TRAINING STANDARDS

National Electrotechnology Training Package

Volume 3

Installation Units

UTE99 Electrotechnology Training Package

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Glossary

Italic typeface is used in this National Training Package and the associated competency standards indicates terms and variables that require further explanation. Explanation of terms and variables that have meaning in a particular unit are given in the range statements and should be referenced accordingly at all times. Those that have a common meaning throughout this standard are explained below.

In many instances, the explanations of relevant terms are direct extracts from or are derived from technical standards published by Standards Australia or jointly by Standards Australia and Standards New Zealand.

It should be noted that some Units of competency have unique features. Consequently, these units have additional glossary terms included within.

Common terms and variables

Accessories -

Any device associated with, and forming an integral part of, the wiring systems such as switch, fuse, plug, socket outlet, lampholder, fitting, adaptor, ceiling rose; connectors, clamps, splitters, termination posts, lugs, strips and blocks; clips, ties and bindings.

Apparatus -

Any equipment forming a component part of an installation used for a particular purpose. *Apparatus* includes, but is not limited to, that contained in the following divisions. It will necessarily include new and emerging technologies:

- **Audio/visual equipment** including televisions, radios, monitors, cameras, closed circuit television, mono and stereo sound systems, gaming machines, electronic display panels, cassette recorders, video cassette recorders, CDROM players, tape recorders, sound and video duplication equipment, digital versatile discs, digital audio tapes, professional and domestic speaker systems, mixer desks.
- **Air conditioning equipment** including room air conditioners, split systems, package units, ducted units, evaporative coolers, ventilation systems.
- **Appliances** including portable electric tools, motor driven pumps, vacuum cleaners, food preparation equipment, hair dryers, refrigerators, washing machines, dish washers, paper shredders, water coolers, clothes dryers, pest exterminators, electric motor driven industrial tools and equipment, sanitary disposal units, radial and tangential fans and blowers.
- **Business equipment** including facsimile machines, photocopiers, printers, scanners, modems, computers and peripherals, financial transaction devices and systems.

- **Communications equipment** including radio transmitters, television transmitters, microwave transmitters and receivers, repeaters, two way radios, antennae, satellite linkage equipment.
- **Computer systems** including personal computers, computer networks, peripherals, supervisory control and data acquisition systems, modems, bridges, servers, routers, automatic data capture equipment.
- **Electrical and electronic controllers and control systems** including switchboards and control centres, alternating and direct current regulated and unregulated power supplies, rectifiers and filters, electromechanical and solid state relays and contactors, programmable controllers, uninterruptable power supplies, oscillators, motor speed controllers, electromechanical and dynamic brakes, battery charging and electroplating equipment, lamp dimmers and flashers, transducers, frequency injection systems.
- **Electrical machines and associated drives** including single phase and polyphase alternating current cage and wound rotor induction motors and synchronous motors and generators, direct current motors and generators, amplidynes, dynamometers, stepper motors, servo motors and synchros, double wound and auto transformers, induction regulators, electronic variable speed and eddy current drives.
- **Energy management and sustainable energy equipment** including solar cells, stand-by batteries, inverters, wind generators, hybrid systems, stand-by alternators, power factor correction controllers.
- **Heating equipment** including single and polyphase instantaneous and quick recovery water heaters, space heaters, induction heaters, electric furnaces, commercial food warmers, microwave and dielectric heaters, electric ranges, stoves and oven tops.
- **Instrumentation/process control devices and equipment** including controllers, transmitters, final control elements, detectors, process loop auxiliary equipment, indicators and recorders, monitors and computer interface equipment.
- **Lighting** including incandescent, quartz halogen and vapour lamps, applications in domestic, commercial, industrial and sporting settings, advertising signs, security lighting, road and highway lighting.
- **Measuring instruments** including digital and analogue ammeters, voltmeters, watt and var meters, frequency meters, phase rotation devices, oscilloscopes, power factor indicators, energy meters, insulation resistance devices, continuity testers, chart recorders, voltage detectors, Wheatstone and double bridges, instruments to measure signal strength, harmonic distortion, electro-magnetic and electro-static fields.
- **Medical electronics and equipment** including x-ray machines, cardiographic monitoring equipment, electrophoresis equipment, electron microscopes, infra-red (deep heat) equipment, physical therapy equipment, CAT scan equipment, ultrasound equipment, defibrillators, infusion pumps, incubators, ventilators, foetal monitors, thermometric

devices, anaesthetic units, gas monitors, dialysis equipment, pacemakers, lasers, endoscopes, blood warmers, physiological monitors.

- **Power distribution/transmission systems** including wood, concrete, steel and composite poles and structures, transmission towers, overhead and underground conductors and cables, electrical metering and recording devices.
- **Refrigeration systems** including refrigerators, freezers, icemakers, cool rooms, freeze rooms, beverage coolers, merchandising and display cabinets, blast freezers.
- **Scanning and detection systems** including: radar systems, sonar systems.
- **Security and fire detection systems** including sensors, controllers, alarm devices, telecommunications interfaces, closed circuit television cameras and monitoring systems.
- **Telecommunication equipment** including switching equipment, PABX, microwave transmitters and receivers, customer premises equipment, customer access networks, transmission equipment.

See also *wiring systems.*

Apparatus, fixed wired -

Apparatus (electrical/electronic) connected to a system of wiring in which cables protected or unprotected are fixed or supported in position.

Appliances -

A fixed (for support only), hand-held (held in hand during normal use), portable (moved whilst in operation or easily moved from one place to another while connected to the supply) or stationary (can be moved, but not easily) consuming device, other than a lamp.

Individuals with responsibilities for co-ordination, design installation, maintenance, production, or servicing activities. This can include:

- site managers
- project managers
- engineers and technicians
- technical experts
- line managers/supervisors
- regulatory personnel
- team leaders
- other personnel designated by an organisation or enterprise

Approval of equipment -

Acceptance by the relevant authority for an item of equipment to be used in a particular situation.

AQF -

Australian Qualifications Framework, which describes qualifications in terms of levels, characterised by the outcomes of vocational education and training.

Capacity, load and duty -

Flow rates of air, fluids and gases; current-carrying capacity; air, fluids and gas pressures; mechanical loading on piping, tubing or cables and supports; maximum demand and current ratings; duty cycles; frequency; environmental conditions.

Categories – general -

Competency can be achieved for any number of the following categories for which **formal endorsement** is to be provided, as prescribed in the evidence guide and critical aspects for each unit. These are:

a. Computer systems: The adaptation of Electrotechnology to the processing and control, communication and storage of information.

b. Electrical: Encompasses the systems associated with wiring reticulation, distribution centres, utilising devices and electrical machines for the conversion of electrical energy into other forms and conversely for the conversion of other forms of energy into electromotive force.

c. Electronics: The use of discrete solid state components and integrated circuits and devices and their associated circuits for application within process control systems, communication systems, computers, measurement, entertainment equipment, electro-medical equipment and the like.

d. Instrumentation: The measurement and control of process system data and parameters for industrial and commercial use. It includes the calibration and maintenance of instrument and processes in the chemical, energy, biotechnology, environmental, food processing and manufacturing industries.

e. Refrigeration and air conditioning: Air conditioning is the provision of clean air to an area at proper temperature and humidity. Refrigeration is the cooling of a space or its contents to a lower temperature than that of the surrounding space or of the ambient atmosphere.

f. Data communications: Encompassing the systems associated with communication distribution equipment, components, and the related devices for the distribution of audiovisual and data between points of transmission and reception.

Categories - relating to wiring systems -

g. Cabling/wiring support and protection: Including cable enclosure, ducts, trunking, roughing and cable trays and conduits, cable supports, aerial systems, catenary systems, underground systems, cable harnesses and looms.

h. Network communications: Including wiring systems and cables for the purpose of transmitting audio, visual or data information and may be associated with such things as twisted pair cables, telephone cables, screened and shielded cables, coaxial cables and optical fibre cables.

i. Power and control – extra low voltage: Including wiring systems and cables for the purposes of providing power and/or analogue or digital control and may be associated with such things as figure eight cables, unshielded twisted pair cables, ribbon cables, coaxial cables, and may include the production of printed circuit boards

j. Power and control – low voltage: Including wiring systems and cables for the purpose of providing power and/or analogue or digital control and may be associated with such things as thermoplastic/elastomer insulated/sheathed cable, multicore, armoured cable, mineral insulated metal sheathed (MIMS) cables, fire retardant cables, flexible cables, trailing cables and busways and includes those cables related to the category power and control extra low voltage.

Categories - relating to powerline switching -

k. Low voltage switching: The isolation and energising of low voltage powerlines for power distribution through approved switching and isolation procedures.

l. High voltage switching: The isolation and energising of high voltage powerlines for power transmission and distribution through approved switching and isolation procedures.

m. System switching: The isolation and energising of feeders in switchgear substations on low voltage and/or high voltage systems including load transfer and may include systems control room operations.

Categories - relating to business support -

n. Administration: Functions of record maintenance, quotation preparation, promotion of work and products, attending to customer and employees enquiries and complaints, preparation of invoices, business plans, service reports, maintenance reports and stock control.

p. Technical: Functions of estimating preparation of quotations, tenders related to installation, maintenance, repair and servicing of electrical/electronic apparatus and systems. Managing contracting projects and contracting business operation.

q. Wholesaling: Sales and supply of apparatus/equipment and electrical accessories to contractors and industrial end-users covering wholesaling-general or wholesaling-warehouse or wholesaling-point of sale.

Circuits -

Covers electrical, hydraulic, pneumatic, optical, magnetic, air flow, hydropic and refrigerant circuits.

Competency can be demonstrated in:

- basic circuits and associated apparatus
- complex circuits and associated apparatus
- systems' circuits and associated apparatus
- advanced circuits/systems and associated apparatus

A hierarchy of circuit complexity has been established within this document (independent of supply circuits) and are defined as follows:

Basic circuits: A basic circuit is defined as a single circuit with a single output.

A single circuit may be controlled by one or more devices and the output may control one or more devices.

Complex circuits: A complex circuit is defined as one made up of more than one interdependent circuit.

A complex circuit is made up of more than one circuit, controlling and processing inputs or outputs.

Systems' circuits: A systems' circuit is defined as one that interconnects between a number of interdependent apparatus.

A systems' circuit is made up of more than one interconnecting circuit controlling and processing apparatus inputs and outputs.

Advanced circuits/systems: Advanced circuits/systems may be complex circuits or systems circuits which contain complicated networks, hybrid circuits and which rely on digital or analogue closed loop feedback for the control of outputs.

Component -

That portion of a unit of *equipment*, which has been designed as a discrete unit and that can be identified as such.

Conditions and ratings -

Relates to flexible cables and plugs that are selected in accordance with Australian and New Zealand Standards and technical data including factors such as:

- Voltage rating
- Current rating

- Sheathing requirement
- Length of cable
- Pin configuration
- Control circuits
- Environmental conditions
- Weather proofing
- Fitting types – shielding, anchorage, earthing and polarity

Consistent performance -

Relates to sufficient evidence being present. This requires evidence that competence has been demonstrated for each element of each unit having been achieved at least three times autonomously and to *requirements.*

Design brief/proposal -

Instructions/specifications/outcomes defining the performance of circuits and associated apparatus, usually for the purpose of ensuring the optimum efficiency, environmental performance, economical effectiveness and operation of the system.

Endorsement: to be reported -

Refers to the endorsement on which an item of *apparatus, appliances, components, equipment, plant and machinery,* enclosures and the like that work can be performed on, (including any inspections, reports and risk assessment), as prescribed in regulations and/or by regulatory authorities, to which the unit applies.

Engineering data -

Refers to documents and other sources from which technical data and product specifications/characteristic are obtained, includes recognised standards publications, manufacturers product data publications and design features.

Environment -

The area surrounding the work site which can be directly or indirectly affected by occurrences at the work site. It includes the atmosphere, soils, drains, underground water tables, and the ecosystem. Protection of the environment would require the proper disposal of waste materials, restriction of burning off, the correct handling of toxic substances, the containment of CFCs and the like.

The protection of the environment would also include the minimisation of those factors that contribute, directly or indirectly, to the production of *greenhouse gases*.

These contributing factors might include the minimisation of waste materials, the correct use of enterprise vehicles and machinery, the re-use or recycling of trade

materials where possible and the overall reduction of energy usage through general awareness and the use of appropriate technologies.

Equipment (which is not apparatus) -

Any contributing part of an *installation* which may or may not be composed of *components.*

Established procedures -

Formal arrangements of an organisation, enterprise or statutory authority of how work is to be done. These may include, for example:

- quality assurance systems incorporating, for example:
  - specifications, requirements and procedures
  - work orders / instructions
  - reporting procedures
  - improvement mechanisms
  - compliance requirements
  - safety management
- work clearance systems incorporating, for example:
  - work permits
  - monitoring and clearance procedures
  - isolation procedures
- OH&S practices
- procedures for operating safety systems, operating plant and equipment and reporting work activities
- maintenance, modification or supply of relevant schematic drawings and technical data
  - arrangements for dealing with emergency situations.

Greenhouse gases -

Gaseous components of the atmosphere contributing to the greenhouse effect. These gases are produced, for example, when fossil fuels are burned to produce electricity and in other industrial processes.

The greenhouse effect leads to global warming with its ecological and environmental problems.

The minimisation of the use of energy in the workplace, derived from burning fossil fuels, reduces the production of greenhouse gases.

See also *environment*

Initial audit -

An audit that is carried out initially to ascertain whether: a) appropriate procedures have been followed to ensure the safety of the area; b) equipment, systems and installation conform with the design specification and are free from damage; c) any modification have been properly documented and appropriately approved.

Installation -

Wiring systems, *apparatus* and other required items as they are fixed in place and connected as necessary to operate as intended.

Modifications -

To make changes to the physical parameters or operational function of a device, component or piece of equipment or apparatus.

Notification (notified) -

Can include verbal, written, electronic or recorded information at completion of work which may be required to be completed in accordance with established procedures.

OH&S policies and procedures -

Arrangements of an organisation or enterprise to meet their legal and ethical obligations of ensuring the workplace is safe and without risk to health. This may include:

- hazardous and risk assessment mechanisms
- implementation of safety regulations
- safety training
- safety systems incorporating,
    - work clearance procedures
    - isolation procedures
    - gas and vapour
    - monitoring/testing procedures
    - use of protective equipment and clothing
- use of codes of practice

Periodic audit -

An audit that is carried out periodically to ascertain whether: a) appropriate procedures have been followed to ensure the safety of the area; b) equipment, systems and installation conform with the design specification and are free from damage; c) any modification have been properly documented and appropriately approved.

Plant and machinery -

Devices or machines (not considered to be hand tools or hand held power tools) used to facilitate construction, installation or maintenance and are removed after the completion of the work. Examples include chain blocks, winches, compressors, ladders, elevated work platforms, explosive power tools, hand operated battery mobile lift and transfer equipment, accessories and attachments and the like.

Requirements -

That to which equipment and procedures and their outcomes must conform and includes statutory obligations and regulations and *standards* called-up by legislation or regulations. Requirements may also include:

- statutory regulations
- codes of practice
- job specifications
- transport documentation
- *standards* called-up in specifications be they Australian/New Zealand or International
- procedures and work instructions
- quality assurance systems
- manufacturers' specifications
- maintenance manuals, schedules and specifications/standards
- circuit/cable schedules
- design specifications
- customer/client requirements and specifications
- specified underpinning knowledge (specified in units' Evidence Guides)
- National and State guidelines , policies and imperatives relating to the *environment*

Representative range -

That which requires a sufficient body of evidence undertaken across a range of activities and work functions to be present in order that a valid, reliable, fair and timely judgement about an individual's performance for attributing competence can be made.

Sample audits -

A sample audit that is carried out to ascertain whether: a) appropriate procedures have been followed to ensure the safety of the area; b) equipment, systems and installation conform with the design specification and are free from damage; c) any modification have been properly documented and appropriately approved.

Servicing -

Undertaking routine inspection, repair and maintenance of circuits, systems or *apparatus*.

Specialisation -

Describes the work environment in which the core technical requirements of learning are to apply.

Standards -

Technical documents, which set out specifications and other criteria for equipment, materials, and methods to ensure they consistently, perform as intended. The s*tandards* referred to in this competency standard are those published by Standards Australia or in joint venture with Standards New Zealand. Competency in the use of other technical standards may be required in industries not restricted to Australian *requirements*. For example, shipping and off-shore petroleum industries are subject to standards agreed to by underwriters and enterprises or some other international convention.

Statutory Authority -

The person or body responsible for the implementation of legislation.

Sustainable Energy Principles and Practice -

Sustainable Energy Practice refers to workplace actions that contribute to the reduction of greenhouse gases. These are caused by the combustion of fossil fuels such as coal and gas. As most electricity is generated using fossil fuels, a reduction in the unnecessary use of electricity reduces the production of greenhouse gases. Also, most materials used in the workplace are manufactured using electricity or gas, so recycling and reducing the wastage of these materials also helps. There is a worldwide commitment to reducing greenhouse gases, which are considered to contribute to global warming. This User Guide promotes workplace strategies to assist in achieving the same goals.

