & Guilds website.

Centre set assignments

Centres must refer to '*Developing assignments – guidance for centres'* and the associated assignment development forms which are available to download from **www.cityandguilds.com**.

Example assignments and specific assessment guidance for each unit is also available for this qualification and can be found on **http://www.cityandguilds.com**.

Approval process for centre set assignments

Centre set assignments must be approved by the external verifier before use. For each assignment, the *assignment sign off sheet* (AD3) must be completed and be made available to the EV for inspection.

Time constraints

Timings for e-assessments are indicated in the test specifications. The centre set and marked assignments will need to have some limits to the time available. The time available may be based on practicalities such as scheduling marking during the required period, but the time available must always be sufficient for candidates to tackle the task fairly, and candidates will be able to negotiate extra time in appropriate circumstances.

Test specifications

The way the knowledge is covered by each online test is laid out in the tables below:

Test 1: Unit 035 Human Factors in Aviation
Duration: 60 minutes

Outcome	Number of questions	%
01 Understand why human factors are important in aviation	2	5
02 Know features of human performance	6	15
03 Know aspects of social psychology	6	15
04 Know personal factors that affect human performance	6	15
05 Know physical aspects of working environments that affect human performance	5	12.5
06 Know categories of task that can affect human performance	5	12.5

07 Understand communication in the workplace	3	7.5
08 Understand how human error occurs	3	7.5
09 Know hazards and risks in aeronautical engineering environments	4	10
Total	**40**	**100**

Test 2: Unit 201 Fundamentals of electronics and avionics
Duration: 90 minutes

Outcome	**Number of questions**	**%**
01 Understand the principles of electrical current and charge	9	15
02 Understand the principles of aircraft electrical power generation	8	13
03 Understand the principles and uses of aircraft batteries	7	12
04 Understand the use of aircraft cables and associated devices	8	13
05 Understand aircraft cabling tasks	1	2
06 Understand aircraft power supplies	7	12
07 Understand aircraft flight instruments and lighting systems	7	12
08 Understand digital aircraft control and monitoring systems	13	22
Total	**60**	**100**

Test 3: Unit 203 Aerodynamics and control in a fixed-wing aircraft
Duration: 90 minutes

Outcome	**Number of questions**	**%**
01 Know the basic properties of the Earth's atmosphere	4	7
02 Understand the nature of airflow around aerodynamic bodies	13	22
03 Understand the characteristics of the basic wing planforms	4	6
04 Understand the principles of aircraft control	9	15

05 Understand the principles of aircraft stability	7	12
06 Understand the purpose and operation of secondary flying control surfaces	10	16
07 Understand methods of balancing and trimming control surfaces	6	10
08 Understand the basic theory of high speed flight	7	12
Total	**60**	**100**

Test 4: Unit 215 Aviation mathematics and science for technicians
Duration: 105 minutes

Outcome	**Number of questions**	**%**
01 Be able to use principles of arithmetic	8	11.5
02 Be able to use SI, Imperial and US customary units	7	10
03 Be able to manipulate algebraic expressions and formulae using standard techniques	7	10
04 Be able to calculate physical properties of common two and three dimensional shapes	5	7
05 Be able to use graphs to determine values and solve engineering problems	6	8.6
06 Understand the nature of matter	9	12.9
07 Understand principles of statics	9	12.9
08 Understand principles of linear, angular and oscillating motion related to aircraft in flight	8	11.4
09 Understand principles of dynamics related to aircraft in flight	7	10
10 Understand principles of fluid motion related to aircraft in flight.	4	5.7
Total	**70**	**100**

5 Units

Availability of units

Below is a list of the learning outcomes for all the units. If you want to download a complete set of units, go to **www.cityandguilds.com**

Structure of units

These units each have the following:

- City & Guilds reference number
- unit accreditation number (UAN)
- title
- level
- credit value
- unit aim
- relationship to NOS, other qualifications and frameworks
- endorsement by a sector or other appropriate body
- information on assessment
- learning outcomes which are comprised of a number of assessment criteria
- notes for guidance

Unit 035 Human factors in aviation

Level: **3**

Credit value: **5**

UAN: **M/503/1263**

Unit aim

The aim of this unit is to give the learner a comprehensive knowledge of human factors within the aircraft industry to assist them in living and working safely. It is a mandatory subject within the industry. The unit covers the complete syllabus of EASA Module 9 for Category B1 and B2 licences.

Learning outcomes

There are **ten** learning outcomes to this unit. The learner will:

1. understand why human factors are important in aviation
2. understand features and limitations of human performance
3. understand aspects of social psychology
4. understand personal factors that affect human performance
5. understand how physical aspects of the working environment affect human performance
6. understand how categories of tasks can affect human performance
7. understand communication in the workplace
8. understand the causes of human error
9. understand the human factors aspects of aircraft incidents
10. understand risk assessments in aeronautical engineering environments

Guided learning hours

It is recommended that **40** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Aeronautical Engineering Level 2 NOS Unit 001 and Level 3 NOS Unit 003.

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Key Skills

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

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

Assessment and grading

This unit will be assessed by:

- An online multiple-choice test.

Unit 035 Human factors in aviation

Outcome 1 Understand why human factors are important in aviation

Assessment Criteria

The learner can:

1. explain the term 'Human Factors'
2. explain why Human Factors is important in the aeronautical engineering workplace
3. explain categories of Human Factor that are important to aeronautical engineering staff

Range/Scope/Unit content

List 1

Meaning of the term and how it is used in aviation
SHEL Model, 'Murphy's Law', anthropometry

List 2

Eg:
Safety of employees, passengers, people on the ground etc
Safety of assets (eg: aircraft, equipment etc)
Long-term health of employees
Efficiency of the organisation

List 3

Eg:
Working environment
Work patterns
Social habits
Work load
Communication
Employee health.

Unit 035 Human factors in aviation

Outcome 2 Understand features and limitations of human performance

Assessment Criteria

The learner can:

1. explain how images are seen and interpreted by humans
2. explain how sounds are heard and interpreted by humans
3. explain limitations of human memory
4. describe factors that affect mental attention span
5. describe how variations in an individual's sight and hearing can affect their behaviour
6. explain how working in challenging environments presents risks to airworthiness.

Range/Scope/Unit content

List 1

To include:

Main parts of the eye

How each part of the eye reacts to light

Rods and cones

Seeing in high and low light

Peripheral vision

Interpretation by the brain

List 2:

To include:

Main parts of the ear

Vulnerable parts of the ear

Effect of noise – percussive, prolonged high intensity, varying pitch

Noise Induced Hearing Loss (NIHL)

Legal requirements for hearing protection

Correct protection for frequency range

List 3

Simple explanation eg:

Time from exposure to information

Form that information is in (audio, visual, words, pictures etc.)

Fatigue

Age

Complexity of information

Artificial stimulants/depressants

Types (iconic, echoic, episodic, symantic)

List 4
Eg:
Overconfidence
Boredom
Fatigue
Complexity of information
Artificial stimulants/depressants

List 5
Individually and i combination (such as in older people)
Sight eg:

- Long and short sight
- Optical illusion including the strobe effect
- Persistence
- Moving from light area to work in the dark
- Optimum lighting for typical tasks
- Long and short sight
- Use of spectacles and magnifiers

Hearing eg:

- High and low tone deafness
- Tinnitus
- Hearing damage, poor communication

Social isolation (at work and at home)

List 6
At height and in confined spaces eg:
Claustrophobia
Fear of heights
Limited access/egress to a large space
Confined space
Specific tasks (eg: inspections on fuselage crown or in equipment bays)
Low concentration
Rushing the task
Cutting corners
Poor vision.

Unit 035 Human factors in aviation

Outcome 3 Understand aspects of social psychology

Assessment Criteria

The learner can:

1. explain areas of individual and group responsibility in aircraft engineering environments
2. explain motivation and de-motivation
3. explain 'peer pressure'
4. explain company culture
5. explain the concepts of team working
6. identify the primary responsibilities of engineering managers and supervisors
7. discuss the basic concept of leadership

Range/Scope/Unit content

List 1

Outline of a typical organisation (must include maintenance)
Typical roles and responsibilities
Individuals and groups or teams
Individual responsibility when working alone and within a team
Group or team responsibilities
Overview of group and inter-group dynamics (eg: rivalry, polarisation, 'social loafing')

List 2

Overview of:
Fulfilling individual needs
Maslow's Hierarchy of Needs
Individual motivation
Motivation by management
Characteristics of motivation and de-motivation
How they can be affected by internal and external factors eg:
Management decisions
Personal situation

List 3

Eg:
Conformity and non-conformity
Pressure from co-workers, not management
Advice and pressure from more experienced colleagues to adopt particular work practices
How it can affect performance of maintenance tasks

List 4

Overview of different types of culture (eg: safety, organisational, shift, team, social etc.)

More detailed knowledge of safety culture and the individual

How company culture can compromise best working practices

List 5

What is a team?

Advantages and disadvantages of team working

Team identity

Working with other teams

Ownership of tasks

Communication

Co-operation

Mutual support

List 6

Difference between management and supervisor roles

What should an employee expect from a supervisor? (eg motivation, support, guidance etc.)

Engineering organisations (eg: part145, military maintenance organisation)

List 7

What is a leader?

The basic characteristics of a leader

How and when any individual might provide leadership eg:

Passing on knowledge and experience to colleagues

Organising and directing group tasks

Inspection and reporting on the work of others.

Unit 035 Human factors in aviation

Outcome 4 Understand personal factors that affect human performance

Assessment Criteria

The learner can:

1. explain effects of personal health and fitness on work performance
2. identify types of stress
3. explain effects of setting time deadlines on individual work performance
4. explain the concept of work overload and underload
5. explain the effects of shift work on sleep and fatigue
6. explain the effects of alcohol, medication and substance abuse
7. explain the personal legal obligations of individuals in the aviation industry.

Range/Scope/Unit content

List 1

Legal requirement for individual physical and mental fitness while at work

Types of medical condition that might affect work eg:

Minor illness (eg: cold, 'flu, sickness etc.)

Major physical illness (eg: heart attack, stroke, cancer etc.)

Mental illness (eg: depression etc.)

Minor physical injury (eg: sprained wrist, pulled muscle, cramp etc.)

Major physical injury (eg: broken bones, lacerations etc.)

Effects of toxins and other substances (eg: carbon monoxide, alcohol, drugs etc.)

Gradual deterioration in physical condition

List 2

Define 'stress' (eustress, distress, acute stress, chronic stress, hypo stress, hyper stress)

Sources:

- Home (eg: family illness, divorce etc.)
- Work (organisational, task related)

Types:

- Acute and chronic stress

Signs of stress (physical, health, behaviour, cognitive, other)

Explain how stress can affect individual performance at work

List 3

Actual, perceived and self-imposed deadlines

Effects of time pressure and deadlines

Managing time pressure and deadlines

List 4
Definition of work overload and underload
Results of work overload and underload
Factors determining workload
Workload management

List 5
What is sleep?
Five stages of sleep
Circadian rhythms
Fatigue (causes, symptoms)
Advantages and disadvantages of shift work
Working at night
Types of shift pattern

List 6
Effects of alcohol
Removal of alcohol from the blood
Effects while fatigued, hungry or combined with medication
Types, effects, short and long term consequences of abuse of:
Alcohol
Prescription medication
Over-the-counter medication
Illegal drugs
Effects on individual work performance

List 7
Eg:
Alcohol limits and legal requirements for aircraft engineers
CAP 562/AN47
Transport legislation/AN45
Health and Safety legislation.

Unit 035 Human factors in aviation

Outcome 5 Understand how physical aspects of the working environment affect human performance

Assessment Criteria

The learner can:

1. explain effects of noise on individuals and groups
2. explain effects of fumes on individual performance
3. explain effects of varying illumination on an individual performance
4. explain effects of variations in climate on an individual performance
5. explain effects of exposure to constant motion and vibration while working
6. explain effects of layout of a working environment on individual performance.

Range/Scope/Unit content

List 1

Eg effects on:
Concentration
Communication

List 2

Eg effects on:
Concentration
Communication
Longer term effects
Safe oxygen levels

List 3

Eg:
Ability to see detail
Moving between areas of different illumination, including well-lit hangar and night flight line
Strobe effect and propellers

List 4

Eg:
Cold/wet, warm/dry, hot/humid environments

List 5

Eg:
Working at height on scissor platforms and cherry picker
Unsteady platforms
Use of rotating or percussive tools
Vibration White Finger (VWF)

List 6

Eg:

The three components of a working environment

Layout

Cleanliness

Ease of movement between work areas

Lighting, noise, atmosphere, temperature etc

Social environment

Tasks, tools and information.

Unit 035 Human factors in aviation

Outcome 6 Understand how categories of tasks can affect human performance

Assessment Criteria

The learner can:

1. explain the importance of planning the execution of a task
2. explain effects of physically demanding work on individual performance
3. explain effects of repetitive tasks on individual performance
4. explain aspects of visual inspection
5. explain aspects of working on complex systems.

