

## Appendix 2

Source: *Electrotechnology Training Package (UEE06), Volume 2 – Part 2.2*

### **Essential knowledge and associated skills**

The Essential Knowledge and Associated Skills (EKAS) play an integral part in each unit of competence and **must** be taken into account when developing learning strategies and assessment tools.

This separate essential knowledge and associated skills forms an integral part of each competency standard unit, and all assessment evidence activities and reporting processes are to incorporate this specification.

In determining strategies for delivery regard is to be had in the preferred use of industry EKAS learning specifications to assure consistency and reliability of outcomes.

The information supplied below has been recommended by industry in providing the underpinning support towards deeming a person competent in a unit or units of competence.

Reference to the *Essential Knowledge and Associated Skills* is found in each Electrotechnology industry competency standard unit. These references are detailed below.

#### **2.1.1 Cable protection and support**

Evidence shall show an understanding of cable protection and support method and accessories to an extent indicated by the following aspects:

- a) Requirements to protect and support cables adequately

Note: Examples of protection are protection against mechanical damage, protection from adverse temperatures and corrosion and protection from magnetic field that may affect the performance of the cable.

- b) Cable support and protection devices, accessories and typical applications

Note: Examples include metallic and non-metallic conduits, duct and trunking, cable ladder and tray, cable clips and ties and related accessories.

- c) Installation techniques encompassing:

- cable installation equipment
- cable drawing and hauling techniques.

#### **2.1.2 Cable types and applications**

Evidence shall show an understanding of the types of cables used in the electrotechnology industry and their application to an extent indicated by the following aspects:

- a) Structural components of cables and their purpose

Note: Components include conductors and conductor material; insulation; sheathings and servings.

- b) Application of various cables types

- c) Cable variates

Note: Cable varieties include single cables, flexible cables, flexible cords, shielded cables, armoured cables, ribbon cables, other similar and like cables.

- d) Typical characteristics and use of power circuit cables and control circuit cables.

#### **2.1.3 Cables in buildings, structures and premises**

Evidence shall show an understanding of installing cables in buildings, structures and premises to an extent indicated by the following aspects:

- a) Building construction method and construction sequence

- b) Typical cable routes through buildings, structures and premises

- c) Building codes affecting the installation of cables in buildings, structures and premises  
Note: Building codes include limitation on penetration structural elements and maintenance of fire protection interiority.
- d) Cable segregation requirements.

#### **2.1.4 Basic cable and conductor terminations**

Evidence shall show an understanding of basic cable and conductor terminations to an extent indicated by the following aspects:

- a) Insulation removal and replacement
- b) Conductor handling and cable terminations encompassing:
- general aspects and soldering involving pins on electronic components and stranded conductors carrying current up to 25 amperes
  - application of connecting devices for conductors and terminals
  - continuity through connections and insulation resistance testing
  - stress release on cables/conductors.

#### **2.1.8 Electronic cable and conductor terminations**

Evidence shall show an understanding of terminating cable and conductor used in electronic equipment to an extent indicated by the following aspects:

- a) Cable and conductor types and characteristics encompassing:
- insulated wire
  - harness wiring
  - high performance cables
- Note: 1. Examples of characteristics are transmission performance parameters and electrical characteristics  
2. Types include UTP, FTP, and STP.
- b) Coaxial cables types and characteristics  
Note: Types include qualshield, trishield coaxial and armour plated coaxial cables.
- c) Cable anchoring and support methods
- d) Termination methods.

#### **2.2.1 Enterprise communication methods**

Evidence shall show an understanding of enterprise communication methods to an extent indicated by the following aspects:

- a) Communicating with personnel encompassing:
- oral communications
  - written procedures and work instructions
- b) Communicating with suppliers
- c) Communicating with customers.

#### **2.2.2 Enterprise work activities records**

Evidence shall show an understanding of work activities records to an extent indicated by the following aspects:

- a) Purpose and extent of maintaining work activities records in an enterprise
- b) Types of records for maintaining work activities in an enterprise
- c) Methods for recording and maintaining work records
- d) Work records required by regulation requirements.

#### **2.2.4 Problem solving techniques**

Evidence shall show an understanding of problem solving concepts and techniques as they apply in the workplace, to an extent indicated by the following aspects:

- a) Identify problems  
Note: Examples may include: process and quality problems; equipment selection, availability and failure; teamwork and work allocation problems; safety and emergency situations and incident; performance gaps; profit improvement and the like.

b) Mathematical tools

Note: Examples may include: average, standard deviation and the like.

c) Use of analytical techniques in problem solving

Note: Examples may include: brainstorming; fishbone diagrams/cause and effect diagrams; logic trees; process logic/process requirements; similarity/difference analysis; pareto analysis; force field/SWOT analysis.

d) Using tools to assistance in problem solving

Note: Examples may include: procedures and work instructions; safety data sheets; job cards; maintenance logs; plant drawing.

e) Determine corrective action encompassing:

- tools
- mode of communication procedure used within each enterprise
- established work procedures and policies
- size and structure of the teams/enterprise
- group goals - team, section, enterprise
- enterprise specific conflict resolution procedures
- action plans
- priority requirements
- measurable objectives
- resource requirements
- methods for reaching objectives
- timelines
- safety requirements
- risk assessment
- environmental requirements

f) Communicate recommendations

Note: Examples may include: feedback requirements; corrective action and analysis; following up recommendations and the like.

g) Implement monitoring encompassing:

- identifying components to be measured
- measurement and monitoring techniques
- measurement and monitoring tools.