Sustainable Energy Practice is closely related to the 'environment'. Sustainable energy practice aims to reduce the amount of wastage in electricity and other forms of energy that lead to the production of greenhouse gases. Many of the principles and practices that apply in the workplace also apply in the home and the general environment. These include:

- examining work practices that may use excessive electrical energy
- reducing energy by using energy efficient machines and appliances (eg. star ratings)
- switching off devices such as lights, machines and computers when not in use
- using power-save devices, such as those incorporated in photocopiers, business machines and the like
- replacing incandescent lamps with compact fluorescent lamps

- using natural light to replace artificial light
- regularly cleaning air conditioner filters
- closing windows and doors when climate control units are used
- insulating dwellings, offices and workplaces and preventing draughts
- using reflective curtains to control heat
- using natural or artificial shade to control sunlight
- using solar water heating
- using automatic processes to manage energy usage
- reusing materials used in construction, engineering and manufacturing
- recycling waste materials
- driving motor vehicles and other machines with care
- using natural gas for heating rather than oil or coal based fuels
- using devices to reduce water usage
- checking for leakage in hot water system pressure relief valves and elsewhere in plumbing systems
- sharing information about energy conservation with other workers

System -

A group or combination of inter-related, inter-dependent or interlocking elements forming a collective entity. Includes *circuits, apparatus, equipment* and the like.

Termination -

The act by means of which an electrical connection to an apparatus is established; specifically a prepared joint or connection between a cable, cord or conductor and a point in an electrical circuit such as a terminal or connection point. Such terminations include soldering, crimping, clamping, wire wrapping, insulation piercing/compression.

Testing devices -

Devices and instruments used to ensure safety requirements and operational functions are met, and to diagnose faults in apparatus, circuits or systems.

Utility -

The provision of energy services such as power, water, gas and telecommunications. In the case of UTE NES013 A it applies specifically to remote area essential services operations.

Wiring systems -

Permitted cables, enclosures, supports and *accessories* for power, measurement, control or communications purposes. (See also *Category*)

Work clearances -

Includes any system of permissions and notifications for safely working on or removing equipment/apparatus for service.

Additional glossary terms related to electrical equipment in hazardous area units of competency

Actions -

To limit risk of an explosion can include organisational arrangements for reporting and rectifying non-conformances; shutting down plant or machinery under emergency conditions; evacuating a hazardous area; reporting non-conformances and conditions of plant and machinery; monitoring the hazards area for presence of an explosive atmosphere; meeting OH&S obligations.

Authority -

Refers to documents from which explosive characteristics of products are obtained and include:

- recognised standards publications
- manufacturers product data publications

Certification documentation -

A formal certificate issued by a certifying body stating that an item of equipment/apparatus conforms to particular requirements of a standard. Documentation may include details of limitations of use and manufacturer's specifications and drawings.

Certification of equipment -

A means of verifying that equipment intended for use in a hazardous area complies with the accepted standards.

Classification of hazardous areas -

A concept, which is accepted internationally, of dealing with the risk of fire and explosion by area classification.

Competent person -

A person who has the relevant competencies described in this competency standard.

Electrical equipment -

Equipment used for power, measurement, control or communication purposes.

N. Pre-assembled Type 1 and Type 2 cold cathode Neon signs only.

P. A **single enclosed control device** contained in an enclosure which is not part of a Control Panel or Distribution/Switch Board.

Q. **Control devices,** e.g. solenoids, limit switches, pressure switches, thermostats.

R. **Electrical heaters,** such as water heaters, duct heaters, heaters incorporated as part of a machine or appliance. e.g. moulding machines, cooking appliances and the like.

S. **Motors** – refers to a single or three phase motor incorporated as part of plant or machinery. For example, a chiller unit, automated production and assembly unit, NC Machine; or independent motors driving such things as pumps, conveyors and other similar parts of plant and machinery.

Engineering assessments -

Using measurements, calculations and test results to determine whether an item of equipment complies with the relevant standard.

Equipment marking -

Information with regards to certification that is required to be marked on each item of equipment incorporating an explosion-protection technique.

Explosion properties of hazardous materials -

- for gases, vapours and mists; vapour pressure; boiling point; flash point; ignition energy; explosive limits relative to vapour density; minimum ignition energy
- for dusts; layer ignition temperature; cloud ignition temperature; minimum ignition temperature

Explosion-protection -

Technique of protection which is applied to equipment or parts of equipment to prevent the ignition of flammable vapours and gases or combustible dusts in hazardous areas. See *Explosion-protected equipment*.

Explosion-protected equipment -

Equipment using the technique which is applied to equipment or parts of equipment to prevent the ignition of flammable vapours and gases or combustible dusts in hazardous areas. Such equipment employs one or more of the following techniques:

T. **Mixed explosion-protection techniques - Ex mixed:** e.g. the use of one or more explosion-protection techniques for the following sub-endorsements. See *explosion-protection*.

- T1 – Ex “pD” – Pressurisation, dust
- T2 – Ex “mD” – Encapsulation, dust
- T3 – Ex “iD” – Intrinsic safety, dust

U. Pressurised enclosure - Ex p: e.g. rotating machines; specific products

V. Dust-exclusion ignition-proof - DIP: e.g. rotating machines; equipment within (DIP) enclosures

W. Non-sparking - Ex n: e.g. rotating machines; equipment within Ex n enclosures

X. Intrinsic safety - Ex i: e.g. specific products

Y. Increased safety equipment - Ex e: e.g. rotating machines; enclosures, equipment within Ex e enclosures

Z. Flameproof enclosure - Ex d: e.g. rotating machines; enclosures (eg. junction boxes; light fitting; stop-start statics); equipment within enclosures

Encapsulation - Ex m

Oil immersion - Ex o

Purging - Ex pl

Sand-filled - Ex q

Special protection - Ex s

Ventilation - Ex v

Hermetic sealing - Ex h

Functions and process equipment -

Activities that produce a potentially hazardous area and the equipment used in such activities.

Gas groups -

Classification of electrical equipment for use in gas or vapour atmosphere according to groups and sub-groups of gases and vapours.

Hazardous area documentation -

Auditable documentation that shows that a hazardous area has been appropriately classified and the electrical equipment complies with the appropriate certification and other explosion-protection requirements specific to the site.

Under Australian/New Zealand Standards or Codes these records are referred to as a 'Verification Dossier' and include:

- Hazardous area classification drawings and justifications
- The explosion-protection systems design drawings/specifications
- Certification documents for each item type of explosion-protected equipment
- Inspection, testing and maintenance schedules and reports

- Re-classification and authorised modifications documentation, where applicable
- Competent persons

Hazard and risk assessment -

Any recognised methodology of identifying hazards and assessing risks such as 'hazard and operability study' (Hazop) and 'fault tree analysis' (HAZAN).

Hazardous materials -

Flammable gases and vapours and combustible dusts.

Inspection, close -

An inspection which encompasses those aspects covered by a visual inspection and, in addition, identifies those non-conformances, (eg loose fasteners), which will become apparent when access equipment, (eg steps), and tools are used. Close inspections do not normally require an enclosure to be opened or equipment de-energised.

Inspection, detailed -

An inspection which encompasses those aspects covered by a close inspection and, in addition, identifies those non-conformances which only become apparent when an enclosure is opened up, or by use of tools and test equipment.

Inspection, maintenance schedules -

A program of periodic inspections and maintenance that follow set procedures and check lists for the purpose of ensuring the integrity of the explosion-protection and to comply with *requirements.* Details of a schedule will vary depending on the nature of the explosion-protection techniques used and environmental conditions.

Inspection, periodic -

Inspections of all equipment carried out on a routine basis, usually as part of scheduled maintenance.

Inspection, sample -

Inspection of a portion of installed equipment for the purposes of monitoring the effects of environmental conditions, vibration, inherent design weakness and the like.

Inspection, schedule -

A formal arrangement for conducting inspections which details the extent, grade and frequency of the inspections and the explosion-protected characteristics and compliances to be checked.

Inspection, visual -

An inspection which identifies, without the use of access equipment or tools, those non-conformances which are apparent to the eye.

Installation -

Explosion-protected equipment, wiring and other required items as they are fixed in place and connected as necessary to operate as intended.

Integrity of explosion-protected equipment -

Aspects of the equipment design and use that afford explosion-protection.

Load and duty requirements -

Wiring systems include: sufficient current-carrying capacity; maximum permitted voltage drop is not exceeded; temperature limits are not exceeded under normal or fault conditions.

Non-conformances -

Visual damage or corrosion of equipment and wiring and loose or missing fasteners.

Non-conformances and faults -

Equipment or wiring that does not conform to the design specification or other requirements.

Other items -

Those items that are not in themselves explosion-protected but have an influence on the integrity of the explosion-protection technique used. For example, an overload device for a motor or associated equipment in the case of intrinsic safety technique.

Pre-commission testing -

- tests specified by *requirement,* such as, performance and setting of protection devices and systems, earth loop impedance, insulation resistance, and earth continuity
- equipment connection and operation tests

Process specialist personnel -

To responsible persons with expertise in the technical aspects of the activities that produce the explosive hazard and include chemical engineers, process engineers, mining engineers, safety managers and the like.

Re-certification -

The submission of previously certified equipment to an approved testing body or authority to determine whether the equipment complies with the accepted standards after modification or where original certification is not fully known.

Recommended actions -

- non-connection of supply until a non-conformance or fault is rectified
- notice of period in which a non-conformance or fault is to rectified
- other actions within the scope of statutory regulations

Regulatory or statutory authority -

The person or body responsible for the implementation of legislation relating to the handling, processing or storage of materials constituting a hazard.

Servicing -

Maintaining, fault finding and repair of equipment, plant and machinery.

Special tools, equipment and testing devices -

Tools for the removal of enclosure covers and connecting conductors; measuring devices such as feeler gauges and micrometer; gas and vapour sensors; electrical testing devices approved for use in a particular hazardous area.

Specifications -

Can include: documentation of hazardous material; documentation of process pressures and temperatures; process flow diagrams.

Standards -

Technical documents which set out specifications and other criteria for equipment, materials and methods to ensure they consistently perform as intended. The *Standards* referred to in this competency standard are those published by Standards Australia or in joint venture with Standards New Zealand. Competency in the use of other technical standards may be required in industries not restricted to Australian/New Zealand *requirements*. For example, shipping and off-shore petroleum industries are subject to standards agreed to by underwriters and enterprises or some other international convention.

Temperature class -

Classification of electrical equipment according to its maximum surface temperature.

Verification dossier -

See *hazardous area records.*

Zones –

The zones into which hazardous areas are classified based upon the frequency of the appearance and the duration of an explosive gas atmosphere.

UTE NES101 A
Install pre-assembled neon signs

Descriptor: Install and maintain cold-cathode illumination systems (type 1) which have been fully assembled and tested in a workshop.

Elements		Performance criteria	
101.1	Plan and prepare for installation	101.1.1	Installation/maintenance is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		101.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		101.1.3	Neon sign is obtained and checked in accordance with *established procedures* and to comply with *requirements*
		101.1.4	Location in which neon sign is to be installed is determined from job *requirements*
		101.1.5	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		101.1.6	*Tools*, *equipment* and *testing devices* needed to carry out the installation work are obtained in accordance with *established procedures* and checked for correct operation and safety
		101.1.7	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*
101.2	Install neon sign	101.2.1	*OH&S policies and procedures* for installing neon signs are followed
		101.2.2	Neon sign is installed in accordance with *requirements*, without damage or distortion to the surrounding environment or services
		101.2.3	Neon signs are terminated and connected in accordance with *requirements*
		101.2.4	Unplanned events or conditions are responded to in accordance with *established procedures*

Elements		Performance criteria	
		101.2.5	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		101.2.6	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
101.3	Inspect and notify completion of work	101.3.1	Final inspections are undertaken to ensure the installed neon sign conforms to *requirements*
		101.3.2	Work completion is *notified* in accordance with *established procedures*

Range statement

General

Generic items in this unit are shown in italics, e.g. *established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance,* with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating *consistent performance* for each element of the unit.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace.
- demonstrating an understanding of the underpinning knowledge and skills identified in the section, of this unit titled ‘Underpinning knowledge’.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

Assessment in this unit is related to the knowledge associated with other units within a qualification structure, where appropriate.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials, types, applications; techniques, marking out, cutting, bending, drilling/punching, soldering, cutting mitres

Assembly/disassembly techniques

Electrical theory.

Fundamental and derived units: basic units; SI derived units; multiples and sub-multiples

Power, work and energy: conservation of energy; torque; losses and efficiency; maximum efficiency of machines

Electrical characteristics of materials: conductors, insulators, semi-conductors; electric charge; electric current; electromotive force

The simple circuit: source, load, current path and control; open-circuit; short-circuit

Resistance: Ohm's law; determine V, I, R; power dissipation

Effects of current: physiological effects; principles of protection from physiological effects; conversion of electrical energy to other forms (heating, light, magnetic, chemical)Sources of electrical energy - conversion of other forms to electrical energy

Using measuring instruments: handling measuring instruments; selecting an instrument; setting-up and connecting into circuits; reading scales and read-outs; setting up a CRO

Factors effecting resistance: length, csa and resistivity; temperature change; influence on practical circuits

Resistors: types and applications; value and rating

Series circuits (single source): determine V, I, R, P; Kirchhoff's Voltage Law; voltage dividerParallel circuits: determine V, I, R, P; Kirchhoff's Current Law; current divider

Series/parallel circuits: determine V, I, R, P; bridge networkResistance measurement: hazards; characteristics of instruments and loading effect; direct, volt-ammeter and bridge method; typical field instruments and applications

Capacitance: concept; units; time constant relationship Capacitors: hazards; factors effecting capacitance; in series; in parallel; measuring/testing/hazards

Inductance: concept; units; time constant relationship

Inductors: factors effecting inductance

Wiring techniques.

Electrical/electronic safety testing: isolation; testing; tagging; earthing; appliance electrical safety testing

Standards pertinent to industry sector: purpose; standards bodies; applications

Cables: types, power, signal; terms; colour coding; structure; identification cables; cable applications

Wiring systems: wiring looms; enclosures and supports; selecting wiring systems

Connectors and terminations: requirements; connectors, types and applications, assembly/disassembly; terminating conductors, extension cords

Accessories and fixings appropriate to industry sector: applications; fixing devices and methods

Parts and component selection.

Part/component identification: name; basic function; mounting/fixing arrangements

Information about parts and components: catalogues (structure of reference books, different and common features)

Computer access (starting the computer and moving around the screens)

Telephone inquiry (knowing who to ask for and posing the right question)

Each of the above with respect to the following: part codes (alpha numeric numbers) and what they mean; manufacturers and manufacturers supply outlets; availability and delivery times; price, including discounts, tax and delivery costs; alternative parts

Ordering procedures: customer approval; supplier requirements; in-house requirements

Receiving/dispatch procedures: supplier requirements; in-house (enterprise) requirements; handling and storage

Drawing interpretation and sketching.

Technical drawing standards appropriate to the industry sector, conventions and specifications to AS 1100, with strong emphasis on interpretation: sheet types, title block information, materials parts list, revision table, grid referencing scales, line types – visible outlines, hidden outlines, dimensioning lines, centre lines; orthogonal projection of views – 3rd angle (detail and assembly drawings); mechanical conventions; fabrication conventions; three dimensional view drawings – axonometric, isometric, oblique; sectioning standards and conventions – whole, part; engineering drawing symbols, components and equipment – mechanical, electrical, electronic, computer, instrument, refrigeration; dimensioning – orthogonal, isometric; layout and plans; geometric tolerance interpretation (straightness, flatness, squareness, parallelism and concentricity only); engineering abbreviations; drawing interpretation techniques – detail drawings, orthogonal projection (3^{rd} angle only) and three dimensional, assembly drawings and three dimensions exploded (e.g. as in equipment manuals)

Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3^{rd} angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

UTE NES102 (A to Z qualifier) A Assemble & erect antennae & associated hardware

Descriptor: Assemble and erect antennae and associated hardware for communications and telecommunications.

Alignment: This unit aligns to and is based on the National Electrotechnology Benchmark Standard EBS 102 - Assemble and erect antennae and associated hardware.

Specific unit outcomes

This is presented as a composite unit that has one specific unit as an outcome, based on the *category* in which competence is achieved. This is done because of the high degree of commonality in process or function. Reporting the unit with the inclusion of a *category* allows for the identification of the necessary training outcomes in terms of the generic and transferable skills and at the same time reflects the work classification(s) generally understood by industry. The specific unit outcome is:

UTE NES102C A Assemble & erect antennae & associated hardware *(Electronics)*

Elements		Performance criteria	
102.1	Plan and prepare for assembly and erection of antennae and associated hardware	102.1.1	Assembly and erection of antennae and associated hardware is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		102.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		102.1.3	Assembly and erection of antennae and associated hardware is checked against job *requirements*
		102.1.4	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		102.1.5	*Tools, equipment* and *testing devices* needed to carry out the installation work are obtained in accordance with *established procedures* and checked for correct operation and safety
		102.1.6	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*

Elements		Performance criteria	
102.2	Assemble and erect antennae and associated hardware	102.2.1	*OH&S policies and procedures* for assembling and erecting antennae and associated hardware are followed
		102.2.2	Antennae and associated hardware are assembled and erected in accordance with *requirements*, without damage or distortion to the surrounding environment or services
		102.2.3	Components assembled are terminated and connected in accordance with *requirements*
		102.2.4	Unplanned events or conditions are responded to in accordance with *established procedures*
		102.2.5	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		102.2.6	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
102.3	Inspect and notify completion of work	102.3.1	Final inspections are undertaken to ensure the assembled and erected antennae and associated hardware conforms to *requirements*
		102.3.2	Work completion is *notified* in accordance with *established procedures*

Range statement

General

Generic items in this unit are shown in italics, e.g. *established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Categories

This unit recognises the commonality of skills and knowledge that exists for the unit as well as the additional specific outcome; which is to be reported on. Therefore, competency can be displayed in the following category and in addition to the respective common underpinning knowledge associated with the selected specialisation:

(C) Electronics

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating consistent performance for each element of the unit in the related *category* and *specialisation* which is to be exhibited across a *representative range* of applications; autonomously and to requirements.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace for each of the categories and areas of specialisation undertaken from those listed in the Range statement or Evidence guide.
- demonstrating an understanding of the underpinning knowledge and skills identified for the categories and related specialisation undertaken in the section, of this unit titled 'Underpinning knowledge'.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of applications which includes such things as apparatus, circuits, wiring systems, *plant, equipment,* tools, *accessories, components* and the like relative to that required for the *category* undertaken within and relevant to this unit of competency; autonomously and to requirements. Equivalent evidence from other sources is also acceptable.