Range/Scope/Unit content

List 1

Eg:
Defining the task
Defining the resources
Personal skills and proficiency
Information

List 2

Eg:
Health and physical condition, effects of ageing
Work environment
Physical effort
Effects of ageing

List 3

Eg:
Ignoring manuals, job cards etc.
Complacency
Making assumptions

List 4

Eg:
Importance of good eyesight
Knowledge of the inspection area
Illumination
Concentration
Systematic search

List 5

Eg:
Simple system: transparent to the engineer
Complex system: opaque to the engineer
Clear understanding of the purpose of the system
System-specific training
Pooling of knowledge and skills
Clear and comprehensive information and guidance.

Unit 035 Human factors in aviation

Outcome 7 Understand communication in the workplace

Assessment Criteria

The learner can:

1. explain the importance of good communication in the workplace
2. explain the importance of accurate work logging
3. explain modes of communication between individuals and teams
4. explain the importance of maintaining individual professional currency
5. explain the importance of information dissemination

Range/Scope/Unit content

List 1

Within and between groups eg:
Prevention of accidents
Maintaining good working relations
Organisational efficiency

List 2

Eg:
Formal work logging
Shift logging
Shift handover
Task staging
Duplicate
Inspection
Stage sheets/check

List 3

Eg:
Verbal
Written
Body language
Workplace social culture
Communication between all levels of an organisation

List 4

Eg:
Refresher training
Reading briefing material
Notices and amendments to maintenance procedures
Reading professional journals
Undertaking up-skilling and further licence training.

Unit 035 Human factors in aviation
Outcome 8 Understand the causes of human error

Assessment Criteria

The learner can:

1. explain the error models and theories used in aeronautical engineering
2. explain types of error that occur during work on aircraft
3. describe the error-incident-accident chain
4. describe methods of managing and avoiding errors.

Range/Scope/Unit content

List 1

Eg
Induced
Variable
Reversible/irreversible
Slips, lapses and mistakes
The 'Swiss Cheese Model'

List 2

Eg:
Complacency
Environmental capture
Rule-based errors
Violations
Individual practices and habits
Errors associated with visual inspection
Latent/active errors

List 3

Eg:
Self discipline
Safety Management System
Anonymous and blame-free reporting
Training
Logging and analysis.

Unit 035 Human factors in aviation

Outcome 9 Understand the human factors aspects of aircraft incidents

Assessment Criteria

The learner can:

1. analyse an incident report to extract information
2. identify a sequence of events from a narrative report
3. identify human factors contributing to an incident
4. draw conclusions from incident data.

Range/Scope/Unit content

List 1

Using extracts from an actual report or a realistic example
Filter out irrelevant detail

List 2

How, why, when where, who
Use presentation aids such as flow diagrams
Identify what should have been done

List 3

Analyse the information and identify contributing factors
Including where possible:

- Personal behaviour
- Environmental conditions
- Management
- Organisational culture

Using eg:

- MEDA
- MEMS

List 4

Including where necessary, brief details of:
Environment
Personal issues
Organisation
Nature and mix of allocated tasks
Recommendations for preventative action.

Unit 035 Human factors in aviation

Outcome 10 Understand risk assessments in aeronautical engineering environments

Assessment Criteria

The learner can:

1. define the terms associated with risk assessment
2. describe the five steps to risk assessment
3. describe the associated risks for workplace hazards
4. describe conclusions from risk assessments
5. explain how to manage workplace emergencies.

Range/Scope/Unit content

List 1

Hazard

Risk

Severity

Likelihood (probability)

List 2

1 - Identify hazards

2 - Decide who might be harmed and how

3 - Evaluate risks and decide on precautions

4 - Record findings and implement them

5 - Review and update

List 3

Step 2

List 4

Steps 2 and 3

Recommend ways of eliminating or reducing to an acceptable level, a range of identified risks

List 5

Steps 3 and 4 eg:

Reduce the likelihood of them happening

Management of workplace emergency situations such as fire, spillage, personal injury etc.

Unit 035 Human factors in aviation

Notes for guidance

The teaching of the knowledge content of this unit should be referenced to the Civil Aviation Authority (CAA) publication CAP715 or its military equivalents. The City & Guilds GOLA examination is based on the content of CAP 715.

This unit contains the complete syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 9 – Human Factors. The equivalent EASA knowledge level indicators for each of the above outcomes are listed below with an abridged description of each level:

Level 1 – "A familiarisation with the principal elements of the subject"

Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"

Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

Outcome 1: EASA Level 2
Outcome 2: EASA Level 2
Outcome 3: EASA Level 1
Outcome 4: EASA Level 2
Outcome 5: EASA Level 1
Outcome 6: EASA Level 1
Outcome 7: EASA Level 2
Outcome 8: EASA Level 2
Outcome 9: EASA Level 2
Outcome 10: EASA Level 2

Note: the above list equates to the EASA requirement for category B licences and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Unit 111 Working safely with aircraft armament systems

Level: **2**
Credit value: **5**
UAN: **D/503/0951**

Unit aim

The aim of this unit is to give learners a solid grounding in safe working on aircraft fitted with armament systems and assisted escape systems (AAES).

Learning outcomes

There are **nine** learning outcomes to this unit. The learner will:

1. understand explosive safety
2. understand aircraft assisted escape systems (AAES)
3. know aircraft armament role equipment
4. know aircraft stores management systems
5. know aircraft gun systems
6. know aircraft missiles
7. understand aircraft countermeasure systems
8. know aircraft weapons
9. understand safety precautions for armed aircraft

Guided learning hours

It is recommended that **40** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Aeronautical Engineering Level 2 NOS Units 7 and 8

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Key Skills

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

- Application of Number

Assessment and grading

(Note: due to the safety implications of this unit, and its product-specific content, the assessment must be centre-set. The pass-mark will be 100% in this case, which is the industry standard.

This unit will be assessed by:

- Centre-set multiple –choice test covering underpinning knowledge
- Centre-set practical assessment.

Unit 111 Working safely with aircraft armament systems

Outcome 1 Understand explosive safety

Assessment Criteria

The learner can:

1. describe what explosives are and how they are categorised
2. describe the Explosive Train
3. explain explosive lifing
4. describe the dangers of static electricity and explosive devices
5. define thunderstorm risk categories and actions
6. describe general explosive safety rules
7. describe dangers involving armed aircraft
8. state the use of role colours and hazard application bands on explosive devices
9. describe the United Nations classification of explosives
10. describe the dangers in relation to Radio Frequency hazards and Explosive devices.

Range/Scope/Unit content

List 1

Define the term 'explosive'
Define terms related to explosives:
Velocity of Detonation
Figure of Power
Figure of Insensitivity
Describe the hierarchy of explosives
Describe the difference between Low and High Explosive

List 2

Eg:
Step-up-System of Detonation
Low explosive train (eg: primer – igniter – propellant)
High explosive train eg:
Two-step (eg: detonator – explosive)
Three step (eg: detonator – booster – main charge)

List 3

Eg:
How explosives deteriorate over time
Effects of environment (temperature, humidity etc)
Labelling and recording of manufacture and expiry dates

List 4

Eg: potential to detonate when in contact with static discharge

List 5

Thunderstorm Category & Definition:

Category 1 (High) - Thunderstorms will develop / have developed in the area

Category 2 (Moderate) - Thunderstorms may develop in the area

Category 3 (Low) - Thunderstorms are not expected in the area. Category & Definition

List 6

General and organisation-specific rules contained in eg:

BAe Systems Explosive & Prohibited Weapons Safety (QMS)

JAP 100A

List 7

Armed aircraft danger areas potential risks

Eg:

Front – Guns, Missiles & Rockets.

Rear – Missiles, Rockets, Chaff & Flare, Towed Decoy, Smoke Marker/Sonar buoy Discharger.

Generally- Bombs, Ejector Release Units, Drop Tanks, Explosive Start Valves

List 8

Colour Coding and Marking of Stores:

Explosive stores carry markings used to indicate:

Primary role

Degree of danger or hazard to personnel who come in contact or handle them

List 9

Reason eg: to facilitate fire fighting

Explosives and ammunition divided according to their behaviour when involved in a fire

Symbols: orange coloured with black numerals denoting the fire division

List 10

Eg: spontaneous detonation of EEDs in the presence of external RF radiation

Define 'intrinsically safe'.

Unit 111 Working safely with aircraft armament systems

Outcome 2 Understand aircraft assisted escape systems (AAES)

Assessment Criteria

The learner can:

1. describe ejection seats fitted to military fast-jet aircraft
2. describe ejection seat major assemblies
3. describe the purpose of ejection seat components
4. describe Command Ejection systems
5. describe Canopy Jettison and Fragmentation Systems.

Range/Scope/Unit content

List 1

One or more seats eg: Tornado, Typhoon
Including safety pin positions and other device selections for:
Safe for Parking
Safe for Maintenance

List 2

Description of:
BTRU
Drogue Gun
Head Box
Top Latch Assembly
Firing Units
Cartridges
Main Gun
QRF
Rocket Pack

List 3

Locate and explain the purpose of:
Main beam assembly
Main Gun Assembly
Top Latch Assembly
Seat pan Assembly
Parachute harness and head box
Quick Release Fittings (QRF)
Barostatic Time Release Unit (BTRU)
Drogue Gun/Parachute Deployment Unit (PDU)
Emergency Oxygen System (EO2)
Leg/Limb Restraint Systems
Harness Power Retraction Unit (HPRU)
Personal Equipment Conector (PEC)

Personal Survival Pack (PSP)
Auto Deployment Unit (ADU)
Auto Liferaft Inflation Unit (ALIU)
Trip rods
Armed/Safe/Egress Handle

List 4
For specific aircraft eg: Tornado, Typhoon:
Command Control Valve
Command Ejection Controller
Command Mode Selector

List 5
For specific aircraft eg: Tornado, Typhoon eg:
MDC
CLC.

Unit 111 Working safely with aircraft armament systems

Outcome 3 Know aircraft armament role equipment

Assessment Criteria

The learner can:

1. identify types of suspension lugs
2. identify items of carriage and release equipment used on aircraft
3. explain the operation of carriage and release equipment.

Range/Scope/Unit content

List 1

Purpose of including:
Bail Lugs
MACE Lugs

List 2

Including:
Wing Pylons
Fuselage Pylons
Twin Store Carrier (TSC)
Carrier Bomb Light Store (CBLS)
Ejector Release Units (ERU): No.122EX; LDERU; HDERU; ALDERU; AHDERU
Fuzing Units

List 3

Operation and purpose of including:
Wing Pylons
Fuselage Pylons
Twin Store Carrier (TSC)
Carrier Bomb Light Store (CBLS)
Ejector Release Units (ERU)
Fuzing Units.

Unit 111 Working safely with aircraft armament systems

Outcome 4 Know aircraft stores management systems (SMS)

Assessment Criteria

The learner can:

1. state the purpose of a SMS
2. identify the components of the SMS.

Range/Scope/Unit content

List 1

For typical aircraft:
Requirement for managing armament stores
Basic function of the SMS

List 2

Including:
Weapon Programming Unit
Weapon Control Panels
Attack / Weapon Release Button
Master Armament Safety Switch (MASS)
Late Arm Switch
Selective / Emergency Jettison
Trigger
Armament System Ground Test Switch (ASGTS).

Unit 111 Working safely with aircraft armament systems

Outcome 5 Understand aircraft gun systems

Assessment Criteria

The learner can:

1. state the purpose of aircraft gun systems
2. identify components of aircraft gun systems
3. explain the operation of aircraft gun systems.

Range/Scope/Unit content

List 1

Specific aircraft eg: Tornado, Typhoon

List 2

Locate and name components eg:
Breech
Barrel
Cocking mechanism

List 3

Eg:
Loading ammunition tanks
Cocking
Firing
Spent case ejection
Ammunition feed
Live round insertion.

Unit 111 Working safely with aircraft armament systems

Outcome 6 Know aircraft missiles

Assessment Criteria

The learner can:

1. identify Air-to-Air and Air-to-Ground missiles
2. identify components of an air-to-air missile
3. explain the operation of an air-to-air missile.

Range/Scope/Unit content

List 1

Identify and name missiles eg:
Sidewinder
ASRAAM
Brimstone
ALARM

List 2

Identify and name components of eg: Sidewinder

List 3

Explain the purpose and operation of eg: Sidewinder.

Unit 111 Working safely with aircraft armament systems

Outcome 7 Understand aircraft countermeasure systems

Assessment Criteria

The learner can:

1. identify countermeasure systems used on aircraft
2. state the purpose of countermeasure systems
3. explain the operation of countermeasure systems.

Range/Scope/Unit content

List 1

Eg:
Chaff
Flare

List 2

Eg: to disrupt and distract enemy airborne target acquisition systems

List 3

Including:
Chaff dispensers and the action of chaff
Flare dispensers and the action of flares.

Unit 111 Working safely with aircraft armament systems

Outcome 8 Know aircraft weapons

Assessment Criteria

The learner can:

1. identify bomb types including
2. identify major bomb components
3. identify role and hazard colour coding.