### **2.2.5 Enterprise customer relations protocol**

Evidence shall show an understanding of enterprise customer relations protocols to an extent indicated by the following aspects:

- a) Purpose of customer relations
- b) Procedures for dealing with customers
- c) Dealing with customer issues.

### **2.2.6 Enterprise quality management system, basics**

Evidence shall show an understanding of enterprise quality management system to an extent indicated by the following aspects:

- a) Purpose of a quality system
- b) Procedures pertaining to the relevant work function
- c) Work instructions pertaining to the relevant work function.

### **2.2.13 User instruction techniques**

Evidence shall show an understanding of instructing users in the use of specific items of equipment and systems to an extent indicated by the following aspects:

a) Methods for evaluating user needs

Note: User needs should include how equipment is used efficiently and safely and identifying wear and tear and damage to the equipment that requires repairing.

b) Basic instruction methods

Note: Methods of instruction should be appropriate to the culture of the users and the equipment for which instruction is given.

c) Methods for evaluating user's ability use equipment correctly.

### **2.2.20 Computer use basics**

Evidence shall show an understanding of computer use basics to an extent indicated by the following aspects:

- a) Starting up
- b) Selecting application
- c) Entering information
- d) Saving
- e) Printing.

### **2.2.40 Electrotechnology Industry organisations and practises**

Evidence shall show an understanding of Electrotechnology industry organisations and practices to an extent indicated by the following aspects:

- a) Electrotechnology vocations encompassing:
  - electrical
  - electronics
  - computer systems
  - data communication
  - refrigeration and air conditioning
  - instrumentation and control
  - lifts
- b) Career paths in Electrotechnology encompassing:
  - Australian Qualification Framework (AQF)
  - qualifications/classifications
  - scope of work-installation, maintenance and servicing
- c) Training in Electrotechnology vocations encompassing:
  - traineeships, apprenticeships
  - licensed Electrician minimum requirements
  - career advancements
- d) Industry organisations encompassing:
  - employers
  - EE-Oz Training Standards and EE-Oz State/Territory Network
  - employee – trade union group (CEPU, ETU)
  - Government - ITABs, TAFE, RTO, ERAC
  - private providers
- e) Qualification requirements encompassing:
  - unit of competency
  - qualification assessments
- f) Policies and practices in Electrotechnology industry encompassing:
  - licensing requirements
  - OH&S requirements
  - awards
- g) Job application encompassing:
  - research
  - writing
  - methods of application
- h) Job interview encompassing:
  - preparation
  - presentation
  - evaluation.

### **2.3.7 Smart device basics**

Evidence shall show an understanding of smart devices with embedded controls to an extent indicated by the following aspects:

- a) Types of devices and their function
- b) Connection into a circuit
- c) Entering and verifying instructions.

### **2.4.11 Personal computers, hardware structure**

Evidence shall show an understanding of personal computers, hardware structure to an extent indicated by the following aspects:

- a) Structure and components and their function  
Note: Examples include motherboards, memory modules, video modules, connecting buses, storage devices and the like.
- b) Assembling and dismantling techniques
- c) Hardware faults and troubleshooting techniques  
Note: Confined to subsystem level.
- d) Basic network hardware and components
- e) Connection of network media
- f) Set up of standard network configuration.

#### **2.4.12.1 Computer hardware sub-assemblies**

Evidence shall show an understanding of computers, hardware components to an extent indicated by the following aspects:

- a) Sub-assemblies architecture and their function
- b) Sub-assemblies faults and troubleshooting techniques
- c) Repair techniques.

### **2.4.14 Personal computer operating systems, basics**

Evidence shall show an understanding of personal computer operating systems to an extent indicated by the following aspects:

- a) Basic function, components and concepts
- b) Operating systems in use
- c) System installation and configuration.

#### **2.5.1.2 Drawings and diagrams**

Evidence shall show an understanding of drawings, diagrams and schedules used in electrotechnology work to an extent indicated by the following aspects:

- a) Drawing types and applications encompassing:
  - drawing layouts and conventions  
Note: Examples include mechanical drawings, electrical/electronic schematics, wiring diagrams, PC boards, location diagrams (architectural drawings), cable routes and switching arrangements and building details.
  - drawing symbols  
Note: Examples include symbols representing electrotechnology circuit components, equipment location and cable routes and control arrangements.
- b) Cable/wiring/connection and equipment/component/schedules.

## 2.5.5 Technical standards, regulations and codes for extra low voltage work

Evidence shall show an understanding of technical standards, regulations and codes related to extra-low voltage work to an extent indicated by the following aspects:

- a) Limitation imposed by regulations
- b) How to read and apply a standard
- c) Aspects of technical Standards that apply to extra-low voltage work.