Interdependent assessment of units

Nil.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Since this unit covers a range of *categories* each having multiple *specialisations* a content listing is provided below. Each *category* has all of the required underpinning knowledge and skill listed even though this sometimes results in duplication between *categories*.

Category: Electronics (C)

Common

Communications fundamentals.

Basic communication systems: time and frequency – domain waveforms; modulation; baseband signal vs bandwidth; electromagnetic wave characteristics/spectrum; wavelength; commercial radio frequency spectrum users

Antennas and electromagnetic wave propagation characteristics: horizontal half wave antenna; vertical half and quarter wave antennae; polarisation; radiation patterns; EM wave propagation at MF, HF, VHF/UHF; polarisation

Modulation systems and requirements: double sideband full carrier amplitude modulation; single sideband suppressed carrier modulation; vestigial sideband modulation; frequency modulation; phase modulation

Amplitude modulation and demodulation: carrier power; sideband power; total power; bandwidth; modulation index; overmodulation; diode detector

Frequency modulation and demodulation: frequency deviation; modulation index; bandwidth; pre-emphasis and de-emphasis; phase modulation; frequency domain diagrams; frequency modulation detectors; limiter amplifier

Single conversion superheterodyne receivers: the TRF receiver; selectivity; sensitivity; AM superheterodyne receiver; frequencies within the AM receivers; superheterodyne advantages; image frequencies; FM superheterodyne receiver; frequencies within common IF frequencies; mixer input and output signals; measurement of sensitivity, selectivity and image rejection; relationships between fr, fo and fif

Receiver specialist circuits: simple AGC; delayed AGC; RF and audio derived AGC; limiter amplifiers; noise blankers; AFC; mute; squelch; RD and IF amplifiers; filters and bandwidth

Specialisation: Communications - broadcast

Antennae installation and servicing.

Electro-magnetic waves, wavelength, reflection, refraction, diffraction, polarisation

Antennae: radiation and reception; electro-magnetic wave transmission including the induction and radiated fields

Use of manufacturers' data to select suitable antennae

Use of field strength meters

Optimum antennae placement

Minimising interference

Installation methods

Application of masthead amplifiers: distribution amplifier; splitters; termination

Transmission lines and antennae.

Time domain reflectometry measurements: function of a transmission line; balanced and unbalanced lines; lumped constant model of a transmission line; velocity factor; surge impedance; characteristics impedance Z of a transmission line

Radio frequency characteristic of transmission lines: voltage and current distribution along a transmission line; SWR and VSWR; SWR bridge; slotted line

Losses in transmission lines: radiation loss; resistance loss; dielectric loss; relationship of losses to operating frequency

Radiation characteristics of antennae: E and H field directions in relation to the driven element the E as the reference field (polarisation); Hertz and Marconi antenna polar patterns; isotropic radiator as a reference; radiation efficiency; antenna gain

Directional antennae: Yagi-Uda parasitic array; broadside array; phrasing elements; log-periodic antenna; collinear antennae; non-resonant antennae

Antenna matching: resistance-reactance model of a shortened antenna; resistance-reactance model of whips and centre fed; matching antennae; loading components; baluns; quarter wave transformers; stub matching

UHF and microwave antennae – satellite and terrestrial: circular polarisation; helix antennae; parabolic dishes – horn feed and Cassegrain feed; gain of parabolic dish antennae

Specialisation: Communications - microwave

Introduction to microwave communications.

Microwave components: effects of stray and inherent inductance and capacitance; passive devices (chip components); PCB; printed components

Active devices: diodes (PIN, gunn, impatt, tunnel, step-recovery); transistors (bipolar, GaAs Fet, HEMT, MMIC); valves (triodes and tetrodes, magnetrons, TWT, klystrons); other devices (DRO, YIG, circulator, isolator, cavity resonator); safety practices

Transmission lines: coaxial cable (rigid, semi-rigid hardline, flexible); connectors (N type, TNC, SMA, B, C); waveguide (modes, coupling, bends and tees, attenuators and termination, directional couplers); microstrip and stripline; antennae

Propagation: free space and atmospheric losses; refraction; reflections; knife-edge diffraction; near-field absorption; satellite communications; linear, circular and cross polarisation

Transmission lines and antennae.

Time domain reflectometry measurements: function of a transmission line; balanced and unbalanced lines; lumped constant model of a transmission line; velocity factor; surge impedance; characteristics impedance Z of a transmission line

Radio frequency characteristic of transmission lines: voltage and current distribution along a transmission line; SWR and VSWR; SWR bridge; slotted line

Losses in transmission lines: radiation loss; resistance loss; dielectric loss; relationship of losses to operating frequency

Radiation characteristics of antennae: E and H field directions in relation to the driven element the E as the reference field (polarisation); Hertz and Marconi antenna polar patterns; isotropic radiator as a reference; radiation efficiency; antenna gain

Directional antennae: Yagi-Uda parasitic array; broadside array; phrasing elements; log-periodic antenna; collinear antennae; non-resonant antennae

Antenna matching: resistance-reactance model of a shortened antenna; resistance-reactance model of whips and centre fed; matching antennae; loading components; baluns; quarter wave transformers; stub matching

UHF and microwave antennae – satellite and terrestrial: circular polarisation; helix antennae; parabolic dishes – horn feed and Cassegrain feed; gain of parabolic dish antennae

Specialisation: Communications - satellite

Introduction to microwave communications.

Microwave components: effects of stray and inherent inductance and capacitance; passive devices (chip components); PCB; printed components

Active devices: diodes (PIN, gunn, impatt, tunnel, step-recovery); transistors (bipolar, GaAs Fet, HEMT, MMIC); valves (triodes and tetrodes, magnetrons, TWT, klystrons); other devices (DRO, YIG, circulator, isolator, cavity resonator); safety practices

Transmission lines: coaxial cable (rigid, semi-rigid hardline, flexible); connectors (N type, TNC, SMA, B, C); waveguide (modes, coupling, bends and tees, attenuators and termination, directional couplers); microstrip and stripline; antennae

Propagation: free space and atmospheric losses; refraction; reflections; knife-edge diffraction; near-field absorption; satellite communications; linear, circular and cross polarisation

Transmission lines and antennae.

Time domain reflectometry measurements: function of a transmission line; balanced and unbalanced lines; lumped constant model of a transmission line; velocity factor; surge impedance; characteristics impedance Z of a transmission line

Radio frequency characteristic of transmission lines: voltage and current distribution along a transmission line; SWR and VSWR; SWR bridge; slotted line

Losses in transmission lines: radiation loss; resistance loss; dielectric loss; relationship of losses to operating frequency

Radiation characteristics of antennae: E and H field directions in relation to the driven element the E as the reference field (polarisation); Hertz and Marconi antenna polar patterns; isotropic radiator as a reference; radiation efficiency; antenna gain

Directional antennae: Yagi-Uda parasitic array; broadside array; phrasing elements; log-periodic antenna; collinear antennae; non-resonant antennae

Antenna matching: resistance-reactance model of a shortened antenna; resistance-reactance model of whips and centre fed; matching antennae; loading components; baluns; quarter wave transformers; stub matching

UHF and microwave antennae – satellite and terrestrial: circular polarisation; helix antennae; parabolic dishes – horn feed and Cassegrain feed; gain of parabolic dish antennae

Specialisation: Entertainment - video

Television antenna systems.

TV signal reception: inadequate/optimum/excessive signal level; multipath transmission; interference

TV antennae: types; operating characteristics; TV antenna terminology; multiple antennae

Transmission lines: types; characteristic impedance; attenuation; bandwidth; standing waves

Antenna distribution systems: identical and adjacent channel interference; masthead/distribution amplifiers; diplexors; triplexors; splitters and couplers; "T" networks and existing loop wired networks; practical small distribution system design; field strength meters; attenuators; VCR output injection

Satellite receivers: block diagram; operating characteristics

Antenna fault-finding

Specialisation: Scanning - radar

Radar principles and applications.

Purpose and uses: mnemonic; environment conditions; design factors that affect performance

Safety aspects: warning labels; conditions that result from electric shock; high voltages; RF radiation; radioactive valves; toxic substances; waveguides; CRT

Electromagnetic wave propagation: transverse waves; transmission lines; impedance matching; standing waves; energy losses

Waveguides: limiting factors; coupling; waveguide parts and types; resonant cavity characteristics; cavity tuning; waveguide shutters; impedance matching; magic T waveguide section; joint waveguide

Pulse forming circuits: four basic types; multivibrators

Typical radar transmitter: types; high-power oscillator; master timing unit; pulse forming network; modulators; switching – thyratrons; master oscillator power amplifier type

Typical radar transmitter: typical block diagram; receiver parameters; heterodyning; mixers; local oscillators; AFC; IF amplifier; diode detector; frequency response; paralysis; fast time circuit; instantaneous AGC; STC; logarithmic receiver

Types of display: inputs required; CRT; deflection; focusing; A-scan display; brilliance control; planned position indicator display (PPI); deflection; rotation synchronisation; raster scan deflection; composite video; raster scan

Types of antenna: RF radiation process; half-wave dipole; parabolic reflectors; cosecant squared reflector; energy feeding devices; cassegrain antenna; dielectric lens; metal plate lens; slotted waveguide radiators; squint angle; measure radiation pattern

Calculations: maximum and minimum theoretical range; true bearing; relative bearing; bearing conversions; slant range; ground range; height

Microwave devices: oscillators; amplifiers; additional RF devices

Continuous wave radars: use

Doppler effect: description

Moving target indicator: function; operation using pulse-to-pulse; PRF agility; frequency agility

Tracking radar: monopulse radar; manually lock onto a target; automatic search and track targets

Secondary radar system (IFF): principles – uses; pulse train

Fault-finding

UTE NES103 (A to Z qualifier) A Install/maintain piping & tubing

Descriptor: Install and terminate non-electrical piping and tubing associated with instrumentation or lifts or refrigeration and air conditioning systems.

Specific unit outcomes

This is presented as a composite unit that has two specific units as outcomes, based on the *category* in which competence is achieved. This is done because of the high degree of commonality in process or function. Reporting the unit with the inclusion of a *category* allows for the identification of the necessary training outcomes in terms of the generic and transferable skills and at the same time reflects the work classification(s) generally understood by industry. The specific unit outcomes are:

UTE NES103B A	Install/maintain piping & tubing *(Electrical)*
UTE NES103E A	Install/maintain piping & tubing *(Refrigeration & a/conditioning)*

Elements		Performance criteria	
103.1	Plan and prepare for installation	103.1.1	Installation is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		103.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		103.1.3	Piping, and tubing is checked against job *requirements*
		103.1.4	Piping and tubing is obtained in accordance with *established procedures* and to comply with *requirements*
		103.1.5	Location in which piping and tubing is to be installed is determined from job *requirements*
		103.1.6	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		103.1.7	*Tools, equipment* and *testing devices* needed to carry out the installation work are obtained in accordance with *established procedures* and checked for correct operation and safety

Elements		Performance criteria	
		103.1.8	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*
103.2	Install piping and tubing	103.2.1	*OH&S policies and procedures* for installing piping and tubing are followed
		103.2.2	Piping and tubing are installed in accordance with *requirements*, without damage or distortion to the surrounding environment or services
		103.2.3	Piping and tubing are terminated and connected in accordance with *requirements*
		103.2.4	Unplanned events or conditions are responded to in accordance with *established procedures*
		103.2.5	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		103.2.6	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
103.3	Inspect and notify completion of work	103.3.1	Final inspections are undertaken to ensure the installed piping and tubing conforms to *requirements*
		103.3.2	Work completion is *notified* in accordance with *established procedures*

Range statement

General

Generic items in this unit are shown in italics, e.g. *established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Categories

This unit recognises the commonality of skills and knowledge that exists for the unit as well as the additional specific outcome; which is to be reported on. Therefore, competency can be displayed on one, some or all of the following categories and in addition to the respective common underpinning knowledge associated with the selected specialisation:

(B) Electrical

(E) Refrigeration and air conditioning

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating consistent performance for each element of the unit in the related *category* and *specialisation* which is to be exhibited across a *representative range* of applications; autonomously and to requirements.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace for each of the categories and areas of specialisation undertaken from those listed in the Range statement or Evidence guide.
- demonstrating an understanding of the underpinning knowledge and skills identified for the categories and related specialisation undertaken in the section, of this unit titled 'Underpinning knowledge'.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of applications which includes such things as apparatus, circuits, wiring systems, *plant, equipment,* tools, *accessories, components* and the like relative to that required for the *category* undertaken within and relevant to this unit of competency; autonomously and to requirements. Equivalent evidence from other sources is also acceptable.

Interdependent assessment of units

Nil.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Since this unit covers a range of *categories* each having multiple *specialisations* a content listing is provided below. Each *category* has all of the required underpinning knowledge and skill listed even though this sometimes results in duplication between *categories*.

Category: Electrical (B)

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials, types, applications; techniques, marking out, cutting, bending, drilling/punching, soldering, cutting mitres

Assembly/disassembly techniques

Specialisation: Control

Fluid power.

Fluid power introduction: definitions – fluid, Fluid power, hydraulics, pneumatics; industry applications – manufacturing, mining/construction, agriculture, transport/material handling, defence

Fluid power components: fluids – function – hydraulic, pneumatic; type – mineral oil (hydraulic), air (pneumatic); handling – storage, transfer; flow generators – hydraulic pump – purpose, types (fixed displacement), external gear, axial in-line piston, unbalanced vane, operation; air compressor – purpose, types (positive displacement), reciprocating piston, valve designs, operation, maintenance; prime movers – electric motor, heat engines, drive methods, direct coupling, vee belt drive; ancillary equipment; hydraulic reservoir – purpose, features/fittings, location; accumulator – construction, purpose, safety precautions; air receiver – purpose, features/fittings, location; heat

exchangers/aftercoolers – purpose, types, location; pressure gauges – operation; flow meter – operation; fluid conductors – purpose, types (pipe, tube, hose), sizing, flow conditions, recommended flow velocities, fittings/threads; actuators – purpose, construction, linear (single rod), piston type, ram type, limited rotation, piston vane, rotary – external gear, axial inline piston, unbalanced vane; seals – purpose, types (compression, pressure energised, composite), applications, materials, installation; valves – directional control, purpose, operating principles, types – shut-off, check, shuttle, sliding spool, poppet, centre conditions – open, closed, actuation methods – manual, mechanical, pressure, electrical, applications; flow control – purpose, types (variable restrictor and variable restrictor with by-pass), application circuits – meter-in, meter-out, bleed-off (hydraulics), exhaust throttling (pneumatics); pressure control – purpose, types – pressure relief, safety value, pressure sequencing, pressure reducting, pressure regulating, applications; filters – purpose, contamination forms/sources, element types, operation, accessories; lubricators – types (oil fog and micro-mist), operation; air service unit – purpose, combination units; portable power – types (linear, rotary, percussive and rotary/percussive), speed control methods, operation, tooling/accessories, lubrication methods, silencers, safety-operator; graphical symbols – definitions, rules, composition; circuitry – pneumatic circuits, hydraulic circuits

Servicing: safety – general workshop, personal, hydraulic systems, pneumatic systems, installation, maintenance

Fluid power principles: Pascal's – force transfer, force multiplication, pressure intensification; Bernoulli – conservation of energy; Charles' – temperature/volume; Boyle's – pressure/volume; combined gas law; performance parameters – power/flow/pressure, flow/displacement/speed, flow/area/velocity; pressure conditions – gauges, atmospheric, absolute

Category: Refrigeration and air conditioning (E)

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials, types, applications; techniques, marking out, cutting, bending, drilling/punching, soldering, cutting mitres

Assembly/disassembly techniques

Refrigeration.

Heat, pressure and temperature: heat low; heat transfer (condition, convection, radiation); gas law; heat measurement; operation of the vapour compression cycle

Components: compressor; evaporator; condenser

Flow control

Pressure temperature relationships: saturation; subcooling; superheating; pressure temperature chart

Absolute and gauge pressure: plotting, basic cycles; saturation curves; subcooling; superheating; measuring heat content

Applications: domestic; commercial; industrial; transport/marine; comfort air conditioning; industrial air conditioning

Refrigeration procedures.

Tubing: types; tubing; annealing

Use of dry nitrogen

Bending methods spring bending tools (lever type) measurement and marking out gain correction

Flaring: types of block; types of flare nut

Pipework: expanding; tube expanders; swaging; recognition of fittings and threads; thread sealants

Silver brazing: joint preparation; fluxes

Job preparation refrigerant isolation/pump down; protection of cabinets from flame brazing in tight corners; use of mirrors pressure testing

Gauges: types; care and maintenance

Valves: service; shredder; piercing

Gauges: fitting; purging; reading; using P.T. chart

Gaskets: types of material; thickness; measuring and marking out

Refrigerants.