Range/Scope/Unit content

List 1

Eg:
3kg and14kg practice bombs

List 2

Tail units
Shear Wires
Lead Electrical Fuzing and Arming (LEFA)

List 3

Colour Coding and Marking of Stores

Unit 111 Working safely with aircraft armament systems

Outcome 9 Understand safety precautions for armed aircraft

Assessment Criteria

The learner can:

1. understand safety precautions relating to armed aircraft.

Range/Scope/Unit content

List 1

Including:

Aircraft Armed signs
Safe Approach to the aircraft
Angle of approach
Check the Master Armament Safety Switch
Undercarriage locks and earthing leads.

Unit 111 Working safely with aircraft armament systems

Notes for guidance

This unit has been designed to cover the essential safety knowledge required by all personnel working on or near aircraft that are fitted with any weapon or device that includes explosive charges. The nature of the subject requires a clear, unambiguous understanding of all of the safety rules, instructions and procedures and this unit allows recognition of an individual's achievement of that understanding. The knowledge in this unit will be assessed by both written and practical (walk-through) means to ensure that the learner is able to relate class-room knowledge to real working environments.

Unit 201 Fundamentals of electronics and avionics

Level: 3
Credit value: 10
UAN: A/503/0956

Unit aim

This unit aims to give the learner sufficient knowledge of aircraft electrical and avionic principles to allow further study on specific systems.

Learning outcomes

There are **eight** learning outcomes to this unit. The learner will:

1. understand the principles of electrical current and charge
2. understand the principles of aircraft electrical power generation
3. understand the principles and use of aircraft batteries
4. know the use of aircraft cables and associated devices
5. understand aircraft cabling tasks
6. understand aircraft power supplies
7. understand aircraft flight instruments and lighting systems
8. understand digital aircraft control and monitoring systems

Guided learning hours

It is recommended that **75** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Aeronautical Engineering Level 3 NOS Units 121, 123 etc

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Key Skills

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

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

Assessment and grading

This unit will be assessed by:

- An online multiple choice test.

Unit 201 Fundamentals of electronics and avionics

Outcome 1 Understand the principles of electrical current and charge

Assessment Criteria

The learner can:

1. describe the structure of the atom
2. describe the distribution of electrical charge in different types of particle
3. describe the molecular structure of electrical materials
4. explain the principle of attraction and repulsion of charged particles
5. explain electrical conduction in different media
6. describe the nature of static electricity
7. describe safety precautions associated with static electricity
8. define terms associated with electricity
9. Illustrate the relationship between voltage, current, resistance and power.

Range/Scope/Unit content

List 1

To a depth which allows understanding of:
Electrical current
Static electricity
Molecules
Compounds

List 2

Atom
Molecule
Compound

List 3

To a depth which allows understanding of:
Electrical current
Operation of semi-conductors
Electrical resistance
Conductors
Insulators

List 4

Simple explanation
Including Coulomb's Law

List 5

Solid, liquid, gas, vacuum

List 6

Eg:
Mechanism of formation of static electricity (friction then separation of different materials)
Types of materials
Environmental conditions
Generation of high discharge voltages
Potential to damage semiconductors etc
Practical examples

List 7
With practical, aircraft-related examples eg:
Refuelling
Conductive tyres
Workshop practice
Lox plants

List 8
Including SI and Imperial (where appropriate) units for each:
Coulomb
Charge
Current
Resistance
Conductance
Electron flow
Conventional current flow
Potential difference
Electromotive force
Voltage
Electrical power

List 9
Practically and theoretically:
Ohms Law
Kirchhoff's Current and Voltage Laws
Series and parallel
Solve practical problems

Unit 201 Fundamentals of electronics and avionics

Outcome 2 Understand the principles of aircraft electrical power generation

Assessment Criteria

The learner can:

1. describe how electricity can be produced using a range of methods
2. explain how to calculate the internal resistance of a battery
3. describe the features of a sinusoidal waveform
4. explain terms relating to a sinusoidal waveform
5. describe the features of other common wave forms
6. make calculations relating to alternating current, voltage and power
7. describe a range of sensors.

Range/Scope/Unit content

List 1

Including:
Light (photoelectric cells)
Heat Thermocouples)
Pressure (piezoelectric)
Chemical action (battery)
Magnetism and motion (generators)

List 2

Standard calculation
Include the effects of internal resistance on an electrical circuit

List 3

Including definitions of:
Phase
Frequency
Cycle

List 4

Sinusoidal values:
Instantaneous
Average
Root mean square
Peak
Peak-to-peak

List 5
Triangular (saw-tooth)
Square

List 6
Calculations for:
Instantaneous
Average
Root mean square
Peak
Peak-to-peak

List 7
The construction, operation and typical aircraft applications of eg:
Piezoelectric crystal
Thermocouple
Photoelectric cell/Light Dependent Resistor (LDR)
“Firewire”.

Unit 201 Fundamentals of electronics and avionics

Outcome 3 Understand the principles and uses of aircraft batteries

Assessment Criteria

The learner can:

1. explain the chemical action of electrical cells
2. describe aircraft batteries
3. explain how the state of charge of aircraft batteries can be determined
4. describe the mandatory safety precautions for the servicing of aircraft batteries
5. describe maintenance procedures for aircraft batteries
6. explain how aircraft batteries are capacity-tested
7. explain constant voltage and constant current charging of aircraft batteries
8. explain 'thermal runaway'

Range/Scope/Unit content

List 1

Basic principles
Qualitative explanation of action
Primary and secondary cells
Standard cell voltages

List 2

Construction and operation of typical:
Dry battery
Lead-acid battery
Nickel-cadmium battery
Other alkaline cells

List 3

Using standard procedures

List 4

Including during:
Charging
Testing
Transportation
Installation
Removal

List 5

Lead-acid
Nickel-cadmium

List 6

Explaining how and why, including:
Definition of capacity
Why capacity reduces
Consequences of un-noticed reduction in capacity
Minimum permissible capacity

List 7
Define constant current
Basic explanation of constant current charging
How and why it is done

List 8
Including:
How thermal runaway happens
Consequences of thermal runaway
How to avoid thermal runaway

Unit 201 Fundamentals of electronics and avionics

Outcome 4 Understand the use of aircraft cables and associated devices

Assessment Criteria

The learner can:

1. describe aircraft cables
2. explain the effect on performance of individual cables when placed in a loom or conduit
3. describe connector types used in aircraft
4. describe crimping tools used in aircraft applications
5. demonstrate the use of wire selection charts
6. describe installation procedures for aircraft cable looms
7. describe the process of soft soldering
8. describe the function and use of general aircraft test equipment
9. describe techniques for testing aircraft cables
10. explain aircraft electrical safety devices.

Range/Scope/Unit content

List 1

Define EWIS (Electrical Wiring Interconnection System)
The construction and purpose of typical cables eg:
High tension
Co-axial
'Kapton' (explain special safety issues)
Special-purpose
General purpose

List 2

Eg:
Reduced current-carrying
Possible signal interference

List 3

Eg connectors used for:
High tension
Power
Data
Communications
Fibre-optics

List 4

Full range of aircraft-use tools for, including:
Ring tongue terminals
Splices
Miniature connectors

Explain:
Construction and operation
Calibration and pre-use checks
Consequences of using an incorrectly calibrated crimp tool

List 5
Explain why and how they are used
Demonstrate using standard industry tables

List 6
Eg:
Safety precautions
Routing
Securing
Protection
Cooling
Screening
Individual cables
Looms
Connectors and connector pins

List 7
When and how it would be used including:
Flux
Solder composition
Heat sources
Cleanliness
Application
Joint inspection

List 8
Electrical and avionic general test equipment including:
Ammeter
Voltmeter
Multimeter (analogue and digital)
Basic oscilloscope

List 9
Including:
Automatic test equipment
Multimeter
Continuity tester
Insulation tester
Time Domain Reflectometer (TDR)

List 10
The function and use of devices such as:
Relays
Fuses
Differential current detection

Unit 201 Fundamentals of electronics and avionics

Outcome 5 Understand aircraft cabling tasks

Assessment Criteria

The learner can:

1. explain the use of crimping tools to terminate cables
2. explain construction processes for aircraft cable looms
3. describe how aircraft cables are identified using the ATA 100 system.

Range/Scope/Unit content

List 1

Use of a range of terminations and crimp tools eg:
Ring tongue terminals
Splices
Miniature connectors
Standard connectors
Testing crimp joints

List 2

General principles and methods using representative aircraft cable and components including:
Different sizes of cable
Different types of cable
Signal and power
Different types of loom tie
Inspection
Repair and maintenance
Standards of cleanliness

List 3

Marking systems eg: ATA100
Marking materials eg:
Ink
Sleeves
Stamping
For a range of cables eg:
Screened
Co-axial
High tension.

Unit 201 Fundamentals of electronics and avionics

Outcome 6 Understand aircraft power supplies

Assessment Criteria

The learner can:

1. describe aircraft battery systems
2. describe the layout of a generic multi-engine electrical power distribution system
3. describe components of an aircraft electrical power distribution system
4. describe the main categories of aircraft electrical-powered services
5. explain how aircraft electrical power is maintained in the event of emergencies
6. explain the sequence of connection and disconnection of aircraft ground/external electrical power
7. describe the standard DC and AC ground power connectors.

Range/Scope/Unit content

List 1

Block diagram
Including the purpose of each component

List 2

Block diagram
Including the purpose of each component

List 3

Generator
Constant speed drive unit
Main battery
Emergency battery
Rotary and static inverters
Transformer rectifier units
Generator control unit
Bus tie relay
Generator control relay
Battery isolation switch
RCCB (Reverse Current Circuit Breaker)

List 4

Vital services
Essential services
Non-essential services

List 5
Using:
Standby generators
Duplication of systems
Batteries
Emergency batteries
Ram air turbines
Transformer rectifier units
Static inverters
Auxiliary power unit

List 6
Engine(s) running, pre/post taxi
DC battery trolley
Ground maintenance
Petrol/diesel power set
Electric/electric power set

List 7
DC and AC connectors
Position and purpose of each pin.

Unit 201 Fundamentals of electronics and avionics

Outcome 7 Understand aircraft flight instruments and lighting systems

Assessment Criteria

The learner can:

1. explain the operation of pitot-static instruments
2. explain gyroscopic motion
3. explain the operation of gyroscopic flight instruments
4. compare the operation of direct and remote reading compasses
5. describe the layout and operation of aircraft stall warning systems
6. describe the layout and operation of the three main aircraft lighting systems.

Range/Scope/Unit content

List 1

Altimeter
Airspeed indicator
Vertical speed indicator
Mach meter

List 2

Qualitative explanation
Define related terms including:
Degrees of freedom
Rigidity
Precession
Gimballing
Topple

List 3

Principles and purpose of:
Artificial horizon
Attitude indicator
Direction indicator
Turn and slip indicator

List 4

Function, purpose and components of eg:
Emergency magnetic compass
Detector unit
Compass computer
Compass indicator

List 5
Typical arrangement and operation of eg:
Sensors
Warning devices

List 6
External: navigation, landing, taxiing, ice
Internal: cabin, cockpit, cargo
Emergency

Unit 201 Fundamentals of electronics and avionics

Outcome 8 Understand digital aircraft control and monitoring systems

Assessment Criteria

The learner can:

1. explain types of electrical signal
2. explain computer terminology
3. explain the purpose of a range of aircraft computer hardware
4. describe the main features of aircraft auto-flight control systems
5. explain radio signals
6. describe aircraft communication systems
7. describe the airborne navigation aids
8. explain the term 'databus'
9. describe aircraft electronic instrument systems
10. describe safety precautions when working on aircraft avionic equipment
11. describe aircraft onboard maintenance systems.

Range/Scope/Unit content

List 1

Analogue and digital

Simple explanation using sketched wave-forms

List 2

Commonly used terminology eg:

Bit

Byte

Software

Hardware

CPU

Chip

Memory:

RAM

ROM

PROM

Hard Drive

List 3

Input devices

Output devices

Microprocessor and interface devices

Visual display

Storage devices

List 4
Eg:
The inherent instability of aircraft
The need for automatic stabilisation
Axes of control
Sensing devices (eg: rate gyros)
Basics of negative and positive feedback and their effect on a control system
Full automatic control including heading and height
Inputs from other systems and ability to program in way-points etc

List 5
Simple explanation of what they are and how they are propagated:
Nature eg:
Electromagnetic waves
Basic frequency bands and their uses
Modulation types (frequency and amplitude)
Propagation eg:
Ionosphere
Sky wave
Typical ranges
Typical shapes of aircraft antennae

List 6
Typical layout and operation of:
VHF
UHF
HF
Intercom
Satcom

List 7
Basic function, inputs and outputs of:
VHF Omni-directional Ranging (VOR)
Instrument Landing System (ILS)
Automatic Direction Finder (ADF)
Distance Measuring Equipment (DME)
Global Positioning System (GPS)
Identification Friend or Foe/Secondary Surveillance Radar (IFF/SSR)
Traffic Alert and Collision Avoidance System (TCAS)
Weather Radar
Radio Altimeter
RNAV/FMS

List 8
Simple explanation including aircraft applications
Overview of databus types and designations

List 9
Layout and operation of a typical system eg:
Electronic Flight Instrument System (EFIS)
Engine Indicating and Crew Alerting System (EICAS)
Electronic Centralised Aircraft Monitoring (ECAM)
Automatic Flight Control System (ACS)

List 10
Eg:
ESD protection
Manual handling
Power management
Working at height

List 11
Typical layout, components and information outputs for a maintenance system eg:
Simple explanation of main monitoring areas and information output
Standard for OMS is ARINC 624

Unit 201 Fundamentals of electronics and avionics

Notes for guidance

This unit contains the complete syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 3 – Electrical Fundamentals for the EASA Category A licence. It also contains parts of the B category requirements for other relevant modules.