### 2.8.1.2 Fundamental electrical principles

Evidence shall show an understanding of electrical principles to an extent indicated by the following aspects:

- a) Fundamental and derived units encompassing:
  - basic units of measurement
  - SI derived units for force, pressure, energy/work temperature and power
  - conversion of units to multiple and submultiple units
  - transposition of a given equation for any variable in the equation
  - value of electrical and related mechanical quantities given in any combination of units, multiple units or submultiple units
- b) Power, work and energy encompassing:
  - relationship between power, work and energy
  - input, output, efficiency or losses of electrical systems and machines in terms of units/multiple units of power
  - effect of losses in electrical wiring and machines
- c) Electrical characteristics of materials encompassing:
  - characteristics of solid conductors, electrolytes, insulators and semi-conductors
  - mechanisms of electrical conduction in solids, liquids and gases
  - the terms “electric charge”, “electric current” and “electromotive force”
- d) The simple circuit encompassing:
  - symbols used to represent an electrical energy source, a load, a switch and a circuit protection device in circuit diagram
  - purpose of each component in the circuit
  - effects of an open-circuit, a closed-circuit and a short-circuit
- e) Resistance encompassing:
  - relationship between voltage and current from measured values in a simple circuit
  - value of voltage, current and resistance in a circuit given any two of these quantities
  - power dissipated in a circuit from voltage, current and resistance values
  - relationship between voltage, current and resistance and the power dissipated in a circuit
- f) Effects of current encompassing:
  - physiological effects of current
  - the fundamental principles (listed in AS/NZS 3000) for protection against the physiological effects of current
  - basic principles by which electric current can result in the production of heat; the production of light; the production of magnetic fields; a chemical reaction
  - typical uses of the effects of current
  - mechanisms by which metals corrode
  - the fundamental principles (listed in AS/NZS 3000) for protection against the damaging effects of current
- g) Sources of electrical energy – conversion of other forms to electrical energy encompassing:
  - basic principles which electricity is produced from a chemical reaction (primary cells, secondary cells and fuel cells); produced from a magnetic field coupled with motion; produced from light; produced from heat; produced from force
  - single emf source equivalent circuit
- h) Using measuring instruments encompassing:
  - safe working procedures when working with instruments
  - handling and storage of instruments to ensure they are protected from damage

- selection of an instrument to measure voltage, current or resistance
- connection of instruments into a circuit to measure voltage, current and resistance
- reading analogue scales and digital readouts in measuring voltage, current and resistance.

### 2.8.2.1 Direct current circuit principles

Evidence shall show an understanding of electrical principles to an extent indicated by the following aspects:

- Factors affecting resistance encompassing:
  - the factors of length, cross-sectional area and material effect the resistance of conductors
  - effects of temperature change on the resistance of various conducting materials
  - the resistance of a conductor from factors such as conductor length, cross-sectional area, resistivity and changes in temperature
  - effects of resistance on the current-carrying capacity and voltage drop in cables
- Resistors encompassing:
  - features of fixed and variable resistor types and typical applications
  - characteristics of temperature, voltage and light dependent resistors and typical applications of each
  - specifying a resistor for a particular application
  - resistance of a colour coded resistor from colour code table and confirm the value by measurement
- Series circuits encompassing:
  - setting up and connecting a single-source series d.c. circuit
  - measurement of resistance, voltage and current values in a single source series circuit
  - the voltage, current, resistances or power dissipated from measured or given values of any two of these quantities
  - relationship between the voltage drops around a circuit and the applied voltage
  - relationship between voltage drops and resistance in a simple voltage divider network
  - output voltage and current levels of connecting cells in series
- Parallel circuits encompassing:
  - setting up and connecting a single-source parallel circuit
  - measurement of resistance, voltage and current values in a single-source parallel circuit
  - the voltage, current, resistance or power dissipated from measured or given values of any of these quantities
  - relationship between currents entering a junction and currents leaving a junction
  - relationship between branch currents and resistances in a two branch current divider network
  - voltage and current levels of connecting cells in parallel
- Series/parallel circuits encompassing:
  - setting up and connecting a single-source series/parallel circuit
  - measurement of resistance, voltage and current values in a single-source series/parallel circuit
  - the voltage, current, resistances or power dissipated from measured or given values of any two of these quantities
  - relationship between voltages, currents and resistances in a bridge network
  - voltage and current levels of connecting cells in series parallel
- Measurement of electrical quantities encompassing:
  - hazards involved in using electrical instruments and the safety control measures that should be taken
  - operating characteristics of analogue and digital meters
  - selecting an appropriate meter in terms of units to be measured, range, loading effect and accuracy for a given application
  - measuring resistance using direct, volt-ammeter and bridge methods
  - instruments used in the field to measure voltage, current, resistance and insulation resistance and the typical circumstances in which they are used
- Capacitance encompassing:
  - definition of capacitance and explain how a capacitor is charged
  - the units by which capacitance is measured
  - relationship between capacitance, voltage and charge
  - behaviour of a series d.c. circuit containing resistance and capacitance components

- h) Capacitors encompassing:
- hazards involved in working with capacitance effects and the safety control measures that should be taken
  - factors which determine the capacitance of a capacitor and explain how these factors are present in all circuits to some extent
  - effects of capacitors connected in parallel by calculating their equivalent capacitance
  - effects on the total capacitance of capacitors connected in series
  - common faults in capacitors
  - testing of capacitors to determine serviceability.