Refrigerants: cylinder identification; properties; applications; codes and regulations; safety and ozone depleting substances

Refrigerant handling

Refrigerant recover systems

Evacuation methods

Leak detecting: pressure testing – safe pressure

Leak testing: fluorocarbon systems; ammonia systems

Contamination: moisture in systems; refrigerant breakdown; system clean up; cold traps

Oils: properties of refrigeration oil; types; selection

Refrigeration system components.

Compressor: types (reciprocating, rotary, centrifugal, scroll)

Condenser: types (air cooled, water cooled, evaporative); pumps; cooling tower/water regulator valve; water treatment; liquid receiver (horizontal, vertical)

Evaporator: types; secondary refrigerants

Flow control: types (hand expansion, low side float, high side float, automatic expansion, thermostat expansion, thermo-electric, capillary tube); refrigerant distributors (venturi, weir, pressure drop, centrifugal)

Refrigerant controls.

Types, operation and application of liquid flow controls: liquid line solenoids; capillary tubes; high side floats; low side floats; manual expansion valves; automatic expansion valves; thermostatic expansion valves, including internal equalised, externally equalised, M.O.P., crossed charged, gas charged, direct operated, pilot operated, thermal-electric, evaporator control systems and distributors

Types, operation and application of vapour flow controls: EPR valves; CPR valves; reversing valves; solenoid valves; condenser bypass

Liquid control testing procedures

Vapour control testing procedures

Selection criteria: plant capacity; pressure drop caused through installation of components evaporator operating temperature; refrigerant condensing temperature

Capillary systems.

Capillary tube system: types of tubes; application; characteristics; function; system unloading; calculating system; operating pressures; critical length; critical charge

Repair/replacement of a capillary tube: use of vacuum pumps/correct refrigerant charging procedure

Use of manufacturers catalogues: the use of refrigeration catalogues/service manuals to select replacement capillary tubes

Commissioning procedures

Codes of practice

Specialisation: Commercial air conditioning

Maintain and service air handling plant.

Filter cleaning methods: cleaning water nozzles, drain trays; humidifies; electrical and water requirements; condensate and drainage points; cooling coils; electrostatic air filters

Identify sludge, scale water contaminates: replacement of cleaning of air filters, water nozzles, ball float; air quantity; location; dust – VAV systems

Accumulated moisture: drainage; terminal units; spray coils

Responsibilities under the ACT: regulators and standards; AS3666, AS1851, AS, AS1470, AS1657, AS1715 and AS2865, ordinance 70, AS1668 part 1; disinfectants; fever – humidifies, portia; fire dampers; patent AS3665 rust prevention

Installation and commissioning of air handling plant.

Introduction: benefits; reasons for training

Safety: water supply and drainage requirements; electrical requirements; special site requirements; location and securing of equipment

Reading manufacturer's drawings and specifications: methods of assembly; fixing; running test

AS3666, AS1851, AS, AS1470, AS1657, AS1715 and AS2865, ordinance 70,: local authority requirements; relevant legislation; legal obligations; development/building approvals

Specialisation: Commercial refrigeration

Merchandising and display cabinets.

Types and construction: deep freeze meat, dairy, fruit and vegetables; multi deck display type; single deck, well type and island cases; glass door/reach-in merchandiser

Components and features: condensing units; refrigerant controls; evaporators and fans; defrosting method and mullions; drain facilities and drain heaters; air distribution and air flow curtains; cabinet air temperature, velocity and direction lighting

Layouts and installation

System and defrost controls: operating conditions; alarm systems; thermostats and pressure controls; defrost timers and controllers; electrical control circuits

Multiple Systems: multiple compressors; multiple evaporators; heat reclaim systems; multi-temperature accessories; controls and sequencing

Commissioning service and maintenance

Post mix and dairy products and refrigeration systems.

Dispensing application: name various types of post mix dispensers, soft ice cream dispenser and milk vats, plate cooling; list typical applications; commercial considerations

Operating cycle: type; water quality, sludge, scale, contaminates; operating temperatures; water nozzles, ball float; storage temperatures; location; refrigeration systems

Responsibilities under the Act: regulators and standards; cleaning; electrical and water requirements; condensate and drainage points

Installation requirements: electrical; water supply; drainage; refrigeration service, fault-finding, maintenance requirements

Commercial ice making systems.

Applications: name various types e.g. cube, flake, cylinder; continuous, intermittent

Operation: operating cycle, harvest cycle; type of ice, clear, opaque; water quality, sludge, scale, water contaminates; operating temperatures; water nozzles, ball float; ice storage; location; refrigerating systems

Responsibilities under the Act: regulators and standards; cleaning; electrical and water requirements; condensate a drainage point

Installation requirements: connecting services, electrical, water supply, drainage; operating conditions; controls; circuit diagrams, electrical, water, drainage, refrigeration; service; fault-finding; maintenance requirements

Specialisation: Domestic appliances

Service clothes washers and clothes dryers.

Codes and regulations: plumbing – water supply drainage, back siphoning; electrical insulating, earthing; manufacturers data

Types and applications: types of washing machines – automatic washers, top load and front load, wringer washers, twin tub washers; application and significant differences: types of clothes dryers – tumble, application

OH&S: OH&S act; manufacturers data; test instruments; tools; service report, customer advice; electrical testing, motors, controllers; timers, operational and safety thermostats; mechanical testing, safety locks, soiled clothes, out of balance, not draining, or filling noisy

Repair/replace faulty components: access to appliance; confirm fault diagnosis; disconnect services, water, electricity; select components from manufacturers data service vehicle, supplier; removal and replacement of electrical controls, motors, capacitors, thermostats, switches, heaters, lead, plug, timer, wiring; removal and replacement of various mechanical items, belts, bearing, door locks, filters, hoses, pumps, float switch, clutch, brakes, dispenser levelling feet, balance control, gaskets, lint screens – adhesives and water sealant, cleaning of cabinets and components, removing rust and minor repairs to cabinets, touching up paint work

Test: set operational and safety controls; check electrical components; operate system and adjust cycle controls etc; carry out leak tests

Service report: information and advice to equipment owners; equipment labels; service report; documentation

Service Refrigerators, freezers and room air conditioners.

Codes and regulations: rating; location; ventilation; dangers and safety precautions; predict electrical hazards; safe working practices; earthing and insulation; testing and making safe

Types, operational features, application and installation requirements: refrigerators, freezers – single door, two door, all refrigerator, combination cabinet, cool water and ice dispensing, chest freezer; air conditioners – window mounted, wall mounted, roof mounted (drop in), split unit, portable

Fault-finding: test instruments and equipment; safety electrical, ventilation; electrical circuit – interpretation of wiring diagrams, sequence of operation, relevant electrical symbols, fuses, making safe, earthing, flash back, fans and fan motors, controllers, time clocks

Service: access to the appliance; confirm fault diagnosis; obtain required components; disconnect services to the appliance; remove faulty component; repair or replace component; reassemble; reconnect services

Safety: set operational and safety controls; check electrical components; operate appliance and adjust cycle controls; carry out leak test; check water supply and drainage leaks

Service reports: information and advice to equipment owners; equipment labels; service reports; documentation

Specialisation: Hotel/club refrigeration

Beverage dispensers.

Types of construction: hotel/club dispensing; balanced beer dispensing

Components and features: operating principles; condensing units; evaporating control; refrigerant control; safety features; hygiene awareness

Layout and installation: location of equipment; installation considerations

System and control methods: operation – conditions; thermostat, pressure controls and evaporator pressure regulating valve, solenoid valves; electrical and piping circuits

Commission: determine design operating conditions; check and adjust controls

Servicing: normal and abnormal operation; fault-finding charts – maintenance charts; repair and replacement of parts; maintenance

Post mix and dairy products and refrigeration systems.

Dispensing application: name various types of post mix dispensers, soft ice cream dispenser and milk vats, plate cooling; list typical applications; commercial considerations

Operating cycle: type; water quality, sludge, scale, contaminates; operating temperatures; water nozzles, ball float; storage temperatures; location; refrigeration systems

Responsibilities under the Act: regulators and standards; cleaning; electrical and water requirements; condensate and drainage points

Installation requirements: electrical; water supply; drainage; refrigeration service, fault-finding, maintenance requirements

Commercial ice making systems.

Applications: name various types e.g. cube, flake, cylinder; continuous, intermittent

Operation: operating cycle, harvest cycle; type of ice, clear, opaque; water quality, sludge, scale, water contaminates; operating temperatures; water nozzles, ball float; ice storage; location; refrigerating systems

Responsibilities under the Act: regulators and standards; cleaning; electrical and water requirements; condensate a drainage point

Installation requirements: connecting services, electrical, water supply, drainage; operating conditions; controls; circuit diagrams, electrical, water, drainage, refrigeration; service; fault-finding; maintenance requirements

Specialisation: Industrial refrigeration

Industrial refrigeration.

Applications: blast freezers; food production; wine/beer production; abattoirs; bulk food storage and markets

Refrigerants: types and applications; codes and regulations; safety and handling

Components: compressors; evaporators; metering devices; auxiliary equipment

Industrial systems: liquid recirculation; dry expansion and flooded; eutectic solutions; continuous ice making; freezing; air blast; liquid immersion; surface contact; chillers

Servicing: testing; commissioning; maintenance; fault-finding and repairs

Commercial ice making systems.

Applications: name various types e.g. cube, flake, cylinder; continuous, intermittent

Operation: operating cycle, harvest cycle; type of ice, clear, opaque; water quality, sludge, scale, water contaminates; operating temperatures; water nozzles, ball float; ice storage; location; refrigerating systems

Responsibilities under the Act: regulators and standards; cleaning; electrical and water requirements; condensate a drainage point

Installation requirements: connecting services, electrical, water supply, drainage; operating conditions; controls; circuit diagrams, electrical, water, drainage, refrigeration; service; fault-finding; maintenance requirements

Compound systems.

Applications

Refrigerants

Special low temperature components: compressor problems; suction pressures; compressor ratios; discharge temperatures; capacity; P.H. diagrams

Low temperature systems (application): two stage; cascade; indirect

Typical low temperature systems (construction): operation; accumulators; solenoid valves; oil separators; intercoolers; RMDs; press regulators; brines; pumps

Advantages of low temperature systems: comparison; characteristics; calculations

Specialisation: Transport refrigeration and air conditioning

Transport/marine refrigeration.

Construction of refrigeration containers: insulation; vapour barriers; systems including containers with their own units, pre-chilled, liquid nitrogen systems, marine holds, marine cold rooms, rail car refrigerated storage, aircraft refrigerated containers, refrigerated pantechnicons and transport storage depots; preparation and storage requirements for transporting refrigerated food products; legislation, security and insurance aspects; electrical power sources; maintenance procedures and fault-finding techniques

Automotive air conditioning.

Heat, pressure and temperature; heat flow; heat transfer; pressure temperature relationships vapour compression; cycle conditioning of refrigerants throughout cycle

Compressors (auto); evaporators (auto); condensers (auto); refrigerant controls (auto); receiver dryer (auto); fitting service gauges; service valves; reclaim units; CFC regulation; vacuum pumps – evacuation; refrigerant contaminants; graduated charging cylinders; liquid charging; vapour charging; thermostats; relays; electro magnetic clutches; basic control circuits; P.O.A. valves; H.P. and L.P. switches; thermistors; pressure testing; leak detecting (halide, electronic, soap bubbles); condenser and evaporators temperature differences; restrictions; compressor valve efficiency; filter driers and strainers; TX valve faults; air filters (heavy equipment)

Specialisation: Vending equipment refrigeration

Merchandising and display cabinets.

Types and construction: deep freeze meat, dairy, fruit and vegetables; multi deck display type; single deck, well type and island cases; glass door/reach-in merchandiser

Components and features: condensing units; refrigerant controls; evaporators and fans; defrosting method and mullions; drain facilities and drain heaters; air distribution and air flow curtains; cabinet air temperature, velocity and direction lighting

Layouts and installation

System and defrost controls: operating conditions; alarm systems; thermostats and pressure controls; defrost timers and controllers; electrical control circuits

Multiple Systems: multiple compressors; multiple evaporators; heat reclaim systems; multi-temperature accessories; controls and sequencing

Commissioning service and maintenance

Post mix and dairy products and refrigeration systems.

Dispensing application: name various types of post mix dispensers, soft ice cream dispenser and milk vats, plate cooling; list typical applications; commercial considerations

Operating cycle: type; water quality, sludge, scale, contaminates; operating temperatures; water nozzles, ball float; storage temperatures; location; refrigeration systems

Responsibilities under the Act: regulators and standards; cleaning; electrical and water requirements; condensate and drainage points

Installation requirements: electrical; water supply; drainage; refrigeration service, fault-finding, maintenance requirements

Drink vending cabinets.

Types and construction: glass door; coin operated

Components and features: condensing units; refrigerant controls; evaporators and fans; defrosting method and mullions; electronic controls; drain facilities and drain heaters; air distribution and air-flow curtains; cabinet air temperature, velocity and direction; accessories; lighting

Installation requirements: location; access and obstructions; power supply and electrical services

System and defrost controls: operating conditions; thermostats and pressure controls; defrost timers and controllers; electrical control circuits

Commission, service and maintain: check and adjust control devices; determine correct air flows; leak testing; normal and abnormal operation; basic servicing techniques

UTE NES104 A
Install & maintain energy management equipment

Descriptor: Install and maintain light and power energy management and load control circuits and equipment and software used in building automation.

Elements		Performance criteria	
104.1	Plan and prepare for installation and maintenance of energy management equipment	104.1.1	Installation and maintenance is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements.*
		104.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site.
		104.1.3	Installation and maintenance work is checked against job *requirements*.
		104.1.4	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements.*
		104.1.5	*Tools*, *equipment* and *testing devices* needed to carry out the work are obtained in accordance with *established procedures* and checked for correct operation and safety.
		104.1.6	Preparatory work is checked to ensure no unnecessary damage has occurred, minimal disruption has occurred and the work complies with *requirements.*
104.2	Install and maintain energy management equipment, software and associated circuits.	104.2.1	*OH&S policies and procedures* are followed.
		104.2.2	*Circuits* are checked as being isolated where necessary using specified testing procedures.
		104.2.3	Installation and maintenance of *apparatus* and associated *circuits* is carried out in accordance with *requirements.*
		104.2.4	Installation and maintenance of *apparatus* and associated *circuits* is carried out without damage and minimal disruption to the building or services.
		104.2.5	Unplanned events or conditions are responded to in accordance with *established procedures.*

Elements	Performance criteria
	104.2.6 Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented.
	104.2.7 On-going checks of the quality of the work are undertaken in accordance with *established procedures*
104.3 Inspect and notify completion of work	104.3.1 Final inspections are undertaken to ensure the installation and maintenance conforms to *requirements.*
	104.3.2 Work completion report(s) are completed and *notified* in accordance with *established procedures.*

Range statement

General

Generic items in this unit are shown in italics, e.g. *established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating *consistent performance* for each element of the unit.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace.
- demonstrating an understanding of the underpinning knowledge and skills identified in the section, of this unit titled ‘Underpinning knowledge’.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

Assessment in this unit is related to the knowledge associated with other units within a qualification structure, where appropriate.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Common

Overview of energy management systems.

Cost of energy

Major energy consumers.

Lifts, plant, lighting, power, building energy deficiencies

Lift management.

Lift optimisation

Standards related to power for lifts

Plant management – mechanical services.

Application of timers

Small point controllers

Sensing circuits

Computer controlled building automation systems – function, major components, block diagram, principles of operation, zero energy band, load reset scheduling, optimum start/stop, night purge, duty cycling

Codes – AS1668.1 and AS1668.2

Test equipment – anemometer, sling psychrometer, thermal hydrograph, manometer, refrigeration gauges, smoke gun, thermometer, alcohol, mercury, electrical/electronic, personal computer software

Lighting management.

Control strategies, circuit control, simple wiring schemes, mains signalling systems, reset systems, large scale microprocessor based control systems, daylight linking, daylight sensors, fluorescent light dimmers.

Switches – layout, time clocks, time delay, programmable

Occupancy detectors

Access, security and emergency lighting.

High efficiency lighting – fluorescent, metal halide, high pressure sodium, reflectors, ballasts

Codes

Test equipment – lux meter, personal computer software

Energy consumption.

Simple wiring schemes

Time delay switches

Programmable switches

Occupancy sensors

Main signalling lighting control/systems

Reset lighting systems

Microprocessors

Time clocks

Load management.

Load reduction methods – soft starters, variable frequency drives

Load shedding – reasons, tariffs, schemes, priority and constraints, AS1735

Power factor correction – supply authority requirements, causes of bad power factor, methods of correction

Harmonics – causes, methods of correction

Uninterruptable power supplies – purpose, applications

Test equipment – multimeter, clamp tester, continuity and insulation resistance tester, power factor meter, power analyser, personal computer software

Building structure.

Effects of thermal efficiency on air conditioning plant

Energy audit process

UTE NES105 (A to Z qualifier) A Install & terminate wiring systems

Descriptor: Install wiring enclosures, cable support systems, cables and *accessories.*

Alignment: This unit aligns to and is based on the National Electrotechnology Benchmark Standard EBS 204 – Install and terminate wiring systems.