The unit is intended to give a broad understanding of electrical and avionics systems in preparation for studying units 019, 020 and 021 of this qualification.

This unit contains the syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 3 A Category and for parts of B Category modules The equivalent EASA knowledge level indicators for each of the above outcomes - required for the A Category items - are listed below with an abridged description of each level:

Level 1 – "A familiarisation with the principal elements of the subject"

Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"

Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

Outcome 1: EASA Level 1 (Module 3)
Outcome 2: EASA Level 1 (Module 3)
Outcome 3: EASA Level 1 (Module 3)
Outcome 4: EASA Level 3 (Module 7.7 – B1 & B2)
Outcome 5: EASA Level 3 (Module 7.7 – B1 & B2)
Outcome 6: EASA Level 3 (Module 13.5 – B2 only)
Outcome 7: EASA Level 2 (Module 11.5 – B1 only)
Outcome 8: EASA Level 3 (Module 11.5 – B1 only)

Note: the above list equates generally to the EASA requirement and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Unit 202 Military policy and regulation in aviation

Level: 3
Credit value: 4
UAN: L/503/0959

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.

Learning outcomes

There are **three** learning outcomes to this unit. The learner will:

1. understand military aviation policy
2. understand military aviation documentation
3. be able to create and maintain military aircraft maintenance documentation.

Guided learning hours

It is recommended that **30** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Aeronautical Engineering Level 2 NOS Units 001, 002 etc.

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Key Skills

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

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

Assessment and grading

This unit will be assessed by:

- an assessment covering practical skills and underpinning knowledge.

Unit 202 Military policy and regulation in aviation

Outcome 1 Understand military aviation policy

Assessment Criteria

The learner can:

1. describe the principal sources of military aviation policy
2. explain the responsibility of maintenance personnel towards local orders and procedures
3. describe the function of military organisational manuals in aircraft maintenance
4. explain the significance of signatures on aircraft maintenance documents
5. explain the levels of personal authority in military aircraft maintenance.

Range/Scope/Unit content

List 1

Eg:
Military Aviation Authority
JAP 100A (Military Aviation Engineering Policy & Regulations)
Current Single Service Aviation Engineering Orders and Procedures

List 2

Eg:
Any Local Military Aviation Engineering Orders

List 3

Eg:
AP 33376 (Trade Structure of the Royal Air Force)
Catalogue of Army Qualifications (CATAQ)
B.R. 3 (Naval Personnel Management)

List 4

Eg:
Legally binding signature
Implications of false declaration

List 5

Eg:
Signing for work
Supervisory
Individual authorisation
Acceptable Deferred Faults Log
Limitations Log
Authority levels (JAP 100A).

Unit 202 Military policy and regulation in aviation

Outcome 2 Understand military aviation documentation

Assessment Criteria

The learner can:

1. describe the content of military aircraft maintenance publications
2. explain the contents of the MOD Form 700 series
3. explain the independent check regulations
4. explain electronic data recording for maintenance purposes
5. explain terminology used in the Aircraft Safety and Servicing Notes
6. explain the purpose and typical content of maintenance instructions.

Range/Scope/Unit content

List 1

Eg:
System of numbering of Air Publications
Main titles common to all aircraft
Examples of main titles (eg: Power plant, Undercarriage, Communications etc.)

List 2

Eg:
Description
Legal status
Sections
Information contained in the folder

List 3

Purpose
From JAP100A-01 Chapter 6.10

List 4

A typical system of Purpose
What it records
How information is organised
Security provisions and procedures
How information is inserted
Legal status of entries
Password
Data accuracy

List 5

As required from list in JAP 100A-01 chapter 0.4

List 6

Purpose

From JAP 100A-01

eg

- Special Technical Instructions (STI)
- Servicing Instructions (SI)
- Urgent Technical Instructions (UTI)
- Routine Technical Instructions (RTI)
- Modifications
- Special Trial Fits (STF)

Unit 202 Military policy and regulation in aviation

Outcome 3 Be able to create and maintain typical military aircraft maintenance documentation

Assessment Criteria

The learner can:

1. extract information from engineering Air Publications for given maintenance tasks
2. carry out all actions required to report a fault on an aircraft that renders it 'unserviceable'
3. complete all required documentation following an aircraft repair task
4. complete all required documentation following scheduled maintenance tasks
5. complete documentation for equipment or components removed from an aircraft.

Range/Scope/Unit content

List 1

For relevant trade tasks eg:
Diagnosis
Repair/replacement
Adjustment
Post-repair testing

List 2

Eg
MOD F700 series forms
Electronic data recording

List 3

Eg
MOD F700 series forms
Electronic data recording

List 4

Eg
MOD F700 series forms
Electronic data recording

List 5

Using relevant equipment conditioning documentation

Unit 202 Military policy and regulation in aviation

Notes for 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 and use of relevant documentation.

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Level: 3
Credit value: 4
UAN: D/503/0965

Unit aim

This unit aims to give the learner a working knowledge of aircraft aerodynamics and control to as a basis for further study. It contains syllabi for the EASA 2042/2003 part 66 Basic Knowledge Requirements Module 8 and for part of Module 11A (11.1 only).

Learning outcomes

There are **eight** learning outcomes to this unit. The learner will:

1. know the properties of the Earth's atmosphere
2. understand the nature of airflow around aerodynamic bodies
3. understand the characteristics of the basic wing plan forms
4. understand the principles of aircraft control
5. understand the principles of aircraft stability
6. understand the purpose and operation of secondary flying control surfaces
7. understand methods of balancing and trimming control surfaces
8. understand the basic theory of high speed flight

Guided learning hours

It is recommended that **40** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Aeronautical Engineering Level 3 NOS Units 140, 154 etc

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Key Skills

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

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

Assessment and grading

This unit will be assessed by:

- An online multiple choice test.

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 1 Know the basic properties of the Earth's atmosphere

Assessment Criteria

The learner can:

1. describe the basic nature and composition of the Earth's atmosphere
2. describe the main layers of the Earth's atmosphere
3. solve problems using the basic gas laws
4. describe the use of the International Standard Atmosphere (ISA) in aviation.

Range/Scope/Unit content

List 1

Air composition
Temperature
Pressure
Density
Position on the Earth's surface
Climatic conditions

List 2

Including the region of constant temperature (with altitude)

List 3

Boyle's Law
Charles' Law
Gay-Lussac's Law
Combined Gas Law

List 4

Quoting values at sea level in SI and Imperial units:
Pressure: psi, Nm^{-2}, bar, millibar, hectopascal
Density: kgm^{-3}
Temperature: °C, Kelvin, °F

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 2 Understand the nature of airflow around aerodynamic bodies

Assessment Criteria

The learner can:

1. describe the main properties of airflow
2. describe how air flows around an aerodynamic body
3. explain how an aerofoil stalls
4. explain the effect of a stalled aerofoil on an aircraft in flight
5. describe the main characteristics of symmetrical and cambered aerofoils
6. describe how the airflow around aerofoils changes with angle of attack and velocity
7. explain how lift and drag affect aircraft performance
8. use standard equations to explain how lift and drag can vary
9. explain how a high lift device alters the flow characteristics of an aerofoil
10. explain how the total drag of an aircraft is generated
11. describe common methods of drag reduction.

Range/Scope/Unit content

List 1

Eg:
Compressible
Viscosity
Changed by temperature, solid objects etc.

List 2

Related to different types of flow including:
Laminar, turbulent (boundary layer)
Free stream
Up and down wash
Vortices
Features including:
Stagnation point/region
Transition and separation points

List 3

Mechanism in terms of airflow

List 4

Effect in terms of passage through the air and degree of control available
Eg: level stall, spin.

List 5
Related to 2 and including:
Chord line
Mean camber line
Angle of attack
Angle of incidence
Fineness ratio
Thickness to chord ratio (percentage)

List 6
With reference to Bernoulli's principle
Including resulting static pressure changes following:
Changes in angle of attack, including around the stall
Velocity changes

Effects including changes in:
Pressure distribution
Total air reaction
Lift
Drag

List 7
Simple explanation

List 8
Including, for both cambered and symmetrical aerofoils:
How the following change with angle of attack:
Lift coefficient
Drag coefficient
Lift/drag ratio

List 9
Eg:
Airflow separation
Changes in lift and drag coefficients

List 10
Including explanations of:
Induced drag
Pressure or form drag
Skin friction
Interference drag
Parasite drag

List 11
Eg:
Polished surfaces
Fairings
Special materials
Aerodynamic shape

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 3 Understand the characteristics of the basic wing planforms

Assessment Criteria

The learner can:

1. describe the basic wing planforms and their typical applications
2. apply simple dimensional calculations for each basic wing planform
3. describe the airflow over each basic wing planform
4. describe the effect of ice, snow and frost build-up on the performance of aerofoils.

Range/Scope/Unit content

List 1

Rectangular
Tapered
Swept
Delta

List 2

Span
Aspect ratio
Taper ratio
Gross wing area
Wash in
Wash out

List 3

Using simple diagrams:
In normal flight
At or near the stall

List 4

Eg:
Change of shape
Increase in weight
Variation in thickness

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 4 Understand the principles of aircraft control

Assessment Criteria

The learner can:

1. explain the relationship between the four main forces acting on an aircraft
2. explain the meaning of 'aircraft control'
3. describe the operation and effect of the primary aircraft control surfaces
4. explain the need for instinctive control
5. describe typical aircraft performance in different phases of flight
6. describe how turning flight is related to the stall
7. describe how turning flight changes the loading on an airframe.

Range/Scope/Unit content

List 1

Lift
Drag
Thrust
Weight
Balancing effect of the tailplane

List 2

Any accepted definition

List 3

Elevator
Aileron
Rudder

List 4

Define instinctive control
Describe the relationship between:
Control movements made by the pilot
Control surface movement
Movement of the aircraft

List 5

Straight and level flight
Climb
Descent
Glide
Turn

List 6
Aerodynamic explanation
Spins

List 7
Simple explanation including the effect on structural defects.

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 5 Understand the principles of aircraft stability

Assessment Criteria

The learner can:

1. explain the nature of aircraft flight stability
2. relate the three aircraft axes to different types of stability
3. explain the differences between statically stable, unstable and neutral aircraft
4. describe major components on an aircraft that affect stability in flight
5. describe typical methods of enhancing stability.

Range/Scope/Unit content

List 1

Eg:
Active stability
Passive stability

List 2

Eg:
Pitch stability eg:
Short period pitch oscillation
Long period pitch oscillations (Phugoid)
Lateral stability eg:
Dutch roll
Directional stability eg:
Weathercocking

List 3

Definitions and examples of:
Static or positive stability
Negative stability (unstable)
Zero stability (neutral)

List 4

Eg:
Position and size of vertical stabiliser(s)
Shape and mounting of the wings (eg: anhedral/dihedral, aspect ratio etc.)
Design of the tailplane

List 5

Eg:
Adjusting the centre of gravity
Design of lifting and control surfaces (eg: wings, canards, tailplane etc.)

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 6 Understand the purpose and operation of secondary flying control surfaces

Assessment Criteria

The learner can:

1. describe secondary effects of roll and yaw and methods of overcoming them
2. describe the arrangement and operation of alternative and combined flying controls
3. describe the general flow characteristics of high lift devices
4. compare the performance of trailing edge high-lift devices
5. describe the aerodynamic problems caused by asymmetric flap operation
6. compare the performance of leading edge high-lift devices
7. explain the purpose and operation of stall strips/wedges
8. describe methods of boundary layer control
9. compare the operation of high drag devices.