## 2.8.6 Electromagnetic principles

Evidence shall show an understanding of electromagnetic principles to an extent indicated by the following aspects:

- a) Magnetism encompassing:
- field patterns around given permanent magnets
  - magnetic induction and its effects
  - principles of magnetic shielding and its application
  - classification of magnetic materials
  - typical applications of permanent magnets
- b) Electromagnetism encompassing:
- magnetic field patterns around a straight current carrying conductor and a solenoid
  - direction in which the magnetic field around a straight current carrying conductor
  - direction of the north pole of a solenoid
  - factors effecting the force and direction between adjacent current-carrying conductors
- c) Magnetic quantities encompassing:
- magnetic terms and units for magnetomotive force, reluctance, magnetic flux, magnetising force and flux density
  - property of permeability and the meaning of actual and relative permeability
  - values of magnetomotive force, magnetising force, flux density, permeability and reluctance in given magnetic circuits
- d) Magnetisation curve encompassing:
- the terms “saturation”, “hysteresis” and “losses” in relation to magnetic materials and circuits
  - magnetic characteristics of various materials from magnetisation curves, permeability curves and hysteresis loops
  - magnetic losses and the resulting effects on the performance of electrical machines
- e) Electromagnetic induction encompassing:
- factors required to induce an emf in a conductor
  - Faraday’s Law
  - direction of induced voltage in a moving conductor in a magnetic field
  - relationship between the forces acting on a closed conductor when an emf is induced in it. (Lenz’s law)
- f) Inductance and inductors encompassing:
- concept of inductance, self-inductance and mutual inductance. (in terms of storage of magnetic energy)
  - factors affecting inductance and how the unit of inductance is derived
  - inductance of a solenoid given necessary physical data
  - value of induced voltage in a given circuit
  - growth/decay of current in an inductor and determine the time constant of a series L-R circuit
  - types of inductors
- g) Application of electromagnetic principles encompassing:
- principles of operation and applications of magnetism, electromagnetism and induction
  - hazards associated with induced voltages
  - situations where the effects of inductance and electromagnetism has an adverse effect
- h) Rotating machine construction and operating principles encompassing:
- main components of a rotating machine
  - voltage generated and back emf induced in the “armature” conductors of a machine

- motor effect produced by an electric current, including the development of torque in a motor and opposing torque in a generator
  - induced voltage in a conductors, force on a conductor and torque of various machines
- i) Generators encompassing:
- circuit arrangement and connection of various types of generators
  - common methods of excitation used for generators
  - methods used to regulate the output voltage of generators
  - effects of load on a generator
  - applications of generators
- j) Machines encompassing:
- circuit arrangements and connections of various common motors
  - performance of motors from measured values
  - effects of load on a motor
- k) Specialty machines encompassing:
- tachogenerator – construction, operation and applications
  - servomotors – construction, operation and applications
  - stepper motors – construction, operation and applications
  - EC motors – construction, operation and applications.

### 2.8.13 Parts and components selection

Evidence shall show an understanding of electrotechnology, parts and component selection to an extent indicated by the following aspects:

- a) Part and component identification encompassing:
- type, number and ratings of a range of typical components used in the electrotechnology and engineering industries
- b) Information about parts and components encompassing:
- catalogues
  - computer access
  - alternative parts
  - telephone inquiry
- Note: Examples of part identification and access may include: part codes, manufacturers and manufacturers supply outlets; availability and delivery times; price, including discounts, tax and delivery costs.
- c) Ordering procedures encompassing:
- customer approval
  - supplier requirements
  - in-house requirements
- d) Receiving/dispatching procedures:
- supplier requirements
  - in-house requirements
  - handling and storage.

### 2.9.1.1 Electronic component basics

Evidence shall show an understanding of the electronic components to an extent indicated by the following aspects:

- a) Types of components
- Note: Examples of types are resistors, inductors, capacitors, diodes, transistor, integrated circuits, printed circuit boards, sub-assemblies, and mounting/enclosing, connection and termination hardware.
- b) The physical features and primary characteristic of components
- Note: 1. Features include shape, size and connections  
2. Characteristics include parameter and power ratings and polarity.
- c) Methods of identifying and marking of component ratings
- d) Identifying and handling static sensitive components.

### 2.9.1.5 Basic electronic principles

Evidence shall show an understanding of basic electronic principles to an extent indicated by the following aspects:

- a) Fundamental concepts:
  - insulators and conductors
  - basic electrical units and engineering prefixes
  - voltage, current and resistance
  - Ohm's Law
  - electrical power
  - digital and analogue multimeters
- b) Alternating Currents and Waveforms:
  - waveforms (sine and square wave)
  - the AC mains supply
  - electrical safety
  - fuses
  - lamps and indicators
- c) Electromagnetic Waves and Signals:
  - electromagnetic waves
  - the Radio Frequency spectrum
  - wave propagation
  - signals and bandwidth
  - transmission lines and antennas
  - harmonics
- d) Capacitance and inductance:
  - inductors and capacitors
- e) Electromagnetic Interference:
  - electrical noise
  - induced currents and voltages
  - cross-talk
  - electromagnetic Interference
- f) Batteries:
  - types of battery
  - battery capacity
  - care of batteries
- g) Techniques in the use of analogue and digital multimeters

Note: Example is broad overview of electronics theory applicable to commonplace electronic and computer equipment servicing and support tasks, and includes general appreciation of the topics and concepts rather than rigorous theoretical calculations and designs.