Specific unit outcomes

This is presented as a composite unit that has four specific units as outcomes, based on the *category* in which competence is achieved. This is done because of the high degree of commonality in process or function. Reporting the unit with the inclusion of a *category* allows for the identification of the necessary training outcomes in terms of the generic and transferable skills and at the same time reflects the cabling/wiring systems generally understood by industry. The specific unit outcomes are:

UTE NES105G A	Install & terminate wiring systems *(Cabling/wiring support and protection)*
UTE NES105H A	Install & terminate wiring systems *(Network communications)*
UTE NES105I A	Install & terminate wiring systems *(Power and control – extra low voltage)*
UTE NES105J A	Install & terminate wiring systems *(Power and control – low voltage)*

Elements		Performance criteria	
105.1	Plan and prepare for installation	105.1.1	Installation is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		105.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		105.1.3	*Wiring systems'* components are checked against job *requirements*
		105.1.4	Accessories are obtained in accordance with *established procedures* and to comply with *requirements*
		105.1.5	Location in which specific items of accessories, *apparatus* and circuits are to be installed is determined from job *requirements*
		105.1.6	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*

Elements		Performance criteria	
		105.1.7	*Tools, equipment* and *testing devices* needed to carry out the installation work are obtained in accordance with *established procedures* and checked for correct operation and safety
		105.1.8	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*
105.2	Install *wiring systems*	105.2.1	*OH&S policies and procedures* for installing electrical wiring systems are followed
		105.2.2	*Wiring systems* are installed in accordance with *requirements*, without damage or distortion to the surrounding environment or services
		105.2.3	*Accessories* are *terminated* and connected in accordance with *requirements*
		105.2.4	Unplanned events or conditions are responded to in accordance with *established procedures*
		105.2.5	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		105.2.6	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
105.3	Inspect and notify completion of work	105.3.1	Final inspections are undertaken to ensure the installed *wiring systems* conforms to *requirements*
		105.3.2	Work completion is *notified* in accordance with *established procedures*

Range statement

General

Generic items in this unit are shown in italics, e.g. *established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Categories

This unit recognises the commonality of skills and knowledge that exists for the unit as well as the additional specific outcome; which is to be reported on. Therefore, competency can be displayed on one, some or all of the following categories and in addition to the respective common underpinning knowledge associated with the selected specialisation:

(G) Cable/wiring support and protection

(H) Network communications

(I) Power and control – extra low voltage

(J) Power and control – low voltage

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating *consistent performance* for each element of the unit in the related *category* which is to be exhibited across a *representative range* of applications; autonomously and to *requirements.*
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace for each of the *categories* undertaken from those listed in the Range statement or Evidence guide.
- demonstrating an understanding of the underpinning knowledge and skills identified for the *categories* undertaken in the section, of this unit titled 'Underpinning knowledge'.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of applications which includes such things as *apparatus, circuits, wiring systems, plant, equipment, tools, accessories, components* and the like relative to that required for the *category* undertaken within and relevant to this unit of competency; autonomously and to requirements. Equivalent evidence from other sources is also acceptable.

Interdependent assessment of units

Nil. However, it is expected that *category* F of this unit would be assessed in conjunction with one other *category* in this unit.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Since this unit covers a range of *categories* each having multiple *specialisations* a content listing is provided below. Each *category* has all of the required underpinning knowledge and skill listed even though this sometimes results in duplication between *categories*.

Category: Cabling/wiring support and protection (G)

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Wiring techniques.

Isolation and tagging

Standards: purpose; standard bodies; applications

Using standards: terms; numbering system; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems; segregation; physical positioning

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials; techniques (marking out, cutting, bending, drilling/punching, joining, cutting meters)

Fitting techniques: dismantling; assembling

Category: Network communications (H)

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials; techniques (marking out, cutting, bending, drilling/punching, joining, cutting meters)

Fitting techniques: dismantling; assembling

Building and building systems.

General safety, safe working and safe use and maintenance of hand and power tools, ladders, etc, in installation situations

Aspects of domestic building structures, building codes and regulations of interest to installers of telecommunications equipment and facilities

Aspects of commercial building structures and their construction of interest to installers

Safe use of explosive powered fixing tools in installing telecommunications equipment and fittings

Information for installers on dealing with advanced/difficult forms of building structures and systems, including – penetrations, running cables, fixing to a variety of surfaces

Wiring techniques.

Isolation and tagging

Standards: purpose; standard bodies; applications

Using standards: terms; numbering system; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems; segregation; physical positioning

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Standards and Regulations – Telecommunications.

Australian Communication Authority (ACA): role; Telecommunication Act 1997

Cabling provider rules, regulations, standards, codes: cabling provider rules; regulations; AS standards; other technical standards; codes; labelling; Certified Components List (CCL)

Registration: mandatory (open, restricted, lift); voluntary; competency requirements and training for registration

Telecommunications cables and installation methods.

Telecommunication cable types, construction, characteristics and applications

Cable identification, labelling and documentation (plans and drawing)

Cable installation: hazards; cable damage prevention; cable dispensers

Building construction: domestic buildings; commercial buildings

Fixing devices

Cable enclosures: types; fixing; regulations

Distribution boxes and back mounts: systems; termination boundaries and devices

Electrical connections: hazards; regulations

Cable preparation and terminations

Hauling mechanisms: indoor; outdoor; methods

Drawing interpretation and sketching.

Technical drawing standards appropriate to the industry sector, conventions and specifications to AS 1100, with strong emphasis on interpretation: sheet types, title block information, materials parts list, revision table, grid referencing scales, line types – visible outlines, hidden outlines, dimensioning lines, centre lines;

orthogonal projection of views – 3rd angle (detail and assembly drawings); mechanical conventions; fabrication conventions; three dimensional view drawings – axonometric, isometric, oblique; sectioning standards and conventions – whole, part; engineering drawing symbols, components and equipment – mechanical, electrical, electronic, computer, instrument, refrigeration; dimensioning – orthogonal, isometric; layout and plans; geometric tolerance interpretation (straightness, flatness, squareness, parallelism and concentricity only); engineering abbreviations; drawing interpretation techniques – detail drawings, orthogonal projection (3^{rd} angle only) and three dimensional, assembly drawings and three dimensions exploded (e.g. as in equipment manuals)

Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3^{rd} angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

Telecommunications systems overview.

Principles and characteristics of sound

Transmission of sound

Telephone transmitters

Telephone receivers

Telephone circuits: components; operation of basic telephone; operation of basic facsimile machine; cables used, colour and termination types

Overview earthing and protection

Customer switching systems (CSS), interfaces and devices: System Distribution Frames (SDF)/Test Point Frames (TPF), power fail and line interface requirements (eg indial, rotary groups, extension and tie-line circuits)

Installation of CSS

Installation and termination requirements overview: ACA regulations and requirements; technical standards; programming of CSS

Hazards: electronic components and circuits; printed circuit boards; physical; static discharge; chemical

Telecommunications earthing and protection.

Telecommunication overvoltage protection system: operating principles; overvoltage and surge/spike suppression protection techniques; overvoltage protection devices; installation of overvoltage protection systems

Earthing protection system: MEN system; TELEX functional earth system; telecommunication system earthing; communication earth system; protective earth barriers for segregation, cable tray, duct and metal equipment enclosures

Electrical interference: types – RFI, EMI; sources of interference; techniques in reducing interference; earthing cable shields

Testing of systems: earth testing instruments; earth testing procedures

Earthing hazards: safety issues to be considered with earthing and bonding

Electrical concepts and applications.

DC resistive circuits: series; parallel; series parallel; measurement of V, I and R; calculation of R, V, I, and P

Capacitance: concept; unit; time constant; capacitors – basic construction and types

Magnetism: magnetic and non magnetic materials; magnetic field patterns; force between magnetic fields; applications

Electromagnetism: magnetic field around a current-carrying conductor and solenoid; force between current-carrying conductors; applications

Electromagnetic induction: induced EMF; inductance, concept, unit, time constant, applications

AC principles: sine waves; frequency; amplitude; peak voltage; peak to peak voltage; RMS voltage; single phase; three phase; generation of AC voltages; circuit measurement; earthing; electrical supply system

Transformers: construction; principles of operation; primary and secondary voltage and current; applications

Motors: motor action; generator action; DC motors; AC motors; applications

Electrical safety testing: regulations

Category: Power and control - extra low voltage (I)

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Wiring techniques.

Isolation and tagging

Standards: purpose; standard bodies; applications

Using standards: terms; numbering system; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems; segregation; physical positioning

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials; techniques (marking out, cutting, bending, drilling/punching, joining, cutting meters)

Fitting techniques: dismantling; assembling

Category: Power and control – low voltage (J)

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials; techniques (marking out, cutting, bending, drilling/punching, joining, cutting meters)

Fitting techniques: dismantling; assembling

Electrical theory.

Fundamental and derived units: basic units; SI derived units; multiples and sub-multiples

Power, work and energy: conservation of energy; torque; losses and efficiency; maximum efficiency of machines

Electrical characteristics of materials: conductors, insulators, semi-conductors; electric charge; electric current; electromotive force

The simple circuit: source, load, current path and control; open-circuit; short-circuit

Resistance: Ohm's law; determine V, I, R; power dissipation

Effects of current: physiological effects; principles of protection from physiological effects; conversion of electrical energy to other forms (heating,

light, magnetic, chemical)Sources of electrical energy - conversion of other forms to electrical energy

Using measuring instruments: handling measuring instruments; selecting an instrument; setting-up and connecting into circuits; reading scales and read-outs; setting up a CRO

Factors effecting resistance: length, csa and resistivity; temperature change; influence on practical circuits

Resistors: types and applications; value and rating

Series circuits (single source): determine V, I, R, P; Kirchhoff's Voltage Law; voltage divider Parallel circuits: determine V, I, R, P; Kirchhoff's Current Law; current divider

Series/parallel circuits: determine V, I, R, P; bridge network Resistance measurement: hazards; characteristics of instruments and loading effect; direct, volt-ammeter and bridge method; typical field instruments and applications

Capacitance: concept; units; time constant relationship Capacitors: hazards; factors effecting capacitance; in series; in parallel; measuring/testing/hazards

Inductance: concept; units; time constant relationship

Inductors: factors effecting inductance

Electromagnetism.

Magnetism: field patterns; magnetic induction and screening; applications

Electromagnetism: magnetic field around a current-carrying conductor; Fleming's right-hand rules; forces between current carrying-conductors

Magnetic quantities: units (magnetomotive force, magnetising force, flux density, reluctance); permeability

Magnetisation curve: magnetic characteristics of materials; saturation and hysteresis; comparing magnetic materials

Induced voltage: factors required to induce an emf; forces acting on a conductor

Inductance: concept; unit; factors effecting inductance; self-inductance and mutual inductance

Application of electromagnetic principles: generator action; motor action; applications; unwanted effects

Single phase AC principles.

Sinusoidal alternating voltage and current: generation of a sinusoidal waveform; sinusoidal waveform characteristics; measuring and calculating values; phase relationships

Phasors: phase relationship terms; phasor representation conventions; phase relationships using phasors

Resistance in A.C. circuits: determine V, I, R, P; relationship between voltages and currents

Inductance in A.C. circuits: reactance; inductance in series; inductance in parallel; inductive components in power circuits and systems

Capacitance in A.C. circuits: reactance; capacitance in series; capacitance in parallel; capacitive components in power circuits and systems

AC circuits: impedance; relationship between resistive and reactive components; series, parallel and series-parallel RLC circuits; determine V, I, R, P in RLC circuits; phasor diagrams of RLC circuits

Resonance: conditions; resonance and frequency; effects on current

Ideal transformer: operating principles; primary and secondary voltage and current; applications

Three phase AC principles.

Power and power factor: true, apparent and reactive power; effects of low power factor; improvement

Multiphase systems: comparison of multiphase system; advantage of three phase system

Three phase principles: generation; relationship between generated voltages; phase sequence

Three phase star-connections: connections; line and phase voltages and currents

Three phase four wire systems: purpose of neutral conductor; line and phase voltages and currents; neutral current

Three phase delta-connections: connections; line and phase voltages and currents

Energy and power requirements of A.C. systems: purpose of energy, power, power factor and demand measurement; methods; power factor improvement

Harmonics: harmonics and selective resonance; sources in A.C. systems; problems

Wiring techniques.

Isolation and tagging

Standards: purpose; standard bodies; applications

Using standards: terms; numbering system; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems; segregation; physical positioning

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Wiring requirements - low current.

Mains and submains: selection of cables (suitable cables, maximum demand, installation conditions, conductor size based on current carrying capacity, conductor size based on voltage drop); circuit/protection

Final subcircuits: selection of cables (number of points, maximum demand, installation conditions, conductor size based on current carrying capacity, circuit protection)

Control and protection: requirements; earthing arrangements; supplementary protection

Switchboards: location; equipment requirements; arrangements of equipment

Damp situation: earthing; wiring system; equipment

Construction and demolition site: supply arrangements; installation requirements; testing

Aerial and underground wiring: cable types; aerial line data; underground wiring systems

Wiring requirements - high current.

Mains and submains: using AS3008.1; installation conditions; current carrying capacity; voltage drop

Final subcircuits: number of points; maximum demand; protection; installation conditions; cable selection

Control and protection: requirements; switchboard equipment (arrangement, CT metering, links, circuit protection and control, fault protection)

Hazardous areas: classifications; wiring systems; methods of explosion protection; fault protection

Special installations requirements: theatres and halls; controlled atmosphere rooms; caravans and caravan parks; boating marinas

Electric motors.

Three phase motors: construction; operating principles; performance characteristics

Motor protection: short duration overloads; sustained overloads; locked rotor; under-voltage supply; repetitive starting or reversing; high operating temperature; high operating temperature; high humidity or moisture; enclosures; protection devices

Purpose of limiting starting current of machines: requirements of SAA and local authorities; three phase starters operation and application; motor vs load: speed torque relationships

Connection methods of three phase starters: methods of breaking AC motors; reversal of rotation of AC motors

AS3000 and service rule requirements: connection; control switches; limitation of transient current; automatic starting; protection against over-temperature

Fault testing: balanced line current; terminal voltage; insulation resistance; winding resistance/continuity; control and power circuit testing

Motor principles and characteristics: "rotating" magnetic field; production of torque; split phase motor; shaded-pole motor; capacitor types; universal motor curves; reversal of rotation

Construction: windings, stators and rotors; starting current devices; protection devices

Applications: comparison of torque/power/speed characteristics; calculation of power, torque speed and efficiency; applications

Fault and fault-finding: common faults; diagnostic testing; fault-finding procedures

Circuit protection.

Earthing and earthing systems: reasons for earthing; AS3000 requirements for an effective earthing system; direct, MEN and ELCB - voltage operated earthing system; principles of operation of each earthing system; layouts of typical earthing of electrical installations; advantages of each earthing system

Circuit protection: causes and effects of excess circuit current and voltage; high level short circuit current - fault current; overload protection requirements; understand circuits protection terminologies relative to prospective fault current, discrimination, inverse and definite minimum time; methods of providing arc control in protection devices - both AC and DC; circuit protection devices, their operating parameters and ratings; voltage dependent circuit protection devices - surge protection

Supplementary earthing protection: isolation; operating principles of RCDs; circuit arrangement for RCDs, single and three phase

Electrical wiring and equipment.

Standards: purpose; standards bodies; applications

Using standards: terms; numbering systems; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Electrical installation safety testing.

Legislated regulations: regulations; responsibilities; testing requirements

Testing installations: insulation; earthing continuity; polarity; transposition of earth and neutral; identification of circuit conductors; operation of installation; operation of RCDs

Documentation: reporting tests; minimum requirements

Electrical drawings and their interpretation.

Purpose and use of block, circuit and wiring diagrams

Use of drawing symbols and Australian Standard 1102

Electrical diagram conventions

Use and construction of switching charts

One-way, two-way and multi-position control of lighting circuits

Circuit wiring methods using sheathed cables and looping terminals

The features purpose and use of site and floor plans and details and standard drawings

Locating the position of electrical services from architectural drawings

Transformers.

Core construction and winding styles used in transformers

Principles of operation of single-wound and double-wound and single phase transformers

The characteristics of the four basic types of transformers

Insulation resistance, continuity, winding identification, polarity marks

Lighting.

Lighting concepts: terms and units; inverse square law; essential factors to produce visual comfort

Luminaires: types; maintenance of luminaires; use of reflectors and/or diffusers

Lamp types: incandescent, gas discharge and high voltage; characteristics, circuit connections and special features; miscellaneous lamp types; auxiliary control; light dimming; RF interference; common faults; testing of circuits; fault-finding

Special lighting situations: special requirements/rules regarding security; safety and emergency lighting; use of standards appropriate to these situations

UTE NES106 (A to Z qualifier) A
Install electrical/electronic apparatus

Descriptor: Install and connect *fixed wired electrical/electronic apparatus.*

Alignment: This unit aligns to and is based on the National Electrotechnology Benchmark Standard EBS 205 - Install electrical/electronic apparatus.