Range/Scope/Unit content

List 1

Description in terms of airflow over control surfaces
Main issue is adverse yaw
Explain the effect of adverse yaw on roll rate
Ways of counteracting averse yaw eg:
Differential ailerons
Frise ailerons
Roll spoilers
Explain the secondary roll effect of applying rudder
Explain this is worse in V-tailed aircraft
Co-ordinated use of rudder and aileron

List 2

Arrangement, operation and reasons for:
Spoilers
All-moving tailplane (slab/stabilator)
Tailerons
Canards
Elevons
Ruddervators
Flaperons

List 3
Using the example of eg: a trailing edge flap
Explanation to centre on:
Airflow changes on deployment eg:
Change in lift and drag coefficients
Airflow separation

List 4
Advantages, disadvantages with respect to aerodynamic effectiveness and operation:
Plain flap
Split flap
Slotted flap
Fowler flap

List 5
Explanation of asymmetric flap and how it happens
Description of the effect on aircraft attitude

List 6
Advantages, disadvantages with respect to aerodynamic effectiveness and operation:
Krueger flap
Leading edge droop
Slots
Slats

List 7
Reason
Position
How they operate

List 8
Eg:
Blown air
Suction
Wing fences

List 9
Including limitations in flight and on the ground
Spoilers
Lift dumpers
Speed brakes

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 7 Understand methods of balancing and trimming control surfaces

Assessment Criteria

The learner can:

1. explain the effects of airspeed on flying controls
2. explain the need for aerodynamic balancing
3. explain the operation of control surface trimming devices
4. describe control surface flutter
5. explain mass balance

Range/Scope/Unit content

List 1

Eg: Increased airspeed = greater force on controls

Eg: Increased airspeed = smaller controlled movements required

List 2

Eg: Counter-acting increased force from increased airspeed

List 3

Include reasons for trimming devices

Balance tab

Anti-balance tab

Spring tab

Trim tab

Servo tab

Variable incidence tailplane

List 4

Related to airspeed

Effects of vibration on:

Pilot

Airframe

Control linkage

List 5

Why is it done and how is it achieved?

Include explanations of:

Out of balance force

Forward and rear limits

Centre of gravity

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 8 Understand the basic theory of high speed flight

Assessment Criteria

The learner can:

1. explain the significance of 'speed of sound' to an aircraft in flight
2. explain terms related to high speed flight
3. explain 'Mach number' and 'critical Mach number'
4. describe the formation and development of shock waves
5. explain terms related to transonic flight
6. explain methods of overcoming problems during transonic flight
7. describe the factors affecting airflow through an intake of a high speed aircraft.

Range/Scope/Unit content

List 1

Define 'speed of sound'

Include variation of speed of sound with atmospheric conditions eg:

Altitude

Air density

Temperature

List 2

Subsonic flight

Transonic flight

Supersonic flight

List 3

Including their significance to aircraft flight

List 4

Including:

How and when they are formed

How and why they develop

Their properties

Effect on the airflow eg:

Movement of the centre of pressure

List 5
Compressibility
Buffet
Shockwave formation
Spanwise flow
Shock stall
Boundary layer flow separation
Control ineffectiveness
Instability

List 6
Swept wings
Wing fences
Saw-tooth leading edges
Notched leading edges
Vortex generators
Area rule
Spoilers
Slab tailplane/stabilators
Active stability devices

List 7
Intakes eg:
Engine intakes
Air scoops
Problems with high sped and supersonic air eg:
Shock wave
Air too fast for engine intake
Solutions eg:
Variable geometry intakes

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Notes for guidance

It is expected that the learner will carry out suitable practical experiments to assist understanding of some aspects of this unit, however these will not be assessed.

This unit contains the syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 8 and for part of Module 11A (11.1 only). The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B1 and B2 categories - are listed below with an abridged description of each level:

Level 1 – "A familiarisation with the principal elements of the subject"

Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"

Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

Outcome 1: EASA Level 2
Outcome 2: EASA Level 2
Outcome 3: EASA Level 2
Outcome 4: EASA Level 2
Outcome 5: EASA Level 2
Outcome 6: EASA Level 2 (B1 only)
Outcome 7: EASA Level 2 (B1 only)
Outcome 8: EASA Level 2 (B1 only)

Note: the above list equates generally to the EASA requirement and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Unit 211 Maintaining aircraft armament expendable stores

Level: 3

Credit value: 18

UAN: L/503/1111

Unit aim

To provide learners with a detailed understanding of aircraft armament expendable stores and associated practical skills.

Learning outcomes

There are **four** learning outcomes to this unit. The learner will be able to:

1. understand Explosives Regulations for aircraft armament expendable stores
2. know the operation, maintenance, handling and preparation of airborne munitions
3. understand the procedures for the Issue and receipt of dangerous goods, explosives and non-explosive stores
4. understand the dangers, regulation and associated hazards when working with Electro-Explosive Devices (EED).

Guided learning hours

It is recommended that **175** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Aeronautical Engineering Level 3 NOS Units 209, 210 etc

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA

Key Skills

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

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

Assessment and grading

This unit will be assessed by:

- A centre-set written examination covering underpinning knowledge.

Unit 211 Maintaining aircraft armament expendable stores

Outcome 1 Understand Explosives Regulations for aircraft armament expendable stores

Assessment Criteria

The learner can:

1. explain the development and uses of a range of explosives
2. identify the hazards associated with explosives
3. explain the Regulations for Explosive Storage Areas (ESA)
4. explain the documentation, posters and signage used in an ESA
5. explain the purpose of the fire division signs and the hazards associated with each
6. identify the hazards and precautions associated with Radio Frequency (RF) radiation and explosives
7. identify typical explosives containers and describe their use.

Range/Scope/Unit content

List 1

Basic history of explosive development
Uses of explosives for selected military purposes:
Eg Offensive, defensive, constructive
Definition of explosion, detonation, maker, date and lot

List 2

Hazards associated with common explosives
Hazard and Role markings
International System of Classification for Dangerous Goods

List 3

Basic rules and regulations:
Layout and positioning of a typical ESA
Personal matters
Security
Estate maintenance
Vehicles entering/leaving site
Need for and purpose of electrical standards
Types of ESA building
Purpose of periodic explosives inspections
Fire and safety precautions
Explosive regulations

List 4

Including the meaning and purpose of:
ESA forms and posters
Quantity distances and explosives classifications

List 5
Fire regulations
Fire Signs:
Eg Hazard division signs, Supplementary signs, Fire posters

List 6
Identification of EED cartridges
Storage of EED cartridges
Causes of accidental initiation
Precautions in preventing accidental initiation

List 7
Explosive and weapon transit containers
Need and purpose of transit container markings
Need and purpose of Hermetic and Authenticity sealing
Regulations for opening containers
Regulations for stacking of explosives and containers
Disposal action for containers, fired brass and scrap
Segregation and isolation of stored explosives.

Unit 211 Maintaining aircraft armament expendable stores

Outcome 2 Know the operation, maintenance, handling and preparation of airborne munitions

Assessment Criteria

The learner can:

1. describe the operation and handling procedures for aircraft bombs, fuses and components
2. describe the operation and usage of aircraft bomb tail units
3. describe the fundamentals of bomb guidance using a Global Positioning System (GPS)
4. describe the procedures to load/unload airborne munitions and associated equipment.

Range/Scope/Unit content

List 1

Purpose of aircraft bombs, exploders, plates, markings, housings and lugs
Identification of aircraft bombs, exploders, plates, markings, housings and lugs
Safety precautions
Frequency of maintenance
Locations for maintenance activities
Typical maintenance processes
Lifing and recording policy
Reporting and documentation action to be taken on discovering a fault
Extrusion/exudation
Store life and recording
Identification of bomb fuses

List 2

Purpose and operation
Identification
Life and recording policy
Shear wires
Safety precautions when handling
Retard and ballistic roles

List 3

Purpose and operation of laser guided bomb systems
The GPS system
Identification and purpose of Precision Guided Munitions (PGM) and components
Identification and purpose of Precision Guided Munitions (PGM) adapter kits
Safety and handling precautions for PGM adapter kits

List 4

Munitions eg

- Bombs 1000lb
- Bombs Paveway II and III
- Bombs practice 14kg and 3kg

Equipment eg

- Carrier Bomb Light Stores (CBLS) 100 and 200's
- CRV7 Launcher 5002
- Cradle Aircraft Fuel Tank Loading, Type B
- Hoist Universal Weapons (HUW)
- Transporting trolley Type S
- Stores Management System (SMS)
- Tool kits
- Voltage detector Mk 6

Missile and rocket launcher load/unload

Aircraft bomb load/unload

Load/unload aircraft countermeasures: chaff and flares

Unit 211 Maintaining aircraft armament expendable stores

Outcome 3 Understand the procedures for the issue/receipt of dangerous goods, explosive and non-explosive stores

Assessment Criteria

The learner can:

1. explain the procedures for issue/receipt of dangerous goods, explosive and non-explosive stores

Range/Scope/Unit content

List 1

Issue/receipt documentation
Storage
Opening explosives containers
Resealing explosives containers
Disposal of explosives containers

Unit 211 Maintaining aircraft armament expendable stores

Outcome 4 Understand the dangers, regulations and associated hazards when working with Electro-Explosive Devices (EED)

Assessment Criteria

The learner can:

1. describe the hazards and precautions associated with Electro Explosive Devices (EED)
2. explain the testing procedures for typical Electro-explosive Devices (EED)

Range/Scope/Unit content

List 1

Purpose of typical EED
Types and sources of RF hazard
Prohibitive RF areas
Safety precautions in RF areas
Accidental initiation
Lifing and recording policy
Occupational hazards in RF areas

List 2

Eg aircraft fire bottles
Safety
Documentation

Unit 212 Aircraft Assisted Escape Systems (AAES)

Level: 3
Credit value: 12
UAN: L/503/1139

Unit aim
To provide learners with a detailed understanding of aircraft assisted escape systems (AAES) and associated practical skills.

Learning outcomes
There are **seven** learning outcomes to this unit. The learner will:
1. understand the construction and operation of a typical AAES
2. understand AAES safety devices
3. know the equipment and safety precautions for working on AAES
4. be able to fit safety devices on AAES
5. be able to disarm and remove an ejection seat from an aircraft
6. be able to carry out maintenance on AAES assemblies and components
7. be able to arm and fit an ejection seat to an aircraft.

Guided learning hours
It is recommended that **115** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards
This unit is linked to the SEMTA Aeronautical Engineering Suite 3 NOS 112.

Endorsement of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Key Skills
This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Key Skills:
- Application of Number
- Communication
- Information and Communication Technology
- Improving Own Learning and Performance
- Problem Solving
- Working with Others

Assessment and grading
This unit will be assessed by:
- an assignment covering practical skills and underpinning knowledge.

Unit 212 Aircraft Assisted Escape Systems (AAES)

Outcome 1 Understand the construction and operation of a typical AAES

Assessment Criteria

The learner can:

1. explain the need for AAES
2. describe AAES construction
3. describe a seat operating sequence
4. explain the purpose of the command selector valve
5. describe developments related to AAES.

Range/Scope/Unit content

List 1

Including:
Outline development history
Aircrew survivability
Increase in aircraft speed/manoeuvrability

List 2

Identify its components and describe their function including:
Command ejection
Canopy jettison system
Cartridges
Firing units
Ejection gun
Rocket pack
Seat pan firing handle
Breech Type Time Delayed Firing Unit (BTTDFU)
Drogue gun
Barostatic Time Release Unit (BTRU)
Manual separation system
Personal Equipment Connector (PEC)
Emergency Oxygen system
Leg restraint system
Personal Survival Pack (PSP)
Harness Power Retraction Unit (HPRU)
Seat Raising Actuator (SRA)

List 3

Typical operating sequence
Manually initiated
Cartridge operated
Rocket assisted
Fully automatic

List 4
Purpose of command ejection
Describe the use:
Selections (Front & Rear)
Initiation of command ejection
Command ejection sequence including valve operation
Compare systems fitted to two or more different aircraft

List 5
Including:
Night Vision Goggles (NVG)
Recent modifications
Future AAES.

Unit 212 Aircraft Assisted Escape Systems (AAES)

Outcome 2 Understand AAES safety devices

Assessment Criteria

The learner can:

1. explain the purpose of AAES safety pins
2. identify AAES pin conditions and when they are used
3. explain personal legal responsibilities for positioning AAES safety pins
4. explain the use of documentation related to safety pin movement.

Range/Scope/Unit content

List 1

Purpose and positions

Eg:

Seat pan firing handle

Canopy jettison system

Miniature Detonating Cord

List 2

Stowage

Safe for Parking

Safe for Maintenance

Safe condition

List 3

Authority required for movement of pins between each condition

Who can move pins (eg weapons technician, aircraft technician, aircrew)

List 4

eg

Recorded using relevant servicing documentation

List 5

Stowage

Safe for Parking

Safe for Maintenance

Safe condition

List 6

Accurate recording of pin movement

Recorded using relevant servicing documentation

Unit 212 Aircraft Assisted Escape Systems (AAES)

Outcome 3 Know the equipment and safety precautions for working on AAES

Assessment Criteria

The learner can:

1. describe the safety precautions to be observed for the canopy jettison system
2. describe the lifting equipment for handling an ejection seat
3. describe the safety precautions for the removal of an ejection seat
4. describe safe storage conditions for AAES explosives
5. describe safe storage conditions for removed seats and seat pans
6. describe the purpose and use of ejection seat stands
7. describe the maintenance requirements for ejection seat stands
8. describe the safety precautions for ejection seat maintenance
9. explain the importance of recorded details of an ejection seat and its components.