### 2.9.1.6 Basic digital principles

Evidence shall show an understanding of basic digital principles to an extent indicated by the following aspects:

- a) Analogue versus digital:
  - digital waveforms
- b) Number systems:
  - binary
  - hexadecimal
  - binary addition and subtraction
  - number system conversions
- c) Codes:
  - ASCII
  - ANSI
  - error detecting codes
    - parity
    - check sums
    - CRC
  - error correction

- d) Basic logic:
  - AND, OR, NOT, XOR
  - truth tables
- e) Data manipulation:
  - clocks and data rates
  - basic storage cell
  - registers
  - ripple counter (binary counting)
  - shift register (serial to parallel conversion)
  - multiplexer and de-multiplexer
  - bus architecture
    - encoding/decoding
    - addressing methods
- f) Analogue to digital conversion
- g) Digital to analogue conversion

Note: Example include a broad overview of digital electronics theory applicable to everyday computer servicing and support tasks and encompasses topics and concepts and is not for in depth theoretical calculations and designs. Also there is no specific logic gates or logic levels involved.

### **2.9.15 Audio and video component functional controls**

Evidence shall show an understanding of the functional controls of audio and video components to an extent indicated by the following aspects:

- a) Types of components and their functional controls
- b) Function set up procedures
- c) Testing.

### **2.9.42 Audio and video system set up**

Evidence shall show an understanding of setting up audio and video systems to an extent indicated by the following aspects:

- a) Audio components in a system
- b) Video components in a system
- c) Component connection arrangements
- d) Set up options and procedures.

### **2.10.30 Wireless devices**

Evidence shall show an understanding of wireless devices to an extent indicated by the following aspects:

- a) Types and applications
- b) Operating principles at sub-system level
- c) Programming functions
- d) Networking set up.

### **2.11.1 Hand tools**

Evidence shall show an understanding of hand tools and their use to an extent indicated by the following aspects:

- a) Hand tools for cutting, shaping, drilling, threading, tapping, and finishing metallic and non-metallic components encompassing:
  - types of tools and their purpose
  - techniques for the correct and safe use of these tools
  - hazards associated with their use
  - care and maintenance of hand tools

- b) Tools for measuring and marking out:
  - types of tools and their purpose
  - techniques for the correct and safe use of these tools
  - hazards associated with their use
  - care and maintenance of hand tools
- c) Tools for dismantling and assembling electrical and electronic components encompassing:
  - types of tools and their purpose
  - techniques for the correct and safe use of these tools
  - hazards associated with their use
  - care and maintenance of hand tools.

### **2.11.2.1 Power tools**

Evidence shall show an understanding of fixed and portable tools and their use to an extent indicated by the following aspects:

- a) Fixed power tools for cutting, shaping, drilling, and finishing metallic and non-metallic components encompassing:
  - types of tools and their purpose
  - techniques for the correct and safe use of these tools
  - hazards associated with their use
  - care and maintenance of fixed power tools
- b) Portable power tools for cutting, shaping, drilling, and structural components encompassing:
  - types of tools and their purpose
  - techniques for the correct and safe use of these tools
  - hazards associated with their use
  - care and maintenance of fixed power tools
  - requirements for use on construction sites.

### **2.11.3.1 Fixing and support devices and techniques**

Evidence shall show an understanding of accessories and support and fixing device and methods and their use to an extent indicated by the following aspects:

- a) Electrical/electronic/instrumentation/refrigeration/airconditioning/telecommunications accessories for supporting, fixing and protecting wiring/cabling/piping and functional accessories
- b) Device for securing and mounting electrical/electronic accessories encompassing:
  - types and safe application of screws, bolts, rivets and similar devices
  - types and safe application of devices for fixing to timber, metal, hollow structures and masonry and concrete
  - types and safe application of fixing adhesives and tapes
  - hazards and safety measures when working with adhesives and chemical fixing devices
  - regulatory requirements for use of powder fixing tools.

### **2.11.4 Dismantling and assembling techniques**

Evidence shall show an understanding of techniques for assembling and dismantling electrotechnology apparatus to an extent indicated by the following aspects:

- a) Purpose of sequencing dismantling and assembling
- b) Importance of marking/labelling and storing parts
- c) Techniques for dismantling and assembling close fitting parts
- d) Use of gasket and seals.

#### **2.11.11.1 Electronic soldering equipment and techniques**

Evidence shall show an understanding of electronic soldering equipment and their use to an extent indicated by the following aspects:

- a) Electronic soldering equipment encompassing:

- types of equipment and their purpose
  - hazards associated with their use
  - care and maintenance of brazing and soldering equipment
- b) Electronic soldering techniques encompassing:
- safe use of equipment
  - preparation of surfaces
  - adjusting heat
  - application
  - basic principles of lead free soldering techniques.

### **2.11.13.1 Brazing and soldering equipment and techniques**

Evidence shall show an understanding of brazing and soldering equipment and their use to an extent indicated by the following aspects:

- a) Silver brazing and soldering equipment encompassing:
- types of equipment and their purpose
  - hazards associated with their use
  - care and maintenance of brazing and soldering equipment
- b) Silver brazing and soldering techniques encompassing:
- safe use of equipment
  - preparation of surfaces
  - adjusting gas flame
  - application
  - use of dry nitrogen to prevent contamination.