Specific unit outcomes

This is presented as a composite unit that has six specific units as outcomes, based on the *category* in which competence is achieved. This is done because of the high degree of commonality in process or function. Reporting the unit with the inclusion of a *category* allows for the identification of the necessary training outcomes in terms of the generic and transferable skills and at the same time reflects the work classification(s) generally understood by industry. The specific unit outcomes are:

UTE NES106A A	Install electrical/electronic apparatus *(Computer systems)*
UTE NES106B A	Install electrical/electronic apparatus *(Electrical)*
UTE NES106C A	Install electrical/electronic apparatus *(Electronics)*
UTE NES106D A	Install electrical/electronic apparatus *(Instrumentation)*
UTE NES106E A	Install electrical/electronic apparatus *(Refrigeration & a/conditioning)*
UTE NES106F A	Install electrical/electronic apparatus *(Data communications)*

Elements		Performance criteria	
106.1	Plan and prepare for installation	106.1.1	Installation is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		106.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		106.1.3	*Apparatus* is checked against job *requirements*
		106.1.4	*Apparatus* is obtained in accordance with *established procedures* and to comply with *requirements*
		106.1.5	Location in which *apparatus* is to be installed is determined from job *requirements*

Elements		Performance criteria	
		106.1.6	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		106.1.7	*Tools, equipment* and *testing devices* needed to carry out the installation work are obtained in accordance with *established procedures* and checked for correct operation and safety
		106.1.8	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*
106.2	Install *apparatus*	106.2.1	*OH&S policies and procedures* for installing electrical *apparatus* are followed
		106.2.2	*Apparatus* are installed in accordance with *requirements,* without damage or distortion to the surrounding environment or services
		106.2.3	Variation to apparatus installation is carried out in accordance to customer/client *requirements*
		106.2.4	*Apparatus* are terminated and connected in accordance with *requirements*
		106.2.5	Unplanned events or conditions are responded to in accordance with *established procedures*
		106.2.6	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		106.2.7	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
106.3	Inspect and notify completion of work	106.3.1	Final inspections are undertaken to ensure the installed *apparatus* conforms to *requirements*
		106.3.2	Work completion is *notified* in accordance with *established procedures*

Range statement

General

Generic items in this unit are shown in italics, e.g. *established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Categories

This unit recognises the commonality of skills and knowledge that exists for the unit as well as the additional specific outcome; which is to be reported on. Therefore, competency can be displayed on one, some or all of the following categories and in addition to the respective common underpinning knowledge associated with the selected specialisation:

(A) Computer systems

(B) Electrical

(C) Electronics

(D) Instrumentation

(E) Refrigeration and air conditioning

(F) Data communications

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating consistent performance for each element of the unit in the related *category* and *specialisation* which is to be exhibited across a *representative range* of applications; autonomously and to *requirements*.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace for each of the *categories* and areas of *specialisation* undertaken from those listed in the Range statement or Evidence guide.

- demonstrating an understanding of the underpinning knowledge and skills identified for the *categories* and related *specialisation* undertaken in the section, of this unit titled 'Underpinning knowledge'.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of applications which includes such things as *apparatus, circuits, wiring systems, plant, equipment,* tools*, accessories, components* and the like relative to that required for the *category* undertaken within and relevant to this unit of competency; autonomously and to requirements. Equivalent evidence from other sources is also acceptable.

Interdependent assessment of units

Nil.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Since this unit covers a range of *categories* each having multiple *specialisations* a content listing is provided below. Each *category* has all of the required underpinning knowledge and skill listed even though this sometimes results in duplication between *categories*.

Category: Computer systems (A)

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials, types, applications; techniques, marking out, cutting, bending, drilling/punching, soldering, cutting mitres

Assembly/disassembly techniques

Electrical theory.

Fundamental and derived units: basic units; SI derived units; multiples and sub-multiples

Power, work and energy: conservation of energy; torque; losses and efficiency; maximum efficiency of machines

Electrical characteristics of materials: conductors, insulators, semi-conductors; electric charge; electric current; electromotive force

The simple circuit: source, load, current path and control; open-circuit; short-circuit

Resistance: Ohm's law; determine V, I, R; power dissipation

Effects of current: physiological effects; principles of protection from physiological effects; conversion of electrical energy to other forms (heating,

light, magnetic, chemical)Sources of electrical energy - conversion of other forms to electrical energy

Using measuring instruments: handling measuring instruments; selecting an instrument; setting-up and connecting into circuits; reading scales and read-outs; setting up a CRO

Factors effecting resistance: length, csa and resistivity; temperature change; influence on practical circuits

Resistors: types and applications; value and rating

Series circuits (single source): determine V, I, R, P; Kirchhoff's Voltage Law; voltage divider Parallel circuits: determine V, I, R, P; Kirchhoff's Current Law; current divider

Series/parallel circuits: determine V, I, R, P; bridge network Resistance measurement: hazards; characteristics of instruments and loading effect; direct, volt-ammeter and bridge method; typical field instruments and applications

Capacitance: concept; units; time constant relationship Capacitors: hazards; factors effecting capacitance; in series; in parallel; measuring/testing/hazards

Inductance: concept; units; time constant relationship

Inductors: factors effecting inductance

Single phase AC principles.

Sinusoidal alternating voltage and current: generation of a sinusoidal waveform; sinusoidal waveform characteristics; measuring and calculating values; phase relationships

Phasors: phase relationship terms; phasor representation conventions; phase relationships using phasors

Resistance in A.C. circuits: determine V, I, R, P; relationship between voltages and currents

Inductance in A.C. circuits: reactance; inductance in series; inductance in parallel; inductive components in power circuits and systems

Capacitance in A.C. circuits: reactance; capacitance in series; capacitance in parallel; capacitive components in power circuits and systems

AC circuits: impedance; relationship between resistive and reactive components; series, parallel and series-parallel RLC circuits; determine V, I, R, P in RLC circuits; phasor diagrams of RLC circuits

Resonance: conditions; resonance and frequency; effects on current

Ideal transformer: operating principles; primary and secondary voltage and current; applications

Wiring techniques.

Electrical/electronic safety testing: isolation; testing; tagging; earthing; appliance electrical safety testing

Standards pertinent to industry sector: purpose; standards bodies; applications

Cables: types, power, signal; terms; colour coding; structure; identification cables; cable applications

Wiring systems: wiring looms; enclosures and supports; selecting wiring systems

Connectors and terminations: requirements; connectors, types and applications, assembly/disassembly; terminating conductors, extension cords

Accessories and fixings appropriate to industry sector: applications; fixing devices and methods

Digital electronics.

Analogue and digital signal definition

Digital combinational circuit operation: binary numbering up to four variables; truth tables; Boolean representation; simplification of Boolean expressions; circuit implementation from Boolean expressions; logic probe/pulser usage for fault-finding

Hexadecimal, binary and decimal number systems and BCD code: hexadecimal numbering system and its BCD representation (up to two digits); binary to decimal conversion (16 bits max.); binary to hexadecimal conversion (16 bits max.); decimal to hexadecimal conversion (four hex digits max.); representation of alphanumeric characters using 7 BIT ASCII code

Electrostatic discharge precautions: effect of ESD; handling components; wrist straps, protective mats, anti-static bags examples of design using ESD techniques

Operation and characteristics of displays: LED displays; types; calculating current limiting resistors; LCD displays – types; drive requirements

Analysis of digital sub-systems – timing diagrams (decoders): operation - discrete components, 2 line; practical MSI devices and applications -2 line and 3 line devices; seven segment display decoder -binary and BCD; priority encoders; multiplexers – operation -discrete component, 2 line; truth table implementation using MSI devices up to eight inputs – folding not required; demultiplexers – operation -discrete component, 2 line input; practical MSI devices

Digital sub-systems examples using up to four MSI devices e.g. keyboards/display, data transfer – timing diagrams/data sheet usage to be emphasised: flop-flop operation – discrete and MSI, SR, D and JK; level and edge triggered flip-flops, synchronous and asynchronous inputs, flip-flop applications based on MSI devices for shift registers – serial and parallel loading and output, shift left, shift right; counters – based on D and JK flop-flops to a maximum of four states, ripple and counters synchronous; modulus counters, up/down counters, limitations on count speed, IC counters (MSI devices) –

presentable counters (up/down), cascading counters (include BCD applications), ring counters – advantages and types; astable and monostable multivibrators

Logic device terminal characteristics: logic levels, supply voltages; power dissipation; input/output drive currents and voltage levels; loading calculations; propagation delays; noise margins; switching speed limitations and speed/power product; open collector/drain outputs; tristate logic and buffers; interfacing of different logic families (include the use of pull-up, pull-down resistors); Schmitt trigger device input output; characteristics

Microprocessors.

Basic 8-bit microprocessor system: semi-conductor RAM ICs; semi-conductor ROM ICs

Microprocessor architecture: central processing unit (CPU); register array; instructions register/decoder; arithmetic logic unit (ALU); accumulator and flags; instruction cycle timing; control lines; index register; general purpose registers

Systems clock circuits fetch and execute: timing cycle; timing relationships to system clock; logic levels of system buses for each clock period of an instruction cycle

Program listing terms: instruction; instruction mnemonic; operation code (op code); address, operand, label, mnemonic and comment fields; machine code and assembly language high level and low level language

Single chip dedicated microprocessors

Regulated power supplies.

Regulated power supplies: principles of operation; advantage/disadvantages – linear shunt, linear series, switchmode

Linear power supplies: block diagram; principles of operation; series transistor; integrated circuits – types, specifications, protection; testing; fault-finding and repair

Switched mode power supplies: block diagram; principles of operation – with/without transformers, step up/step down/inverter; terminology; components; suppression techniques; testing; repair/replacement

DC power supplies.

Power supplies

Block diagrams

Waveform measurements; uses

Ideal an practical diodes; Ge and Si diodes

Half-wave and full-wave rectifier circuits; average voltages for half-wave and full-wave rectifier circuits

Capacitive filtering

Ripple voltages: based on load variations; based on capacitor choice; current limiting resistors

Zener diode applications

Three terminal regulators

Power supply faults and repair

Data communications.

Standards: elements of data communication system; transmission modes (simplex, half and full-duplex); transmission techniques; voice transmission fundamentals; interfacing devices and standards; OSI seven layer model; modem fundamentals; modem modulation techniques; integrated services digital network (ISDN); packet switching services, X.25

Local area networks.

Local area networks (LANs): concepts; cabling arrangements; network standards; network operating systems; LAN access control methods; installation of a PC based network (file servers, workstations, print servers); LAN management; LAN internet working; metropolitan area networks; wide area networks; TCP/IP concepts; virtual LANs; network maintenance and troubleshooting

Specialisation: Building services – fire protection

Programmable controllers.

Introduction to control systems: block diagram of any control system (input, process, output); methods of control (relay, static logic, programmable); introduction to PLC systems; advantages and disadvantages of PLCs; block diagram of PLC system

Basic PLC operation: definitions, terminology and block diagram; scan cycle; basic programming rules; addressing for I/O; halt; run

Programming (using a hand programmer): flowcharts/steps to use when programming; clearing memory; ladder format; Boolean/mnemonic/statement list format; series circuits; parallel circuits; latching circuits; stack register operation; combination series/parallel circuits; inversion elements; timers

(DOE); counters; monitor discrete I/O and timer/counter values; edit (insert and delete elements)

Connect discrete input and output devices to a PLC

Programmable controllers - advanced procedures.

Installation procedures and precautions: personal safety; AS3000 and AS1543 implications; interpret manufacturer's installation specifications; basic commissioning procedures; environmental limitations/protection; physical positioning of CPU and I/O racks; routing signal/power cables; signal/power earthing requirements; selection of sink vs source modules; selection of relay vs transistor vs Triac modules

Advanced discrete programming: derived timers (off delay, self resetting, constant cycle); reversible counters; cascading timers; cascading counters; combining timers and counters; internal relays/flags/markers; latching relays (set/reset); jump instructions; master control instruction; bit shift registers; scan time considerations; one shot; retentive (power fail) functions; simple step sequence instructions

External program storage devices: IC storage (ROM, EPROM, E^2PROM); cassette tape; computer (hard/floppy) disks; save and retrieve a program to/from an external storage medium

Software design: use software to develop/edit a process control solution; use software to monitor the status of a process; use software to document a program; produce a hard copy (print-out) of a fully documented program

Basic diagnostics: use the force instruction to aid in fault-finding; use inbuilt hardware/software diagnostics to determine errors; using error codes locate and rectify a fault

Personal computer servicing.

Introduction to computers: types/models/classes; hardware components; definitions and terminology; introduction to software; minimum system configuration

Computer PC hardware: motherboard/s and their major components; power supplies; keyboards; monitors and adaptors; disk drives; printer; sundry devices

Operating systems: types of operating systems and versions thereof; file and data structures; file naming conventions; directory structures and access; operating system bootstrapping process; operating system commands; basic concepts of Batch (startup) files and their use; basic concepts of configuration files

Building automation fire protection installation.

Purpose of automatic fire detection and alarm systems: preservation of life; protection of buildings and equipment

Standards and codes: general legislation and codes; specific legislation – Halon systems, ionisation smoke detectors; legal liability

Fire characteristics: principles of fire detection – fire growth; principles of fire suppression

Generic automatic fire detection and alarm system: overview of automatic fire detection and alarm system

Fire detection actuating devices: fire detector classification; detector patterns; detector types, principles of operation and performance; heat detectors – electro-pneumatic, fusible alloy, bimetallic, solid state, thermo-plastic; smoke detectors – ionisation, photo-electric, beam light obscuration, sampling light scatter (aspirating); flame detectors – infra-red, ultra-violet, manual call points; special purpose detectors – flammable vapour/gas detectors, explosion detectors

Control and indicating equipment (CIE): fire panels; classification; types; principles of operation; installation; commissioning report as per AS 1670

Emergency warning and intercommunication system (EWIS): purpose; types; installation; codes and requirements; manufacturers' specifications and requirements – AS3000 series, AS1670, AS2220, AS1668

Alarms: local alarms – purpose, types, installation; transmitted alarms – purpose, types, installation; control outputs – purpose, types, installation; pump control – purpose, pump actuation; codes and requirements – manufacturers' specifications, manufacturers' requirements for handling; building codes Australia – AS1668, AS1670, AS1851

Suppression systems: sprinkler systems; sequence of operation; purpose of interfacing devices; special purpose gaseous, dry chemical, foam, explosion suppression; suppression actuating devices; purpose; sequence of operation; purpose of interfacing devices; types of interfacing devices; installation of interfacing devices; purpose of actuation devices; types of actuation devices; installation of actuation devices; codes and requirements – manufacturers' specifications, manufacturers' requirements for handling; building codes Australia – AS1670, AS1851, AS1668

Cabling: types of fire cables – mineral insulated metal sheathed cable (MIMS), radox cable, data cable, fibre optic cable; codes and requirements – manufacturers' specifications and requirements, AS3000 series, AS1670, ACA standards; installation of fire cables; detector selection – detector installation; detection systems – conventional, distributed, network; detection system installation; codes and requirements; manufacturers' specifications; manufacturers' requirements for handling; building codes Australia – AS1670, AS1851, AS3000

Specialisation: Building services – security

Security systems.

Regulations applicable to the security industry

Design of domestic security system

Building construction

Mechanical detectors: pressure pads; trip wires; window tape; screens; switches; vibration

Electro-mechanical detectors: ultra sonic; microwave; glass break; smoke; active infra-red beams; passive infra red; strain system; electromagnetic; optical fibre cable

Batteries: types; applications; maintenance

Relays: types, applications

Security panels

Communication systems

Close circuit television (CCTV)

Locking devices

Lighting

CCTV.

Safety; principles; uses; field of view determination; depth of field; definition vs broad view; electronic and auto iris; focussing; setting up; picture sleeping; coaxial connections; mounting – location, sealed housings, unsealed housings, heated housings; adjusting a monitor; mutiplexors – setting up, adjusting; pan/tilt devices – auto pan, pan/tilt controller; microprocessor based CCTV systems; analysing picture quality; test equipment – vector scope, signal generator, portable or hand held monitors for setting up cameras

Security systems programming and diagnostics.

Logic circuits; microprocessor driven circuits; upgrading – firmware, software; detectors – types, features, common problems, continuity, voltage; devices – detector options, count, sensitivity; control equipment; test equipment – digital meters, analogue meters, tone generators (F set), continuity tester; Laptop computers – DOS, Win 3.11, Win 95, Code pads

Advanced security systems.

Fibre optics – applications, terminations, physical properties; intrinsically safe wiring – where needed, alternatives; modems – commands, uses

Specialisation: Business equipment

Operational concepts of business machines.

Photocopiers: copy processes; copier components; maintenance procedures

Facsimile machines: components; transmission methods; maintenance procedures

Personal computers: components; operating systems; software; input/output devices; CD ROM

Printers: printer types, processes; basic components; maintenance procedures

Visual Display units, VDU: operating processes; display types; compatibility

Scanners: types; scanning methods; components; software

Other business equipment: calculators and typewriters; micrographic and electronic storage; integrated office equipment; applications

Chemicals handling: corrosive substances; flammable materials; safety

DC stepper motors

Laser devices: types; wavelength; safety

Electronic communications between business machines.

Digital signals: identification; measurement

Modem communications: modem protocols; measurement

Ports and plugs: functions; identification

Multiplexing/de-multiplexing techniques

Facsimile protocols: test sheets; test results

Computers interfaces: interpretation of readings; faults

Electronic memories: number systems; packages; terminology

Specialisation: Control

Digital subsystems.

Digital to analogue conversion: typical applications; DA performance characteristics; types – summing type DA converter, R2R ladder DA converter

Analogue to digital conversion: typical applications; AD performance characteristics; types – digital ramp AD converter, successive approximation AD converter, dual slope AD converter, simultaneous (flash) AD converter

Advanced interfacing techniques: logic interface circuits – driving a load (sink and source) from a logic circuit, transistor switches, relays, opto input and output isolation, driver ICs; sensor interfacing

Programmable array devices: applications; types – PLA (programmable logic array), PAL (programmable array logic), PEEL (programmable electrically erasable logic); circuit operation; programming requirements

Amplifier applications.

Coupling methods in multistage amplifiers: capacitance; transformer; direct; characteristics of each method; frequency response; stage gain

Negative feedback: voltage shunt feedback; voltage series feedback; current shunt feedback; current series feedback; effect of feedback on gain, bandwidth, distortion input/output resistance

Power amplifier principles: classes of amplification; conduction angle; efficiency

Transformer coupled power amplifiers: circuit schematics; class A; class B; reflected resistance; efficiency; bias requirements; thermal stability

Complimentary symmetry power amplifiers: quasi complimentary; circuit schematics; class B; class AB; efficiency; bias requirements; cross over distortion; thermal stability; DC balance

Programmable controllers.