Range/Scope/Unit content

List 1

Eg:
Canopy jettison initiator unit
Jack head piston
Canopy unlocking jacks
Canopy rocket motors
Miniature Detonating Cord

List 2

Including safety precautions required when using including:
Slings and lifting straps (serviceable tags fitted)
Hoists
Pre-use checks
Maintenance of lifting equipment

List 3

Safety precautions necessary before and during seat removal eg:
Cartridge removal

List 4

Eg:
Environment
Labelling, sets
Storage and fitted life
In accordance with current regulations

List 5
Location
Environment
Labelling/Serial No/Seat Set
Transportation

List 6
Safe seat transportation
Prevent seat damage

List 7
Including:
Pre-use checks
Inspection
Lubrication
Wheels and tyre pressures

List 8
Before and during the maintenance procedure

List 9
Component serial numbers
Modification state of ejection seat and components
Vital Checks
Independent checks

Unit 212 Aircraft Assisted Escape Systems (AAES)

Outcome 4 Be able to fit safety devices on AAES

Assessment Criteria

The learner can:

1. perform pin moves
2. create documentation related to safety pin movement.

Range/Scope/Unit content

List 1

Stowage
Safe for Parking
Safe for Maintenance
Safe condition

List 2

Accurate recording of pin movement
Recorded using relevant servicing documentation.

Unit 212 Aircraft Assisted Escape Systems (AAES)

Outcome 5 Be able to disarm and remove an ejection seat from an aircraft

Assessment Criteria

The learner can:

1. use the correct maintenance procedures
2. disarm relevant systems
3. remove the ejection seat
4. disarm remaining armed components
5. store explosives removed from the AAES.

Range/Scope/Unit content

List 1

Identify correct maintenance procedures
Use procedures in eg: Air Publications, Maintenance procedures

List 2

Identify relevant systems
Using information in eg: Air Publications, Relevant maintenance documentation
Disarm the system eg: Remove and label cartridges
Temporarily store cartridges
Label system

List 3

Ensure the aircraft is prepared for seat removal eg: canopy removal
Remove seat eg:
Disconnect hoses, lanyards etc
Disconnect seat securing devices eg: pins, bolts etc
Attach lifting device
Use safety assistants
Lift seat from aircraft
Secure seat on correct stand
Labelling/serial numbers
Documentation

List 4

Safety
Labelling/serial numbers

List 5

Storage of cartridges In accordance with current regulations.

Unit 212 Aircraft Assisted Escape Systems (AAES)

Outcome 6 Be able to carry out maintenance on AAES assemblies and components

Assessment Criteria

The learner can:

1. use relevant maintenance procedures
2. maintain documentation
3. maintain ejection seat components
4. replace ejection seat components
5. test the ejection seat gas system
6. use correct maintenance procedures.

Range/Scope/Unit content

List 1

Eg:
Air publications
Relevant maintenance documentation
Servicing Instructions
Technical Instructions
Modifications

List 2

Eg:
F707
Seat set maintenance records

List 3

Components eg: ,Parachute pack, PEC connector, Personal Survival Pack
Seat pan
Drogue gun
Breech Type Time Delay Firing Unit (BTTDFU)
Barostatic Time Release Unit (BTRU)

List 4

Leg/arm restraint lines
Harness Power Retraction Unit (HPRU) straps
Seat pan firing handle
Oxygen cylinder
Parachute pack, PEC connector, Personal Survival Pack

List 5
Integrity and pressurisation:
Seat pan
Manual separation

List 6
Special Instructions
Special technical instructions
Preliminary warning Instructions
Urgent Technical Instructions
Advance information leaflets
After Flight (A/F)
Before Flight (B/F)
Turnround (T/R)
A/F-B/F
Loose Article search
Using relevant servicing documentation.

Unit 212 Aircraft Assisted Escape Systems (AAES)

Outcome 7 Be able to arm and fit an ejection seat to an aircraft

Assessment Criteria

The learner can:

1. describe safety precautions for ejection seat fitting
2. explain the importance of stage checks whilst refitting an ejection seat
3. create and maintain documentation
4. use correct maintenance procedures
5. re-arm systems and components in sequence
6. prepare an ejection seat for refitting
7. fit an ejection seat.

Range/Scope/Unit content

List 1

Safety precautions before and during the seat fit

List 2

Vital checks
Independent checks
Relevant documentation
Air publications

List 3

Relevant servicing documentation
Component life records

List 4

Eg:
Servicing Instructions
Technical Instructions
Modifications
Relevant servicing documentation

List 5

Safety
Air publications
Maintenance documentation
Vital checks
Independent checks
Cartridges

List 6

Eg:
Slings and lifting straps (serviceable tags fitted)
Hoists
Pre-use checks
Maintenance of lifting equipment
Safety

List 7

Information from Air Publications
Vital checks
Independent checks
Complete maintenance documentation.

Unit 212 Aircraft Assisted Escape Systems (AAES)

Notes for 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 Assisted Escape Systems used in military aircraft.

Assessment is to be designed to demonstrate underpinning knowledge and use of relevant documentation.

Unit 213 Maintaining aircraft gun systems

Level: **3**
Credit value: **10**
UAN: **R/503/1112**

Unit aim
To provide learners with a detailed understanding of aircraft gun systems and associated practical skills.

Learning outcomes
There are **nine** learning outcomes to this unit. The learner will:
1. understand the operation of aircraft gun systems
2. understand ammunition used in aircraft guns
3. be able to assemble ammunition belts
4. understand the fitting, removal and harmonisation of aircraft guns
5. be able to work on aircraft gun installations
6. be able to load and unload aircraft gun systems
7. understand the maintenance of aircraft gun barrels
8. be able to maintain aircraft guns and components
9. understand actions to be taken following hazardous incidents.

Guided learning hours
It is recommended that **100** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards
This unit is linked to the SEMTA Aeronautical Engineering Suite 3 (2008) NOS 111

Endorsement of the unit by a sector or other appropriate body
This unit is endorsed by SEMTA.

Key Skills
This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Key Skills:
- Application of Number
- Communication
- Information and Communication Technology
- Improving Own Learning and Performance
- Problem Solving
- Working with Others

Assessment and grading
This unit will be assessed by:
- centre-set assignments covering practical skills and underpinning knowledge.

Unit 213 Maintaining aircraft gun systems

Outcome 1 Understand the operation of aircraft gun systems

Assessment Criteria

The learner can:

1. describe safety issues surrounding aircraft guns and their maintenance
2. describe the construction and configuration of aircraft guns
3. describe gun safety devices and their principles of operation
4. explain the operation of an aircraft gun.

Range/Scope/Unit content

List 1

Eg:
Explosives
Manual handling
Cocking and firing mechanism
Misfires and stoppages
Positioning of armed aircraft

List 2

eg:
Barrel
Cradle group
Breech cylinder housing group
Electric firing unit and re-cocking cable
Feed mechanism and locking pin
Feed configuration

List 3

Mechanical
Electrical

List 4

Operation of a typical gun and the function of each part eg components of:
Barrel
Cradle group
Breech cylinder housing group
Electric firing unit and re-cocking cable
Feed mechanism and locking pin
And
Re-cocking unit
Gun electronic unit
Automatic fire
Gas purging
Misfires and stoppages.

Unit 213 Maintaining aircraft gun systems

Outcome 2 Understand ammunition used in aircraft guns

Assessment Criteria

The learner can:

1. explain principles of operation of ammunition types
2. describe the construction of ammunition and associated items.

Range/Scope/Unit content

List 1

Use and purpose including eg:
Drill
Target practice
Target practice tracer
High Explosive
Armour piercing
Re-cocking cartridge

List 2

Eg:
Ammunition:
Drill
Target practice
Target practice tracer
High Explosive
Armour piercing
Re-cocking cartridge
Colour Coding
Other items eg:
Ammunition fuses
Ammunition links.

Unit 213 Maintaining aircraft gun systems

Outcome 3 Be able to assemble ammunition belts

Assessment Criteria

The learner can:

1. apply the safety precautions for handling ammunition
2. assemble ammunition belts
3. perform joining and breaking lengths of belt
4. perform tests on belts of ammunition
5. replace faulty links
6. complete gun system documentation.

Range/Scope/Unit content

List 1

Including conditions for handling loose and belted ammunition eg:
Electrically initiated ammunition
One belt on the table at a time
Avoid impact of anything on percussion cap
Loading areas to be licensed by local area/current regulations
Ammunition prep room
ESA

List 2

Eg:
Linking/delinking machine
Correctly aligned rounds
Safety precautions

List 3

Using links and ammunition in the correct sequence

List 4

For example:
Flexibility eg: role test, spread test, rotation test
Roll test
Rotation test
Spreading test
Exchanging faulty links

List 5

Using serviceable links and correct ammunition

List 6

Relevant documentation recording eg:
Quantity, type and sequence of ammunition

Unit 213 Maintaining aircraft gun systems

Outcome 4 Understand the fitting, removal and harmonisation of aircraft guns

Assessment Criteria

The learner can:

1. explain principle of aircraft gun installations
2. describe the safety precautions for fitting and removing an aircraft gun
3. explain the principles of aircraft gun harmonisation
4. explain the equipment and information required for aircraft gun harmonisation
5. describe the safety precautions required for gun harmonisation
6. describe the basic procedures for harmonising an aircraft gun.

Range/Scope/Unit content

List 1

Including the purpose eg:
Strong attachment points
Ammunition tanks
Adjustments to be made for harmonisation

List 2

Including:
Check all switches in accordance with maintenance schedules
Gun hoisting/lifting equipment
Manual handling
Ground support equipment

List 3

Purpose and basic principles including:
Meaning of 'harmonisation'
Reason for harmonisation: - Gun aiming, bullet trajectory
Forward looking sensors (HUD etc)

List 4

Information: data and procedures
Purpose of the equipment eg: Gun harmonisation boards, Harmonisation diagrams, Aircraft jacks
Levelling beams
Clinometer
Gun harmonisation equipment eg:
Telescope
Gauge
Reticule and adapter
Laser unit
Mandrel

List 5
Eg:
Ensure the gun is unloaded
Cockpit switch checks

List 6
Eg:
Aircraft jacking and levelling
Use of the gun harmonisation kit
Use of the mandrel and laser unit
Harmonisation board and its position

Unit 213 Maintaining aircraft gun systems

Outcome 5 Be able to work on aircraft gun installations

Assessment Criteria

The learner can:

1. prepare and fit an aircraft gun to an aircraft
2. remove an aircraft gun from an aircraft
3. complete gun fit/removal documentation
4. harmonise an aircraft gun to within operational limits
5. record actions on relevant documentation.

Range/Scope/Unit content

List 1

Meaning of 'harmonisation'
Reason for harmonisation: - Gun aiming
Forward looking sensors (HUD etc)

List 2

Eg:
Gun harmonisation boards
Harmonisation diagrams
Aircraft jacks
Levelling beams
Clinometer
Gun harmonisation equipment eg:
Telescope
Gauge
Reticule and adapter
Laser unit
Mandrel

List 3

Eg:
Ensure the gun is unloaded
Cockpit switch checks

List 4

Eg:
Aircraft jacking and levelling
Use of the gun harmonisation kit
Use of the mandrel and laser unit
Harmonisation board and its position

List 5
Air publications
In accordance with maintenance procedures

List 6
Complete relevant documentation eg:
F707
Role equipment documentation.

Unit 213 Maintaining aircraft gun systems

Outcome 6 Be able to load and unload aircraft gun systems

Assessment Criteria

The learner can:

1. apply the safety precautions for loading and unloading aircraft guns
2. prepare and load aircraft guns
3. perform unloading procedure of aircraft guns
4. record load and unload details .

Range/Scope/Unit content

List1

Including:

Aircraft pointing in a safe direction

Post safety personnel/notices

Check all switches in accordance with maintenance schedules

List 2

Using:

Air publications

Maintenance procedures

Manual handling procedures

Ground support equipment

Safety precautions

List 3

Using:

Air publications

Maintenance procedures

Manual handling procedures

Ground support equipment

Safety precautions

List 4

Eg:

Flight servicing documents F700 series

Gun record cards

Unit 213 Maintaining aircraft gun systems

Outcome 7 Understand the maintenance of aircraft gun barrels

Assessment Criteria

The learner can:
1. describe the principle parts of an aircraft gun barrel
2. describe the process of cleaning and inspection of an aircraft gun barrel
3. explain the importance and functioning of an electronic barrel gauge.