### **2.11.14 Piping and tubing techniques**

Evidence shall show an understanding of techniques for working with piping and tubing to an extent indicated by the following aspects:

- a) Risks of working with piping and tubing and their control measures
- b) Techniques encompassing:
- cutting pipe and tubing
  - bending, shaping/setting pipe and tubing
  - joining connecting/terminating pipe and tubing, this includes flaring, swaging, silver, brazing and various types of tube and threading fittings.

### **2.18.1 Occupational Health and Safety principles**

Evidence shall show an understanding of Occupational Health and Safety to an extent indicated by the following aspects:

- a) The basic legal requirements covering occupational health and safety in the workplace encompassing:
- general aims and objectives of the relevant state or territory legislation relating to OHS
  - employer and employee responsibilities, rights and obligations
  - major functions of safety committees and representatives, and
  - powers given to Occupational Health and Safety Inspectors
- b) The requirements for personal safety in the workplace encompassing:
- the safety precautions that are required to ensure personal safety in the workplace
  - potential hazards in relation to improper industrial housekeeping, and
  - sources of pollution in an engineering environment and outline control measures
- c) Workplace safety check, identifying potential workplace hazards and suggested measures for accident prevention encompassing:
- safety checklist for a typical workplace environment
  - identifying and reporting potential workplace hazards, and
  - methods of prevention of safety hazards within a typical workplace environment
- d) working safely with electrical tools or equipment encompassing:
- causes of electrical accidents and state the effects that electric shock can cause

- purpose of circuit protection devices, such as fuses, circuit breakers and Residual
  - Current Devices (RCDs), and
  - safe isolation of an electrical supply
- e) emergency procedures for the rescue of an electric shock victim equipment
- f) emergency first aid for an electric shock victim.

Note: Emergency first aid is limited to first-on-the scene assistance to a victim of electric shock, and basics of CPR.

### **2.18.2 Electrical safe working practices**

Evidence shall show an understanding of working safely on or around electrical equipment through the application of risk management principles and control measures for dealing with non-electrical hazards and extra-low voltage, low-voltage and high-voltage hazards and high-current hazards. The following aspects indicate the extent of understanding required:

- a) Risk management and assessment of risk encompassing:
- principle and purpose of risk management, and
  - processes for conducting a risk assessment
- b) Hazards associated with low-voltage, extra-low voltage and high-currents encompassing:
- arrangement of power distribution and circuits in an electrical installations
  - parts of an electrical system and equipment that operate at low-voltage and extra-low voltage
  - parts of an electrical system and equipment where high-currents are likely
- c) Risks and control measures associated with high-voltage encompassing:
- parts of an electrical system and equipment that operate at high-voltage
  - the terms ‘touch voltage’, ‘step voltage’, ‘induced voltage’ and ‘creepage’ as they relate to the hazards of high-voltage, and
  - control measures used for dealing with the hazards of high-voltage
- d) Optical fibre safety encompassing:
- coherent optical sources and joining procedures
  - laser safety class 3a devices or their replace
- e) Risks and control measures associated with low voltage encompassing:
- risks associated with modifying electrical installations, fault finding, maintenance and repair
  - control measures before, while and after working on electrical installations, circuits or equipment
  - isolation and tagging-off procedures
  - risks and restrictions in working live
  - control measures for working live
- f) Risks and control measures associated with harmful dusts and airborne contaminants
- Note: Sources include thermal insulation, fibrous cement materials and asbestos and other fibre reinforced switchboard materials.
- g) Safety, selection, use, maintenance and care of test equipment encompassing:
- safety characteristics of electrical testing devices
  - safe use of electrical testing device, and
  - checks and storage methods for maintaining the safety of testing devices.

### **2.18.9 Electronic safe working practices**

Evidence shall show an understanding of working safely on or around electronic equipment through the application of risk management principles and control measures for dealing with non-electrical hazards and extra-low voltage, low-voltage and high-voltage hazards and high-current hazards. The following aspects indicate the extent of understanding required:

- a) Risk management and assessment of risk encompassing:
- principle and purpose of risk management, and
  - processes for conducting a risk assessment
- b) Hazards associated with low-voltage, extra-low voltage and high-currents encompassing:
- parts of an electronic systems and equipment that operate at low-voltage and extra-low voltage
  - parts of an electronic systems and equipment where high-currents are likely

- c) Risks and control measures associated with high-voltage encompassing:
  - parts of an electronic systems and equipment that operate at high-voltage
  - the terms used - ‘touch voltage’, ‘step voltage’, ‘induced voltage’ and ‘creepage’ as they relate to the hazards of high-voltage, and
  - control measures used for dealing with the hazards of high-voltage
- d) Risks and control measures associated with low voltage encompassing:
  - risks associated with installation, fault finding, maintenance and repair
  - control measures before, while and after working on electronic systems or equipment
  - isolation and tagging-off procedures
  - risks and restrictions in working live
  - control measures for working live
- e) Risks and control measures associated with the high levels of radiation encompassing:
  - RF hazards
  - maximum exposure levels to RF
  - maximum exposure to microwave radiation
- f) Optical fibre safety encompassing:
  - coherent optical sources and joining procedures
  - laser safety class 3a devices or their replace
- g) Safety, selection, use, maintenance and care of test equipment encompassing:
  - safety characteristics of electrical testing devices
  - chemical cleaning solvents, glues and joining wastes used in electronics
  - safe use of electrical testing device, and
  - checks and storage methods for maintaining the safety of testing devices.