Introduction to control systems: block diagram of any control system (input, process, output); methods of control (relay, static logic, programmable); introduction to PLC systems; advantages and disadvantages of PLCs; block diagram of PLC system

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Connect discrete input and output devices to a PLC

Programmable controllers - advanced procedures.

Installation procedures and precautions: personal safety; AS3000 and AS1543 implications; interpret manufacturer's installation specifications; basic commissioning procedures; environmental limitations/protection; physical positioning of CPU and I/O racks; routing signal/power cables; signal/power earthing requirements; selection of sink vs source modules; selection of relay vs transistor vs Triac modules

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scan time considerations; one shot; retentive (power fail) functions; simple step sequence instructions

External program storage devices: IC storage (ROM, EPROM, E^2PROM); cassette tape; computer (hard/floppy) disks; save and retrieve a program to/from an external storage medium

Software design: use software to develop/edit a process control solution; use software to monitor the status of a process; use software to document a program; produce a hard copy (print-out) of a fully documented program

Basic diagnostics: use the force instruction to aid in fault-finding; use inbuilt hardware/software diagnostics to determine errors; using error codes locate and rectify a fault

Specialisation: Data capture

Digital subsystems.

Digital to analogue conversion: typical applications; DA performance characteristics; types – summing type DA converter, R2R ladder DA converter

Analogue to digital conversion: typical applications; AD performance characteristics; types – digital ramp AD converter, successive approximation AD converter, dual slope AD converter, simultaneous (flash) AD converter

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Programmable array devices: applications; types – PLA (programmable logic array), PAL (programmable array logic), PEEL (programmable electrically erasable logic); circuit operation; programming requirements

Telemetry.

Telemetry systems

Advantages and limitations of analogue, digital, pneumatic and fibre optic types

Standards pertaining to telemetering including the International Standard CCI TT V24

Standard signal in common use

Analogue signal converters, signal conditioners, isolators, lighting protection, barrier modules to hazardous areas, analogue multiplexers, transmitters and receivers

Comparison or analogue and digital signals including accuracy and discrimination

Digital word and message structures

Series used in fibre optic systems, physical construction of fibre for light transmission, types of fibre and cladding

Types and characteristics of light sources

Types and characteristics of light detectors

Safety procedures in handling fibre and light sources

Types of transmission lines and links

Digital data links and database lines. RS232, RS422, transmission rates and signals acceptable for use

Specialisation: Networks

Multimedia computer systems.

Multimedia systems: multimedia PC (MPC) 1 standard; multimedia PC (MPC) 2 standard; new multimedia standards; pixel resolution; scanning resolution; output resolution; printer resolution

Mother boards: microprocessor speeds; INTEL ICOMP index rating; cache memory speeds; system bus transfer speeds (VL-bus, PCI bus, ISA 8 bit, EISA bus, micro channel bus, other bus systems); configuration of a mother board; fault-finding

Multimedia storage devices: RAM, hard disk drive; multimedia storage devices; removable storage hard disk drive; floppy disk drive; CD-ROM drive; digital tape (DAT) drive; other devices

Video cards: video processor; graphic processing; video RAM; bus interfaces; resolution; full motion video; still image

Sound cards: sound card standards; MIDI interface sound card applications; sound card connectors; FM synthesis; wave table; sound card file formats

CD-ROMs: CD-ROM standards; CD-ROM cache memory; CD-ROM drive transfer speeds; CD-ROM interfaces; photo CD compatible; CD recordable; multi-session compatible; CD-ROM publisher; CD-ROM archiving

Colour printers: types of colour printers

Colour scanners: types of scanners; one pass, three pass; scanning software

Category: Electrical (B)

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials, types, applications; techniques, marking out, cutting, bending, drilling/punching, soldering, cutting mitres

Assembly/disassembly techniques

Electrical theory.

Fundamental and derived units: basic units; SI derived units; multiples and sub-multiples

Power, work and energy: conservation of energy; torque; losses and efficiency; maximum efficiency of machines

Electrical characteristics of materials: conductors, insulators, semi-conductors; electric charge; electric current; electromotive force

The simple circuit: source, load, current path and control; open-circuit; short-circuit

Resistance: Ohm's law; determine V, I, R; power dissipation

Effects of current: physiological effects; principles of protection from physiological effects; conversion of electrical energy to other forms (heating,

light, magnetic, chemical)Sources of electrical energy - conversion of other forms to electrical energy

Using measuring instruments: handling measuring instruments; selecting an instrument; setting-up and connecting into circuits; reading scales and read-outs; setting up a CRO

Factors effecting resistance: length, csa and resistivity; temperature change; influence on practical circuits

Resistors: types and applications; value and rating

Series circuits (single source): determine V, I, R, P; Kirchhoff's Voltage Law; voltage dividerParallel circuits: determine V, I, R, P; Kirchhoff's Current Law; current divider

Series/parallel circuits: determine V, I, R, P; bridge network Resistance measurement: hazards; characteristics of instruments and loading effect; direct, volt-ammeter and bridge method; typical field instruments and applications

Capacitance: concept; units; time constant relationship Capacitors: hazards; factors effecting capacitance; in series; in parallel; measuring/testing/hazards

Inductance: concept; units; time constant relationship

Inductors: factors effecting inductance

Electromagnetism.

Magnetism: field patterns; magnetic induction and screening; applications

Electromagnetism: magnetic field around a current-carrying conductor; Fleming's right-hand rules; forces between current carrying-conductors

Magnetic quantities: units (magnetomotive force, magnetising force, flux density, reluctance); permeability

Magnetisation curve: magnetic characteristics of materials; saturation and hysteresis; comparing magnetic materials

Induced voltage: factors required to induce an emf; forces acting on a conductor

Inductance: concept; unit; factors effecting inductance; self-inductance and mutual inductance

Application of electromagnetic principles: generator action; motor action; applications; unwanted effects

Single phase AC principles.

Sinusoidal alternating voltage and current: generation of a sinusoidal waveform; sinusoidal waveform characteristics; measuring and calculating values; phase relationships

Phasors: phase relationship terms; phasor representation conventions; phase relationships using phasors

Resistance in A.C. circuits: determine V, I, R, P; relationship between voltages and currents

Inductance in A.C. circuits: reactance; inductance in series; inductance in parallel; inductive components in power circuits and systems

Capacitance in A.C. circuits: reactance; capacitance in series; capacitance in parallel; capacitive components in power circuits and systems

AC circuits: impedance; relationship between resistive and reactive components; series, parallel and series-parallel RLC circuits; determine V, I, R, P in RLC circuits; phasor diagrams of RLC circuits

Resonance: conditions; resonance and frequency; effects on current

Ideal transformer: operating principles; primary and secondary voltage and current; applications

Three phase AC principles.

Power and power factor: true, apparent and reactive power; effects of low power factor; improvement

Multiphase systems: comparison of multiphase system; advantage of three phase system

Three phase principles: generation; relationship between generated voltages; phase sequence

Three phase star-connections: connections; line and phase voltages and currents

Three phase four wire systems: purpose of neutral conductor; line and phase voltages and currents; neutral current

Three phase delta-connections: connections; line and phase voltages and currents

Energy and power requirements of A.C. systems: purpose of energy, power, power factor and demand measurement; methods; power factor improvement

Harmonics: harmonics and selective resonance; sources in A.C. systems; problems

Wiring techniques.

Electrical/electronic safety testing: isolation; testing; tagging; earthing; appliance electrical safety testing

Standards pertinent to industry sector: purpose; standards bodies; applications

Cables: types, power, signal; terms; colour coding; structure; identification cables; cable applications

Wiring systems: wiring looms; enclosures and supports; selecting wiring systems

Connectors and terminations: requirements; connectors, types and applications, assembly/disassembly; terminating conductors, extension cords

Accessories and fixings appropriate to industry sector: applications; fixing devices and methods

Wiring requirements - low current.

Mains and submains: selection of cables (suitable cables, maximum demand, installation conditions, conductor size based on current carrying capacity, conductor size based on voltage drop); circuit/protection

Final subcircuits: selection of cables (number of points, maximum demand, installation conditions, conductor size based on current carrying capacity, circuit protection)

Control and protection: requirements; earthing arrangements; supplementary protection

Switchboards: location; equipment requirements; arrangements of equipment

Damp situation: earthing; wiring system; equipment

Construction and demolition site: supply arrangements; installation requirements; testing

Aerial and underground wiring: cable types; aerial line data; underground wiring systems

Electric motors.

Three phase motors: construction; operating principles; performance characteristics

Motor protection: short duration overloads; sustained overloads; locked rotor; under-voltage supply; repetitive starting or reversing; high operating temperature; high operating temperature; high humidity or moisture; enclosures; protection devices

Purpose of limiting starting current of machines: requirements of SAA and local authorities; three phase starters operation and application; motor vs load: speed torque relationships

Connection methods of three phase starters: methods of breaking AC motors; reversal of rotation of AC motors

AS3000 and service rule requirements: connection; control switches; limitation of transient current; automatic starting; protection against over-temperature

Fault testing: balanced line current; terminal voltage; insulation resistance; winding resistance/continuity; control and power circuit testing

Motor principles and characteristics: "rotating" magnetic field; production of torque; split phase motor; shaded-pole motor; capacitor types; universal motor curves; reversal of rotation

Construction: windings, stators and rotors; starting current devices; protection devices

Applications: comparison of torque/power/speed characteristics; calculation of power, torque speed and efficiency; applications

Fault and fault-finding: common faults; diagnostic testing; fault-finding procedures

Circuit protection.

Earthing and earthing systems: reasons for earthing; AS3000 requirements for an effective earthing system; direct, MEN and ELCB - voltage operated earthing system; principles of operation of each earthing system; layouts of typical earthing of electrical installations; advantages of each earthing system

Circuit protection: causes and effects of excess circuit current and voltage; high level short circuit current - fault current; overload protection requirements; understand circuits protection terminologies relative to prospective fault current, discrimination, inverse and definite minimum time; methods of providing arc control in protection devices - both AC and DC; circuit protection devices, their operating parameters and ratings; voltage dependent circuit protection devices - surge protection

Supplementary earthing protection: isolation; operating principles of RCDs; circuit arrangement for RCDs, single and three phase

Specialisation: Control

Electrical wiring and equipment.

Standards: purpose; standards bodies; applications

Using standards: terms; numbering systems; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Wiring requirements - high current.

Mains and submains: using AS3008.1; installation conditions; current carrying capacity; voltage drop

Final subcircuits: number of points; maximum demand; protection; installation conditions; cable selection

Control and protection: requirements; switchboard equipment (arrangement, CT metering, links, circuit protection and control, fault protection)

Hazardous areas: classifications; wiring systems; methods of explosion protection; fault protection

Special installations requirements: theatres and halls; controlled atmosphere rooms; caravans and caravan parks; boating marinas

Electrical installation safety testing.

Legislated regulations: regulations; responsibilities; testing requirements

Testing installations: insulation; earthing continuity; polarity; transposition of earth and neutral; identification of circuit conductors; operation of installation; operation of RCDs

Documentation: reporting tests; minimum requirements

Electrical drawings and their interpretation.

Purpose and use of block, circuit and wiring diagrams

Use of drawing symbols and Australian Standard 1102

Electrical diagram conventions

Use and construction of switching charts

One-way, two-way and multi-position control of lighting circuits

Circuit wiring methods using sheathed cables and looping terminals

The features purpose and use of site and floor plans and details and standard drawings

Locating the position of electrical services from architectural drawings

Interpretation of wiring and schematic diagrams.

Construction and operation of relays, contactors and starters

Contact ratings of contactors

Power and control circuits

Control circuit symbols and drawing conventions

Conversion of wiring diagrams to ladder diagrams

Control circuit components and their operation

Selection of circuit components from manufacturers' catalogues

Basic control circuit wiring: push-button on-off control; remote stop-start operation; timer circuits; circuits with interlocks; jogging (inching) circuits (non-latching); press safety circuits

Fault-finding techniques

Advanced circuit design techniques: documenting circuit design; modifying circuits

Application of programmable controllers in circuit design

Drawing interpretation and sketching.

Technical drawing standards appropriate to the industry sector, conventions and specifications to AS 1100, with strong emphasis on interpretation: sheet types, title block information, materials parts list, revision table, grid referencing scales, line types – visible outlines, hidden outlines, dimensioning lines, centre lines; orthogonal projection of views – 3rd angle (detail and assembly drawings); mechanical conventions; fabrication conventions; three dimensional view drawings – axonometric, isometric, oblique; sectioning standards and conventions – whole, part; engineering drawing symbols, components and equipment – mechanical, electrical, electronic, computer, instrument, refrigeration; dimensioning – orthogonal, isometric; layout and plans; geometric tolerance interpretation (straightness, flatness, squareness, parallelism and concentricity only); engineering abbreviations; drawing interpretation techniques – detail drawings, orthogonal projection (3^{rd} angle only) and three dimensional, assembly drawings and three dimensions exploded (e.g. as in equipment manuals)

Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3^{rd} angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

Transformers.

Core construction and winding styles used in transformers

Principles of operation of single-wound and double-wound and single phase transformers

The characteristics of the four basic types of transformers

Insulation resistance, continuity, winding identification, polarity marks

Lighting.

Lighting concepts: terms and units; inverse square law; essential factors to produce visual comfort

Luminaires: types; maintenance of luminaires; use of reflectors and/or diffusers

Lamp types: incandescent, gas discharge and high voltage; characteristics, circuit connections and special features; miscellaneous lamp types; auxiliary control; light dimming; RF interference; common faults; testing of circuits; fault-finding

Special lighting situations: special requirements/rules regarding security; safety and emergency lighting; use of standards appropriate to these situations

DC machines.

DC machine principles: generated emf, lap and wave windings; control of output voltage; armature reaction; commutation; interpoles and compensating windings; back emf, torque and speed; losses and efficiency

DC machine types and connections: permanent magnet; separately excited; shunt, series, compound and series universal; reversal

DC machine characteristics and applications for shunt, series and compound: excitation/voltage; speed/voltage; load voltage/load current; torque/load current; torque/speed; speed/load current; applications

DC motor starters: starting current; concept of current limitation; calculation of resistance for limiting starting current; operation of common types of starters

Specialised DC machines: tachogenerator; servomotors; stepper motors

Programmable controllers.

Introduction to control systems: block diagram of any control system (input, process, output); methods of control (relay, static logic, programmable); introduction to PLC systems; advantages and disadvantages of PLCs; block diagram of PLC system

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Connect discrete input and output devices to a PLC

Basic power supplies (D.C.).

Rectifier diode: P-N junction; silicon and germanium characteristics; diode specifications; terminal identification; diode ohm meter testing

Half wave rectifier: basic circuit; VAC/VDC relationship; peak inverse voltage; measurement and testing

Centre tapped full wave: basic circuit; VAC/VDC relationship; peak inverse voltage; measurement and testing

Bridge rectifier: basic circuit; VAC/VDC relationship; measurement and testing

Three phase rectifiers: half wave; full wave; waveforms; % ripple; calculations of V and I for resistive loads

Basic filter circuits: capacitor; inductive; L section; Pi section

Zener regulators: zener diode characteristics; shunt regulator circuit; regulator specifications; line/load regulation; series resistor calculations; applications

Three-terminal regulators: characteristics and specifications; connection diagram; circuit stability requirements; reverse voltage protection methods

Dual polarity supplies: need for dual polarity; basic IC dual polarity regulator

Basic power supply protection: fuses; VDR's; LCR networks

Power control systems.

Methods of power control and phase angle control

Pulsed power control: bimetal thermostat heaters; half-wave/full-wave control - duo temperature soldering irons; series resistor control – continuously variable

Power control devices, symbols and specification and in-circuit operation: operation of typical half-wave and full wave power control circuits; limitations of phase angle control and noise reduction methods; fault-finding and safety problems

Cells and batteries.

Primary cells: definition; basic composition and construction; common types; terminal voltage; typical applications; storage, handling and disposal

Secondary cells: definition; basic composition and construction; common types; terminal voltage; typical applications; storage, handling and disposal

Cell configurations: series; parallel; terminal voltage; battery capacity

Secondary batteries: charge/discharge process; charge condition monitoring; internal resistance; commissioning procedures

Storage battery banks: applications; charging methods; change over/on line methods; ventilation requirements; types of batteries; capacities; routine maintenance; handling procedures; first aid requirements

Transducers.

Types of transducers and their applications: thermistor (NTC and PTC); light dependent resistor (LDR); photo-transistor; opto-coupler; speaker –electro magnetic, dynamic, Piezzo; magnetic pick up cartridge; light emitting diode; strain gauge; hall effect device; thermocouple; Peltier effect device; Piezzo electric device; microphone

Synchronous machines.

Principles of operation: construction details; cooling; excitation methods; effect of load alternator voltage; voltage regulation; ratings; parallel operation

Portable alternators: constructional details of common types; ratings

Three-phase synchronous motors: construction details; principles of operation; effect of load; effect of varying field excitation; starting methods; applications

Single-phase synchronous motors: common types; constructional details; applications

Concepts of instrumentation.

Flow, temperature, pressure and other appropriate measurements

Appropriate terminology: span, range, accuracy, precision, errors, zero, reputability, sensitivity, hysteresis, etc. (select from AS1541)

Development of SI units, engineering and scientific notation, imperial and metric conversion using calculations, mm Hg, mm Hg, Pa (hPa, Kpa, Mpa etc.), inches water, PSI, etc. also non-standard SI units – kgcm2, etc.