Range/Scope/Unit content

List 1
Including their function eg:
Bore
Rifling
Gas ports
Blast deflector
Barrel bearing
Barrel catch
Breach face

List 2
Eg importance of:
Removing debris
Lubricant type and quantity
Un-lubricated areas
Inspection points to include:
Gas erosion
Stripped or crushed lands
Wear to barrel catch recess and buttress guides
Damage to two-part threads
Excessive pitting and corrosion to the barrel bore
Cracks
Criteria for rejecting the barrel as unserviceable

List 3
Including:
Sensing heads
Feeder tube and adaptors
Transducer
Control s and indicators
Menus
Pre-use checks
Operation
Maintenance
Interpretation of results

Unit 213 Maintaining aircraft gun systems

Outcome 8 Be able to maintain aircraft guns and components

Assessment Criteria

The learner can:

1. perform the operation of an aircraft gun
2. select gauges and test equipment used in aircraft gun maintenance
3. disassemble an aircraft gun
4. inspect gun components
5. perform tests on gun components
6. identify faults in aircraft gun components
7. perform cleaning and lubrication of aircraft gun components
8. perform cleaning of aircraft gun barrels
9. perform lubrication an aircraft gun barrel
10. conduct gauging of aircraft gun barrels using a typical electronic gauge
11. reassemble an aircraft gun after maintenance
12. conduct tests on an aircraft gun following maintenance
13. record maintenance on relevant documentation.

Range/Scope/Unit content

The maintenance should be to a depth equivalent to that required by a typical 500 round maintenance procedure

List 1

Operation of a typical gun and the function of each part eg components of:

- Barrel
- Cradle group
- Breech cylinder housing group
- Electric firing unit and re-cocking cable
- Feed mechanism and locking pin

And

- Re-cocking unit
- Gun electronic unit
- Automatic fire
- Gas purging
- Misfires and stoppages

List 2
Select and explain the purpose of:
Gun barrel gauge
Dial test indicator
Vernier gauge
Surface plate
Feeler gauges
Reference cartridges
Test set for gun electrical system
Go/No-go gauges

List 3
To the depth required by eg a 500 round maintenance:
Safety
Slide position
Gun unloaded
Pre-maintenance mechanical functioning checks
Component groups eg:
Barrel
Cradle group
Breech cylinder housing group
Electric firing unit and re-cocking cable
Feed mechanism and locking pin

List 4
Eg:
Visual inspection
Using gauges
Eg:
Dial test indicator
Vernier gauge
Surface plate
Feeler gauges
Reference cartridges
Go/No-go gauges

List 5
Using eg:
Test set for gun electrical system
Electrical/electronic test

List 6
Using correct repair methods and spares

List 7
In accordance with maintenance schedules
Using prescribe materials
Complete relevant documentation

List 8
In accordance with maintenance schedules
Clean using prescribed materials

List 9
In accordance with maintenance schedules
Using prescribed lubricants

List 10
Using a prescribed electronic gun barrel gauge:
Pre-use check
Using correct gauge and adaptors for barrel size and type
Record and interpret results
Classify the barrel in accordance with given criteria.
Complete relevant documentation

List 11
In accordance with maintenance schedules

List 12
Including gauging during re-assembly eg:
Breech cylinder/ breech cylinder housing clearance.
Cartridge Headspace
Safety

List 13
Eg:
Hand functioning
Mechanical functioning with drill rounds
Re-cocking unit functioning
Electrical functioning

List 14
Complete relevant documentation eg:
F707
Other relevant documentation.

Unit 213 Maintaining aircraft gun systems

Outcome 9 Understand actions to be taken following hazardous incidents

Assessment Criteria

The learner can:

1. define the term 'hazardous incident'
2. explain the process of hazardous incident reporting
3. explain possible causes and consequences of a hazardous incident for gun systems.

Range/Scope/Unit content

List 1

Illustrate with examples:
Heavy landing
Excessive 'g' in a controlled manoeuvre
Violent use of brakes
Excessive in-flight turbulence
Lighting strike

List 2

Eg:
Who reports?
Where are the procedures to be found?
Why are checks done?
Listing in operational flying procedures

List 3

Should include the following:
Causes:
Wind shear
Sudden loss of power or lift
Pilot error
Consequences:
Disturbance of gun harmonisation
Aircraft temporarily grounded
Hazardous incident checks (general procedure):
Visual inspection
Gun harmonisation checks.

Unit 213 Maintaining aircraft gun systems

Notes for 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 Gun Systems used in military aircraft.

Assessment is to be designed to demonstrate underpinning knowledge and use of relevant documentation.

Unit 214 Maintaining weapons electrics maintenance practices

Level: 3
Credit value: 8
UAN: Y/503/1113

Unit aim

To provide learners with a detailed understanding of aircraft weapons electrical practices with associated practical skills.

Learning outcomes

There are **five** learning outcomes to this unit. The learner will be able to:

1. be able to work safely on an aircraft weapons electrical installation
2. understand the selection and use of tools, equipment, material and information
3. be able to prepare and terminate aircraft electrical cables using a range of terminations
4. be able to manufacture aircraft cable assemblies
5. be able to repair aircraft cable assemblies.

Guided learning hours

It is recommended that **75** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Aeronautical Engineering Suite 3 NOS 087, 088.

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Key Skills

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

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

Assessment and grading

This unit will be assessed by:

- an assignment covering practical skills and underpinning knowledge.

Unit 214 Maintaining weapons electrics maintenance practices

Outcome 1 Be able to work safely on an aircraft weapons electrical installation

Assessment Criteria

The learner can:

1. identify safety hazards in a workshop environment
2. demonstrate workshop/hangar working and emergency procedures.

Range/Scope/Unit content

List 1

Work hazards and precautions
Eg working with:
Electricity
Pressurised gasses (including oxygen)
Oils
Chemicals
Soldering /rework station
Immediate actions eg:
Fire
Spillage
Electric shock
Personal injury

List 2

Simulated or actual emergency drills and procedures
Fire extinguisher locations
First aid location
Emergency exits
Emergency telephone numbers

Unit 214 Maintaining weapons electrics maintenance practices

Outcome 2 Understand the selection and use of tools, equipment, material and information

Assessment Criteria

The learner can:

1. explain the term 'wiring husbandry' and how it applies to aircraft wiring
2. describe the function of common hand tools used in aircraft wiring tasks
3. describe correct tools and equipment required for specific tasks
4. explain the procedures used to ensure tools remain within calibration limits
5. explain the symbols and terminology used on aircraft electrical diagrams.

Range/Scope/Unit content

List 1

Relevant air publications
eg:
Regular inspection
Minor repairs
Renewing protective cladding
Removal of contaminants
Correct installation and routing

List 2

Including:
Snips
Cable stripping tools
Termination tools
Torque wrench
Loom wrapping tools
Lacing
Heat shrink sleeves
Potting compound
Pin/socket insertion tools
Grommets
'P' clips

List 3

eg:
Stripping and crimping tools
Soldering iron
Heat shrink gun

List 4
eg:
Care in use and periodic calibration of:
Go-No Go gauges
Cable strippers
Crimp tools
Meters

List 5
Including those in:
Relevant Air Publications
Relevant local statutory requirements
Location diagrams
Wiring diagrams
Circuit/Cable loom coding.

Unit 214 Maintaining weapons electrics maintenance practices

Outcome 3 Be able to prepare and terminate aircraft electrical cables using a range of terminations

Assessment Criteria

The learner can:

1. select and check correct tools and equipment
2. prepare a range of electrical cables and connectors
3. dismantle a range of electrical connectors
4. assemble a range of electrical connectors
5. terminate a range of electrical cable using soldered and crimped terminals
6. use standard test equipment to test the integrity of terminations and connectors.

Range/Scope/Unit content

List 1

Eg:
Snips
Cable stripping tools
Termination tools
Torque wrench
Loom wrapping tools

List 2

Cable selection charts
Aircraft cable eg:
Nyvin, thin-walled, co-axial, data-bus, fibre-optic, gore cable, high tension, GSE cable
Connectors eg: bayonet, screw, jack types

List3

Eg:
BNC connector
Bayonet
Screw
Jack

List 4

Eg:
Relevant Air Publications
Cable selection charts
Ring tongue terminals
In-line splices
Crimping tools
Soldering process
De-soldering pumps

De-soldering braid
Safety

List 5
Eg:
Relevant Air Publications
Cable selection charts
Ring tongue terminals
In-line splices
Crimping tools
Soldering process

List 6
Relevant Air publications
Continuity tests

Unit 214 Maintaining weapons electrics maintenance practices

Outcome 4 Be able to manufacture aircraft cable assemblies

Assessment Criteria

The learner can:

1. prepare aircraft weapon cables for assembly into looms
2. assemble aircraft weapon cable looms
3. apply protection to aircraft weapon cable looms
4. use standard test equipment to test the integrity of a cable loom.

Range/Scope/Unit content

List 1

Eg:
Use looming pattern boards
Cable identification sleeves

List 2

Eg:
Protect against moisture and contaminant ingress (eg: lubricants, potting compounds, paints)
Ease of identification
Access for repair and modification
Explain the reasons for using particular looming techniques
Demonstrate different looming techniques eg:
Assembling connectors (insertion and other special tools)
Lacing (including: whipping, knotted start/finish, spot ties, lock stitching, branching)

List 3

To include:
Selecting heat-shrink tubing (eg: Thermofit)
Safety when using a heat shrink gun
Correct fitting of heat shrink tubing
Potting compound (selection, mixing, application, curing)
Recognition of faults in protective processes

List 4

Eg:
Continuity tester ('buzz box' etc.)
Multimeter (AVO, Fluke etc).
Safety Ohm meter
Insulation resistance tester.

Unit 214 Maintaining weapons electrics maintenance practices

Outcome 5 Be able to repair aircraft cable assemblies

Assessment Criteria

The learner can:

1. select a range of tools and accessories for use in cable repair
2. prepare damaged aircraft weapons cable assemblies for repair
3. repair damaged weapons cable assemblies
4. inspect repaired aircraft weapons cable assemblies
5. test repaired aircraft weapons cable assemblies

Range/Scope/Unit content

List 1

Select and explain the use of

Eg:

De-soldering tool

Solder and crimp splices

List 2

Eg:

Cut

Strip

Label

Correct size and type of splice

Position of splices (eg: staggered)

List 3

Using a range of techniques

Re-loom as necessary to original specification

Staggered splices

List 4

Eg:

Physical and electrical integrity of connectors

Use correct /inspection test equipment (eg: visual, continuity, insulation, bonding)

Use specialist weapons test equipment

Correct loom dimensions

Lacing and marking correct

Integrity of protective sleeves/coatings/potting.

List 5

Physical and electrical integrity of connectors

Use correct /inspection test equipment (eg: visual, continuity, insulation, bonding)

Use specialist weapons test equipment

Correct loom dimensions
Lacing and marking correct
Integrity of protective sleeves/coatings/potting.

Unit 214 Maintaining weapons electrics maintenance practices

Notes for 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 Weapons Electrics Maintenance Practices used on military aircraft.

Assessment is to be designed to demonstrate underpinning knowledge and use of relevant documentation.

Unit 215 Aviation mathematics and science for technicians

Level: 3

Credit value: 8

UAN: D/503/1128

Unit aim

This unit aims to give the learner the maths and science knowledge in an aviation context to allow further study of aircraft manufacturing and maintenance practices.

Learning outcomes

There are **ten** learning outcomes to this unit. The learner will:

1. be able to use principles of arithmetic
2. be able to use SI, Imperial and US customary units
3. be able to manipulate algebraic expressions and formulae using standard techniques
4. be able to calculate physical properties of common two and three dimensional shapes
5. be able to use graphs to determine values and solve engineering problems
6. understand the nature of matter
7. understand principles of statics
8. understand principles of types of motion related to aircraft in flight
9. understand principles of dynamics related to aircraft in flight
10. understand principles of fluid motion related to aircraft in flight

Guided learning hours

It is recommended that **70** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Aeronautical Engineering Level 3 NOS Units 155, 177 etc.

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Key Skills

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

- Application of Number

Assessment and grading

This unit will be assessed by:

- An online multiple choice test.

Unit 215 Aviation mathematics and science for technicians

Outcome 1 Be able to use principles of arithmetic

Assessment Criteria

The learner can:

1. define arithmetical terms
2. use standard operators on arithmetical expressions
3. calculate the LCM and HCF of arithmetical expressions
4. use basic operators on fractions
5. convert between fraction, decimal and percentage values
6. simplify fractions by cancelling
7. distinguish between ratio and proportion
8. calculate percentage values for common engineering variables
9. calculate by manipulating simple arithmetic ratios
10. distinguish between direct and inverse proportion
11. calculate the constant of proportionality for arithmetical expressions.
12. define types of decimal values
13. distinguish between 'significant figures' and 'decimal places'
14. convert numbers to standard form
15. manipulate arithmetic expressions in standard form
16. estimate values for expressions involving decimal values.