### **2.20.1 Sustainable energy principles**

Evidence shall show an understanding of sustainable energy principles to an extent indicated by the following aspects:

- a) Notions of sustainable energy
- b) Sustainable energy work practices.

### **2.20.2 Environmental and heritage awareness**

Evidence shall show an understanding of environmental and building regulation effecting electrotechnology work to an extent indicated by the following aspects:

- a) Types of heritage listings
- b) Purpose and principles of regulations related maintaining heritage sites
- c) Responsibilities of those working in and around heritage sites
- d) Scope of environmental protection and related regulations
- e) Purpose and principles of regulations related to environmental protection
- f) Responsibilities of those working in and around environmentally protected sites
- g) The protocols for working in and around protected environments and heritage sites.

### **2.20.3 Introduction to renewable energy technologies**

Evidence shall show an understanding of renewable energy principles and technologies to the extent indicated by the following aspects:

- a) Major non-technical issues:
  - impact of economic, social, environmental and political issues on the use of renewable energy technologies
  - how each of the non-technical issues impact on the application of a selected renewable energy technology

- b) Energy services and demand:
- definition of the terms: energy, power, energy efficiency, end use energy, primary energy, embodied energy
  - calculation relating to energy, power and time with the appropriate number and time with the appropriate number of significant figures
  - units and symbols for energy, power, time and temperature using standard SI units and prefixes
  - conversion of energy and power quantities from one unit to another using conversion tables
  - the two laws that apply to any energy conversion process
  - efficiency of a simple energy conversion process
  - energy services required by a domestic dwelling
  - power and energy consumption of individual appliances and systems using appropriate meters or other methods
  - calculation of the end use and primary energy required for these energy services
  - selection of the most appropriate energy source for each of these services
  - justification in terms of environmental, economic, social and political constraints
  - selection of appropriate energy efficient appliances and technologies
- c) The solar resource:
- definition of the terms: irradiation, latitude, solar constant, direct and diffuse radiation, azimuth and altitude angles, irradiance, solar window, tilt angle, solstice, equinox
  - units and symbol for irradiation and irradiance and the conversion of one unit to another using conversion tables
  - measurement of solar irradiance with a solarimeter
  - solar radiation data tables and contour maps
  - position of the sun for a given date, time and latitude using a sun path diagram
  - times when an obstacle will shade a given collector
  - how radiation varies throughout the year on the surface of a collector which is either fixed, single-axis tracking or double-axis tracking
  - appropriate tilt angles for fixed and seasonally-adjustable collectors at a given latitude and given application
  - calculation of the effect of single-axis tracking and double-axis tracking on collected radiation using radiation data tables
- d) Solar thermal systems:
- definition of the terms: conduction, convection, radiation, collector heat loss co-efficient, conductivity, specific heat, solar fraction
  - components for a solar thermal system including collector, storage, reticulation and control
  - solar collector types suitable for low, medium and high temperature applications
  - different types of domestic solar hot water (SWH) systems
  - how the components of thermosiphon and pumped storage systems operate
  - heat loss mechanisms in collectors
  - stratification in storage tanks
  - backup energy systems
  - control and protection strategies
  - solar fraction of a domestic SHW system with the use of table or nomograms
- e) Energy efficient building design:
- definition of the terms: thermal comfort, passive system, active system, aspect of the site, orientation of the building, thermal mass
  - the climate factors which affect building design
  - relationship between thermal comfort and climate
  - relationship between the seasonal variation of the sun's path and the heat gain of the building elements (roof, walls, windows, floor)
  - effect of the thermal conductivity of building materials on heat flows to and from the building
  - use of thermal mass in reducing temperature variations within the building
  - use of ventilation
  - thermal performance of a dwelling using both indoor and outdoor hourly temperature measurements over the period of at least one day
  - effect of insulation, glazing, orientation, shading devices, thermal mass and ventilation on the thermal performance of a building
  - an active solar system which could be used in a dwelling to complement passive design features in extreme climates
  - aspects of an existing dwelling that contribute to or detract from thermal performance

- f) Photovoltaic arrays:
- definition of the terms: photovoltaic (PV) cell, module, series, parallel, array, maximum power point (MPP), nominal operating cell temperature (NOCT), short circuit current (ISC), open Circuit voltage (VOC), I-V curve, current at maximum power point (IMP), voltage at maximum power point (VMP)
  - calculations relating to voltage, current and power with the appropriate number of significant figures and using standard SI units and prefixes
  - types of commercially available PV modules, their efficiency and typical applications
  - I-V curve for a typical PV module and label the approximate position of MPP and values of ISC, VOC, IMP and VMP
  - effect of irradiance and temperature on ISC, VOC, IMP and VMP
  - function of blocking and bypass diodes
  - current and voltage of a single module to produce the I-V characteristic curve
  - major specification criteria for a PV module
  - size and configuration of a PV array for a given load and system voltage using tables or nomograms
- g) Wind energy resources:
- definition of the terms: kinetic energy, specific wind power, vertical wind speed profile, surface roughness, temperature inversion layer, cut in ( $v_C$ ), rated ( $v_R$ ) and furling ( $v_F$ ) wind
  - speeds, rated power (PR), power co-efficient (cP), output co-efficient (cO), tip speed ratio
  - units and symbols for wind speed, specific wind power and air density
  - large scale wind patterns over the Australian continent, their causes and the effect of local terrain on wind speed, direction and turbulence
  - specific wind power for given wind speeds
  - wind speed at different heights above ground level
  - the mean wind speed based on wind speed frequency distribution data in the form of a histogram
  - suitable minimum tower height for a wind
  - energy conversion System (WECS) sited downwind from an obstacle
  - isovent maps
  - types of wind-measuring instruments and the minimum requirements for assessing wind energy at a given site
  - measurement of wind speed and direction
  - characteristics of horizontal axis and vertical axis, upwind and downwind, lift and drag propelled wind turbines
  - power vs wind speed curve for a typical WECS showing  $v_C$ ,  $v_R$ ,  $v_F$ , and PR
  - major specification criteria for a WECS
  - sizing a WECS for a given load, efficiency and annual mean wind speed using tables or a nomogram
- h) Micro-hydro system basis:
- definition of the terms: flow rate, gross or static head, potential energy, net or dynamic head, hydraulic efficiency, MHS efficiency, equivalent pipe length, reaction turbine, impulse turbine
  - units and symbols for: flow rate, head, gravitational constant
  - methods each assessing flow rate and head
  - measurement of stream flow rate and head
  - assessment from contour maps
  - different MHS in terms of their physical and operating characteristics
  - major specification criteria for an MHS for electricity generation
  - suitable type and size of MHS for a given load, efficiency, available flow rate and net head using tables or a nomogram
- i) Energy storage:
- methods of energy storage
  - energy density of the energy storage methods above by mass and volume
  - define the following terms in relation to batteries: nominal voltage, cell, primary and secondary cells, battery, charge and discharge rate, amp hour capacity, watt hour capacity, state of charge (SOC), depth of discharge (DOD), specific gravity (SG), watt hour and amp hour efficiency, cycle life
  - major features of common types of batteries suitable for stand-alone power systems
  - state of charge of a lead-acid battery through measurement of specific gravity or battery voltage using safe working practices
- j) Stand alone power system basis:
- d.c. sub-system efficiency
  - block diagram of a typical SPS

- function of each SPS system component
  - typical efficiencies of each component
  - major characteristics of different types of commercially available regulators, inverters and battery chargers
- k) Biomass:
- definition of the terms: biogas, producer gas, biofuels, feedstock, gross and net calorific values
  - biofuels and their specific energy contents
  - method of production of one of these five biofuels including: source of raw material/feedstock, conversion process, yield
  - applications for each of the biofuels
  - assessment of the biomass resource required to meet a particular energy service eg cooking, hot water, space heat, transport, process heat, electricity
  - social, political and economic impact of large scale use of selected biomass resources.

#### **2.20.4 Greenhouse reduction strategies**

Evidence shall show an understanding of greenhouse reduction strategies to the extent indicated by the following aspects:

- a) Greenhouse gas emissions profile:
- goals and principles of the National Greenhouse Strategy
  - what a greenhouse gas inventory is, why it is required, and the sectors to which it applies
  - uses to which the National Greenhouse Gas Inventory can be applied
- b) Understanding and communicating climate change and its impacts:
- the possible impact of climate change in Australia
  - techniques for improving the understanding of climate change
  - techniques for communicating to and educating the general public on greenhouse gas induced climate change
- c) Partnerships for greenhouse action:
- actions achievable by each level of government to implement the NGS
  - methods by which the community activity can be engaged in the reduction of greenhouse gas emissions
  - initiatives that can be undertaken by the private sector to reduce greenhouse gas emissions
  - advantages of international partnerships
  - emissions trading system
- d) Efficient and sustainable energy use and supply:
- techniques for reducing the greenhouse intensity of energy supply
  - types of renewable energy sources suitable for use in Australia
  - methods and technique for improving end-use efficiency
- e) Efficient transport and sustainable urban planning:
- how integrating land use and transport planning can assist the greenhouse problem
  - how each of the following can be used to mitigate greenhouse gas; travel demand and traffic management strategies; encouraging greater use of public transport, walking and cycling; freight and logistics systems; improving vehicle fuel efficiency and fuel technologies
- f) Greenhouse sinks and sustainable land management:
- how enhancing greenhouse sinks and encouraging sustainable forestry and vegetation management can complement the AGS
  - how greenhouse gas emissions are obtained from agricultural production and describe techniques to mitigate the emissions
- g) Models of greenhouse best practice in industrial processes and waste management:
- types and methods of reducing greenhouse gas emissions from industry
  - methods of reducing methane emissions from waste treatment and disposal
- h) Adaptation to climate change:
- salient points in each of the key sectors that require analysis and the strategies required in the need for adaptation to climate change
- i) Kyoto Protocol and greenhouse gas sinks:
- Kyoto Protocol
  - Greenhouse gas sinks and greenhouse mitigation.