Range/Scope/Unit content

List 1

Including: positive, negative and real numbers

List 2

Add, subtract, multiply, divide

A range of first degree expressions in an aeronautical context

List 3

Expressions with at least four component values

List 4

Basic rules of fractions

Proper and improper fractions

List 5

Standard fractions found in engineering (eg: imperial sizes)

Non-standard 'awkward' fractions

Proper and improper fractions

List 6

Suitable proper and improper fractions

List 7
Nil

List 8
Eg:
Engine thrust
Voltage variation
Fuel tank contents

List 9
Nil

List 10
Nil

List 11
Nil

List 12
Recurring
Terminating
Non-terminating

List 13
Definitions and examples

List 14
Using more complex expressions than in '2.' with all basic operators

List 15
Rules of estimation
Practice with and without calculator
The implications of erroneous estimation in an engineering context.

Unit 215 Aviation mathematics and science for technicians

Outcome 2 Be able to use SI, Imperial and US customary units

Assessment Criteria

The learner can:

1. define the base SI units of measurement
2. define the base Imperial units of measurement
3. convert base and derived units between Imperial, US Customary and SI units
4. calculate derived unit conversion factors using base units
5. explain the terms 'relative error' and 'absolute error'
6. apply error arithmetic to experimental data
7. convert aircraft fuel loads between US Customary, Imperial and SI units
8. convert system pressures between Imperial and SI units
9. extract data from analogue and digital system gauges

Range/Scope/Unit content

List 1

Metre, kilogram, second, ampere, Kelvin, Pascal, Newton Joule
Names and symbols for preferred prefixes:
Giga (G), mega (M), kilo (k), nano (n), pico (p)
Include their typical uses

List 2

Foot (ft), pound (lb), minute (min), Fahrenheit (F)
Include their typical uses

List 3

All those commonly used in engineering
With and without a calculator
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,

List 4

Using both arithmetical means and standard reference tables/graphs/calculators
For Imperial and SI systems

List 5
Explanation of the definition
Using suitable examples from engineering

List 6
Relevant to engineering
Tolerance

List 7
Pounds, kilograms, litres, imperial gallons, US gallons
Explain the reasons for doing this accurately

List 8
Eg:
Pascal
Bar
Atmosphere
Psi
Nm^{-2}
Explain the reasons for doing this accurately

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

List 9
Using common scales eg: pounds, kilograms, litres, US gallons
Aircraft and refueler fuel gauges
Aircraft system pressure gauges
Ground support system pressure gauges

List 10
Eg: oxygen, nitrogen, air, fuel

List 11
Eg: oxygen, nitrogen, air, fuel

Unit 215 Aviation mathematics and science for technicians

Outcome 3 Be able to manipulate algebraic expressions and formulae using standard techniques

Assessment Criteria

The learner can:

1. factorise algebraic expressions
2. define 'algebraic expression', 'equation' and 'identity'
3. simplify expressions containing brackets, powers and roots
4. solve simultaneous equations
5. solve second degree equations
6. evaluate aeronautical and scientific formulae by substituting data
7. use formulae to obtain engineering and scientific data

Range/Scope/Unit content

List 1

By grouping and extracting common factors

List 2

Basic definitions with examples

List 3

Using BODMAS
Including nested brackets
Indices and powers
Negative and fractional indices

List 4

Simple equations using basic methods

List 5

With one unknown

List 6

Eg:
Gas laws
Aircraft weighing
Aircraft loading (C of G etc)

List 7

Eg: Specific gravity, Pressure, Temperature and heat.

Unit 215 Aviation mathematics and science for technicians

Outcome 4 Be able to calculate physical properties of common two and three dimensional shapes

Assessment Criteria

The learner can:

1. define the components of a circle
2. solve problems related to dimensions of a circle
3. create geometrical constructions
4. use coordinate systems
5. use formulae to calculate dimensions of plane figures
6. use formulae to calculate surface area and volume of common solids.

Range/Scope/Unit content

List 1

Radius
Diameter
Circumference
Arc
Chord

List 2

Radius
Diameter
Circumference

List 3

Simple constructions on paper eg:
Triangle
Square
Rectangle
Parallelogram
Circle

List 4

Rectangular
Polar

List 5
Using:
sine, cosine and tangent relationships
Triangle
Square
Rectangle
Parallelogram

List 6
Cube
Cylinder
Cone
Sphere

Unit 215 Aviation mathematics and science for technicians

Outcome 5 Be able to use graphs to determine values and solve engineering problems

Assessment Criteria

The learner can:

1. select scales and origins for graph axes
2. extract values from graphs
3. extrapolate linear graphs to determine x and y intercepts
4. determine *y, x, m and c* from linear equations and graphs
5. solve graphically pairs of simultaneous equations
6. recognise graphical representations of sine and cosine waveforms
7. determine data values from graphs and tables
8. apply graphical techniques to the solution of engineering problems.

Range/Scope/Unit content

List 1

By examining experimental data using various origins

List 2

Including interpolate between known points

List 3

Extrapolate Graph Trends

List 4

Graphically and by calculation

List 5

First order equations

List 6

Recognise peak values and phase difference

List 7

Pressure
Density
Relative density
Temperature

List 8

Eg:
ICAO tables
Take-off performance graphs
Fuel data.

Unit 215 Aviation mathematics and science for technicians

Outcome 6 Understand the nature of matter

Assessment Criteria

The learner can:

1. explain the kinetic theory of matter
2. identify common engineering chemical elements by name and symbol
3. explain the three basic states of matter and the changes of state of common substances
4. explain the three main bonds at molecular level
5. describe the nature of molecules found in metals and non-metals
6. explain the difference between heat and temperature
7. explain the relationship between the common temperature scales
8. convert temperature values between the common temperature scales
9. use the ISA tables to derive specific values.

Range/Scope/Unit content

List 1

Explanation including:
Random motion of particles
Brownian motion
Gas properties of pressure, temperature and volume
Conduction, Convection, Radiation, Adiabetic compression

List 2

Eg carbon, iron, aluminium, copper

List 3

Solid, liquid, gas
Include all state changes: solid > liquid > gas >liquid > gas
Basic explanation of latent heat
Common features of state changes such as the expansion of water when frozen.

List 4

Metallic
Ionic
Covalent
Relative strengths of each bond
Reasons for forming each type

List 5
Materials used in aircraft eg:
Steel
Aluminium alloys
Plastics
Conductors
Insulators

List 6
Engineering explanation using aircraft related examples

List 7
Kelvin
Degrees Fahrenheit
Degrees Celsius
Thermometers

List 8
Kelvin
Degrees Fahrenheit
Degrees Celsius

List 9
Eg:
Altitude
Temperature
Density.

Unit 215 Aviation mathematics and science for technicians

Outcome 7 Understand principles of statics

Assessment Criteria

The learner can:

1. identify forces represented graphically as vectors
2. explain the concept of equilibrium
3. define the meaning of 'the moment of a force about a point'
4. define centre of gravity
5. solve problems involving straight levers, bell cranks and aircraft loading
6. solve problems graphically using the 'triangle of forces' theorem
7. solve problems graphically using the 'parallelogram of forces' theorem
8. define pressure and its units
9. explain the difference between gauge pressure and absolute pressure
10. solve problems involving atmospheric, gauge and absolute pressures
11. calculate pressures in liquids using basic physical measurement.

Range/Scope/Unit content

List 1

Define 'vector'

Draw vector lines to represent forces in a system

List 2

With respect to mechanical systems

List 3

Basic principle of moments

List 4

Explain the meaning

Examples of position in common objects including aircraft

List 5

Relate problems to aircraft eg:

Bell crank on control cables

Aircraft balance about main undercarriage on the ground

Aircraft loading to adjust C of G

List 6

Including some aircraft-related problems

List 7

Including some aircraft-related problems

List 8

The atmosphere

Free liquids and gases
Constrained liquids and gases
Stress and strain of materials
Gas laws (Boyle's Charles)

List 9
Aircraft-related examples

List 10
Aircraft related

List 11
Measuring height
Applying ρ p = þ gh

Unit 215 Aviation mathematics and science for technicians

Outcome 8 Understand principles of linear, angular and oscillating motion related to aircraft in flight

Assessment Criteria

The learner can:

1. define speed, velocity and acceleration
2. state Newton's Laws of Motion
3. explain the relationships F = ma and W = mg
4. define the equations of linear motion for constant acceleration
5. solve problems related to an aircraft in flight
6. define basic terms for angular motion
7. define terms for oscillating motion
8. explain simple harmonic motion in terms of mass-spring and simple pendulum systems
9. calculate the natural frequency of small oscillations in a pendulum.

Range/Scope/Unit content

List 1

Including acceleration due to gravity and its approximate value

List 2

In standard form

Include aircraft-related examples

List 3

Including aircraft-related examples

List 4

$s = ut + \frac{1}{2}at^2$

$v = u + at$

$v^2 = u^2 + 2as$

List 5

Using:

Newton's Laws of Motion

Linear motion equations

List 6

Centripetal acceleration

Centrifugal force

Angular velocity

Calculations

List 7
For elastic systems:
Free vibration
Simple harmonic motion
Forced vibration
Resonance
Time period
Cycle
Frequency
Amplitude

List 8
Applying definitions in (7.)

List 9
Using the simplified version of the pendulum formula for small oscillations.

Unit 215 Aviation mathematics and science for technicians

Outcome 9 Understand principles of dynamics related to aircraft in flight

Assessment Criteria

The learner can:

1. define terms relating to simple machines
2. solve problems involving simple machines
3. explain terms related to gyroscopic motion
4. define work and power
5. define common forms of energy
6. explain the concept of the conservation of energy
7. solve simple problems involving potential and kinetic energy
8. explain terms related to friction
9. solve simple problems involving friction affecting objects on horizontal surfaces.

Range/Scope/Unit content

List 1

Velocity ratio
Mechanical advantage
Efficiency

List 2

Related to aircraft where possible:
Relationship between pressure, force and area
Pulley systems
Worm and wheel
Levers
Gears
Screw jack
Efficiency

List 3

Momentum
Inertia
Rigidity
Precession
Gimbal Lock, Degrees of freedom

List 4

Calculations

List 5
Potential
Kinetic
Heat
Electrical
Chemical

List 6
Eg: ‘energy can neither be created nor destroyed, but only converted from one form to another’

List 7
Related to aircraft where possible:

List 8
Static friction
Dynamic friction
Coefficient of friction
Reaction
Normal force

List 9
Applying definitions in 8

Unit 215 Aviation mathematics and science for technicians

Outcome 10 Understand principles of fluid motion related to aircraft in flight

Assessment Criteria

The learner can:

1. explain density and relative density (specific gravity)
2. solve simple problems involving changing altitude
3. explain viscosity
4. describe the effects of streamlining on the properties of air over an aerofoil surface
5. explain Bernoulli's Principle for a non-viscous fluid
6. explain the relationship between Bernoulli's principle, a venturi and lift on an aerofoil

Range/Scope/Unit content

List 1

Including practical examples eg: fuel

List 2

Changes with altitude of air properties:

Density

Pressure

Temperature

List 3

In terms of:

Resistance to fluid flow

Shear stresses close to the system boundary

List 4

Velocity of the air

Resistance of the air

List 5

Eg: potential energy, kinetic energy and pressure energy remain constant in the streamline

List 6

Simplified explanation.

Unit 215 Aviation mathematics and science for technicians

Notes for guidance

This unit contains the complete syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 1 – Mathematics and Module 2 – Physics, for Category A Licences but is taught to the depth for Category B1. B1 syllabus paragraphs not covered are:

- 1.2b – Logarithms (only)
- 2.3b – Thermodynamics
- 2.4 – Optics (Light)
- 2.5 – Wave Motion and Sound

The equivalent EASA knowledge level indicators for each of the above outcomes are listed below with an abridged description of each level:

Level 1 – "A familiarisation with the principal elements of the subject"

Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"

Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

Outcome 1: EASA Level 2
Outcome 2: EASA Level 2
Outcome 3: EASA Level 2 (3.1-3) EASA Level 2 (3.4-7)
Outcome 4: EASA Level 2 (except 4.3 – EASA Level 1)
Outcome 5: EASA Level 2
Outcome 6: EASA Level 1 (except 6.6-8 – EASA Level 2)
Outcome 7: EASA Level 2
Outcome 8: EASA Level 2
Outcome 9: EASA Level 2
Outcome 10: EASA Level 2

Note: the above list equates to the EASA requirement for category B licences and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Appendix 1 Relationships to other qualifications

Literacy, language, numeracy and ICT skills development

This qualification 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 such 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.

Useful contacts

UK learners **General qualification information**	**T: +44 (0)844 543 0033** **E: learnersupport@cityandguilds.com**
International learners General qualification information	T: +44 (0)844 543 0033 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	T: +44 (0)844 543 0000 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	T: +44 (0)844 543 0000 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	T: +44 (0)844 543 0000 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	T: +44 (0)844 543 0000 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	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413

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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 operates from three major hubs: London (servicing Europe, the Caribbean and Americas), Johannesburg (servicing Africa), and Singapore (servicing Asia, Australia and New Zealand). The Group also includes the Institute of Leadership & Management (management and leadership qualifications), City & Guilds Land Based Services (land-based qualifications), the Centre for Skills Development (CSD works to improve the policy and practice of vocational education and training worldwide) and Learning Assistant (an online e-portfolio).

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