Instrumentation standards (brief overview only): ISA (Instrumentation Society of America); ISO (International Standards Organisation); SAMA (Scientific Apparatus Manufacturers America); BSI (British Standards Institution); AS (Australian Standards); ANSI (American National Standards Symbols and Terminology); Manufacturer Calibration Standards; fluids in process piping colour coding

Identification and purpose of instruments measuring processes directly and those measuring indirectly

Signal transmission of two-wire, 20-100 kPa, 4-20 mA, 1-5V, other applicable standards

Principles of levers, links and calibration of indicator recorder instrument

Application of safety standards at all times (tools, lifting techniques, electrical safety and CPR, pressure lines, housekeeping)

Interpretation of appropriate graphs and tables associated with instrumentation

Specialisation: Energy supply

Electrical wiring and equipment.

Standards: purpose; standards bodies; applications

Using standards: terms; numbering systems; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Wiring requirements - high current.

Mains and submains: using AS3008.1; installation conditions; current carrying capacity; voltage drop

Final subcircuits: number of points; maximum demand; protection; installation conditions; cable selection

Control and protection: requirements; switchboard equipment (arrangement, CT metering, links, circuit protection and control, fault protection)

Hazardous areas: classifications; wiring systems; methods of explosion protection; fault protection

Special installations requirements: theatres and halls; controlled atmosphere rooms; caravans and caravan parks; boating marinas

Electrical installation safety testing.

Legislated regulations: regulations; responsibilities; testing requirements

Testing installations: insulation; earthing continuity; polarity; transposition of earth and neutral; identification of circuit conductors; operation of installation; operation of RCDs

Documentation: reporting tests; minimum requirements

Electrical drawings and their interpretation.

Purpose and use of block, circuit and wiring diagrams

Use of drawing symbols and Australian Standard 1102

Electrical diagram conventions

Use and construction of switching charts

One-way, two-way and multi-position control of lighting circuits

Circuit wiring methods using sheathed cables and looping terminals

The features purpose and use of site and floor plans and details and standard drawings

Locating the position of electrical services from architectural drawings

Interpretation of wiring and schematic diagrams.

Construction and operation of relays, contactors and starters

Contact ratings of contactors

Power and control circuits

Control circuit symbols and drawing conventions

Conversion of wiring diagrams to ladder diagrams

Control circuit components and their operation

Selection of circuit components from manufacturers' catalogues

Basic control circuit wiring: push-button on-off control; remote stop-start operation; timer circuits; circuits with interlocks; jogging (inching) circuits (non-latching); press safety circuits

Fault-finding techniques

Advanced circuit design techniques: documenting circuit design; modifying circuits

Application of programmable controllers in circuit design

Drawing interpretation and sketching.

Technical drawing standards appropriate to the industry sector, conventions and specifications to AS 1100, with strong emphasis on interpretation: sheet types, title block information, materials parts list, revision table, grid referencing scales, line types – visible outlines, hidden outlines, dimensioning lines, centre lines; orthogonal projection of views – 3rd angle (detail and assembly drawings); mechanical conventions; fabrication conventions; three dimensional view drawings – axonometric, isometric, oblique; sectioning standards and conventions – whole, part; engineering drawing symbols, components and equipment – mechanical, electrical, electronic, computer, instrument, refrigeration; dimensioning – orthogonal, isometric; layout and plans; geometric tolerance interpretation (straightness, flatness, squareness, parallelism and concentricity only); engineering abbreviations; drawing interpretation techniques – detail drawings, orthogonal projection (3^{rd} angle only) and three dimensional, assembly drawings and three dimensions exploded (e.g. as in equipment manuals)

Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3^{rd} angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

Transformers.

Core construction and winding styles used in transformers

Principles of operation of single-wound and double-wound and single phase transformers

The characteristics of the four basic types of transformers

Insulation resistance, continuity, winding identification, polarity marks

Lighting.

Lighting concepts: terms and units; inverse square law; essential factors to produce visual comfort

Luminaires: types; maintenance of luminaires; use of reflectors and/or diffusers

Lamp types: incandescent, gas discharge and high voltage; characteristics, circuit connections and special features; miscellaneous lamp types; auxiliary control; light dimming; RF interference; common faults; testing of circuits; fault-finding

Special lighting situations: special requirements/rules regarding security; safety and emergency lighting; use of standards appropriate to these situations

DC machines.

DC machine principles: generated emf, lap and wave windings; control of output voltage; armature reaction; commutation; interpoles and compensating windings; back emf, torque and speed; losses and efficiency

DC machine types and connections: permanent magnet; separately excited; shunt, series, compound and series universal; reversal

DC machine characteristics and applications for shunt, series and compound: excitation/voltage; speed/voltage; load voltage/load current; torque/load current; torque/speed; speed/load current; applications

DC motor starters: starting current; concept of current limitation; calculation of resistance for limiting starting current; operation of common types of starters

Specialised DC machines: tachogenerator; servomotors; stepper motors

Programmable controllers.

Introduction to control systems: block diagram of any control system (input, process, output); methods of control (relay, static logic, programmable); introduction to PLC systems; advantages and disadvantages of PLCs; block diagram of PLC system

Basic PLC operation: definitions, terminology and block diagram; scan cycle; basic programming rules; addressing for I/O; halt; run

Programming (using a hand programmer): flowcharts/steps to use when programming; clearing memory; ladder format; Boolean/mnemonic/statement

list format; series circuits; parallel circuits; latching circuits; stack register operation; combination series/parallel circuits; inversion elements; timers (DOE); counters; monitor discrete I/O and timer/counter values; edit (insert and delete elements)

Connect discrete input and output devices to a PLC

Basic power supplies (D.C.).

Rectifier diode: P-N junction; silicon and germanium characteristics; diode specifications; terminal identification; diode ohm meter testing

Half wave rectifier: basic circuit; VAC/VDC relationship; peak inverse voltage; measurement and testing

Centre tapped full wave: basic circuit; VAC/VDC relationship; peak inverse voltage; measurement and testing

Bridge rectifier: basic circuit; VAC/VDC relationship; measurement and testing

Three phase rectifiers: half wave; full wave; waveforms; % ripple; calculations of V and I for resistive loads

Basic filter circuits: capacitor; inductive; L section; Pi section

Zener regulators: zener diode characteristics; shunt regulator circuit; regulator specifications; line/load regulation; series resistor calculations; applications

Three-terminal regulators: characteristics and specifications; connection diagram; circuit stability requirements; reverse voltage protection methods

Dual polarity supplies: need for dual polarity; basic IC dual polarity regulator

Basic power supply protection: fuses; VDR's; LCR networks

Power control systems.

Methods of power control and phase angle control

Pulsed power control: bimetal thermostat heaters; half-wave/full-wave control - duo temperature soldering irons; series resistor control – continuously variable

Power control devices, symbols and specification and in-circuit operation: operation of typical half-wave and full wave power control circuits; limitations of phase angle control and noise reduction methods; fault-finding and safety problems

Cells and batteries.

Primary cells: definition; basic composition and construction; common types; terminal voltage; typical applications; storage, handling and disposal

Secondary cells: definition; basic composition and construction; common types; terminal voltage; typical applications; storage, handling and disposal

Cell configurations: series; parallel; terminal voltage; battery capacity

Secondary batteries: charge/discharge process; charge condition monitoring; internal resistance; commissioning procedures

Storage battery banks: applications; charging methods; change over/on line methods; ventilation requirements; types of batteries; capacities; routine maintenance; handling procedures; first aid requirements

Transducers.

Types of transducers and their applications: thermistor (NTC and PTC); light dependent resistor (LDR); photo-transistor; opto-coupler; speaker –electro magnetic, dynamic, Piezzo; magnetic pick up cartridge; light emitting diode; strain gauge; hall effect device; thermocouple; Peltier effect device; Piezzo electric device; microphone

Energy supply.

Generation: definition; primary energy sources; power stations; power station output; acts and legislation relating to generation

Transmission: system requirements; principle components of a power system; voltage levels; grid systems; acts/legislation relating to transmission; future trends

Distribution: high voltage distribution systems; medium/low voltage distribution systems; radial feeders; parallel feeders; ring main feeders; acts/legislation relating to distribution

Substations: purpose; location; layout

Overhead and underground systems: relative merits; applications; planning; installation

Metering and load control.

Metering: purpose

Metered quantities: energy; maximum demand

Accuracy classes for metering systems

Kilowatt hour meter: construction; operation; adjustments; testing

Demand meter: construction; operation

Metering circuits: direct metering; instrument transformer metering

Electronic metering systems: types; applications; connections

Recording meters: types; applications; connections

Load control: purpose; methods

Specialisation: Fire protection

Electrical wiring and equipment.

Standards: purpose; standards bodies; applications

Using standards: terms; numbering systems; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Wiring requirements - high current.

Mains and submains: using AS3008.1; installation conditions; current carrying capacity; voltage drop

Final subcircuits: number of points; maximum demand; protection; installation conditions; cable selection

Control and protection: requirements; switchboard equipment (arrangement, CT metering, links, circuit protection and control, fault protection)

Hazardous areas: classifications; wiring systems; methods of explosion protection; fault protection

Special installations requirements: theatres and halls; controlled atmosphere rooms; caravans and caravan parks; boating marinas

Electrical installation safety testing.

Legislated regulations: regulations; responsibilities; testing requirements

Testing installations: insulation; earthing continuity; polarity; transposition of earth and neutral; identification of circuit conductors; operation of installation; operation of RCDs

Documentation: reporting tests; minimum requirements

Electrical drawings and their interpretation.

Purpose and use of block, circuit and wiring diagrams

Use of drawing symbols and Australian Standard 1102

Electrical diagram conventions

Use and construction of switching charts

One-way, two-way and multi-position control of lighting circuits

Circuit wiring methods using sheathed cables and looping terminals

The features purpose and use of site and floor plans and details and standard drawings

Locating the position of electrical services from architectural drawings

Interpretation of wiring and schematic diagrams.

Construction and operation of relays, contactors and starters

Contact ratings of contactors

Power and control circuits

Control circuit symbols and drawing conventions

Conversion of wiring diagrams to ladder diagrams

Control circuit components and their operation

Selection of circuit components from manufacturers' catalogues

Basic control circuit wiring: push-button on-off control; remote stop-start operation; timer circuits; circuits with interlocks; jogging (inching) circuits (non-latching); press safety circuits

Fault-finding techniques

Advanced circuit design techniques: documenting circuit design; modifying circuits

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Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3^{rd} angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

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Lighting.

Lighting concepts: terms and units; inverse square law; essential factors to produce visual comfort

Luminaires: types; maintenance of luminaires; use of reflectors and/or diffusers

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Special lighting situations: special requirements/rules regarding security; safety and emergency lighting; use of standards appropriate to these situations

DC machines.

DC machine principles: generated emf, lap and wave windings; control of output voltage; armature reaction; commutation; interpoles and compensating windings; back emf, torque and speed; losses and efficiency

DC machine types and connections: permanent magnet; separately excited; shunt, series, compound and series universal; reversal

DC machine characteristics and applications for shunt, series and compound: excitation/voltage; speed/voltage; load voltage/load current; torque/load current; torque/speed; speed/load current; applications

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Three phase rectifiers: half wave; full wave; waveforms; % ripple; calculations of V and I for resistive loads

Basic filter circuits: capacitor; inductive; L section; Pi section

Zener regulators: zener diode characteristics; shunt regulator circuit; regulator specifications; line/load regulation; series resistor calculations; applications

Three-terminal regulators: characteristics and specifications; connection diagram; circuit stability requirements; reverse voltage protection methods

Dual polarity supplies: need for dual polarity; basic IC dual polarity regulator

Basic power supply protection: fuses; VDR's; LCR networks

Power control systems.

Methods of power control and phase angle control

Pulsed power control: bimetal thermostat heaters; half-wave/full-wave control - duo temperature soldering irons; series resistor control – continuously variable

Power control devices, symbols and specification and in-circuit operation: operation of typical half-wave and full wave power control circuits; limitations of phase angle control and noise reduction methods; fault-finding and safety problems

Cells and batteries.

Primary cells: definition; basic composition and construction; common types; terminal voltage; typical applications; storage, handling and disposal

Secondary cells: definition; basic composition and construction; common types; terminal voltage; typical applications; storage, handling and disposal

Cell configurations: series; parallel; terminal voltage; battery capacity

Secondary batteries: charge/discharge process; charge condition monitoring; internal resistance; commissioning procedures

Storage battery banks: applications; charging methods; change over/on line methods; ventilation requirements; types of batteries; capacities; routine maintenance; handling procedures; first aid requirements

Transducers.

Types of transducers and their applications: thermistor (NTC and PTC); light dependent resistor (LDR); photo-transistor; opto-coupler; speaker –electro magnetic, dynamic, Piezzo; magnetic pick up cartridge; light emitting diode; strain gauge; hall effect device; thermocouple; Peltier effect device; Piezzo electric device; microphone

Building automation fire protection installation.

Purpose of automatic fire detection and alarm systems: preservation of life; protection of buildings and equipment

Standards and codes: general legislation and codes; specific legislation – Halon systems, ionisation smoke detectors; legal liability

Fire characteristics: principles of fire detection – fire growth; principles of fire suppression

Generic automatic fire detection and alarm system: overview of automatic fire detection and alarm system

Fire detection actuating devices: fire detector classification; detector patterns; detector types, principles of operation and performance; heat detectors – electro-pneumatic, fusible alloy, bimetallic, solid state, thermo-plastic; smoke detectors – ionisation, photo-electric, beam light obscuration, sampling light scatter (aspirating); flame detectors – infra-red, ultra-violet, manual call points; special purpose detectors – flammable vapour/gas detectors, explosion detectors

Control and indicating equipment (CIE): fire panels; classification; types; principles of operation; installation; commissioning report as per AS 1670

Emergency warning and intercommunication system (EWIS): purpose; types; installation; codes and requirements; manufacturers' specifications and requirements – AS3000 series, AS1670, AS2220, AS1668

Alarms: local alarms – purpose, types, installation; transmitted alarms – purpose, types, installation; control outputs – purpose, types, installation; pump control – purpose, pump actuation; codes and requirements – manufacturers' specifications, manufacturers' requirements for handling; building codes Australia – AS1668, AS1670, AS1851

Suppression systems: sprinkler systems; sequence of operation; purpose of interfacing devices; special purpose gaseous, dry chemical, foam, explosion suppression; suppression actuating devices; purpose; sequence of operation; purpose of interfacing devices; types of interfacing devices; installation of interfacing devices; purpose of actuation devices; types of actuation devices; installation of actuation devices; codes and requirements – manufacturers'

specifications, manufacturers' requirements for handling; building codes Australia – AS1670, AS1851, AS1668

Cabling: types of fire cables – mineral insulated metal sheathed cable (MIMS), radox cable, data cable, fibre optic cable; codes and requirements – manufacturers' specifications and requirements, AS3000 series, AS1670, ACA standards; installation of fire cables; detector selection – detector installation; detection systems – conventional, distributed, network; detection system installation; codes and requirements; manufacturers' specifications; manufacturers' requirements for handling; building codes Australia – AS1670, AS1851, AS3000

Specialisation: Installation and servicing

Electrical wiring and equipment.

Standards: purpose; standards bodies; applications

Using standards: terms; numbering systems; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Wiring requirements - high current.

Mains and submains: using AS3008.1; installation conditions; current carrying capacity; voltage drop

Final subcircuits: number of points; maximum demand; protection; installation conditions; cable selection

Control and protection: requirements; switchboard equipment (arrangement, CT metering, links, circuit protection and control, fault protection)

Hazardous areas: classifications; wiring systems; methods of explosion protection; fault protection

Special installations requirements: theatres and halls; controlled atmosphere rooms; caravans and caravan parks; boating marinas

Electrical installation safety testing.

Legislated regulations: regulations; responsibilities; testing requirements

Testing installations: insulation; earthing continuity; polarity; transposition of earth and neutral; identification of circuit conductors; operation of installation; operation of RCDs

Documentation: reporting tests; minimum requirements

Electrical drawings and their interpretation.

Purpose and use of block, circuit and wiring diagrams

Use of drawing symbols and Australian Standard 1102

Electrical diagram conventions

Use and construction of switching charts

One-way, two-way and multi-position control of lighting circuits

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Contact ratings of contactors

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Control circuit components and their operation

Selection of circuit components from manufacturers' catalogues

Basic control circuit wiring: push-button on-off control; remote stop-start operation; timer circuits; circuits with interlocks; jogging (inching) circuits (non-latching); press safety circuits

Fault-finding techniques

Advanced circuit design techniques: documenting circuit design; modifying circuits

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Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3rd angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

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Lighting.

Lighting concepts: terms and units; inverse square law; essential factors to produce visual comfort

Luminaires: types; maintenance of luminaires; use of reflectors and/or diffusers

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Special lighting situations: special requirements/rules regarding security; safety and emergency lighting; use of standards appropriate to these situations

DC machines.

DC machine principles: generated emf, lap and wave windings; control of output voltage; armature reaction; commutation; interpoles and compensating windings; back emf, torque and speed; losses and efficiency

DC machine types and connections: permanent magnet; separately excited; shunt, series, compound and series universal; reversal

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Three phase rectifiers: half wave; full wave; waveforms; % ripple; calculations of V and I for resistive loads

Basic filter circuits: capacitor; inductive; L section; Pi section

Zener regulators: zener diode characteristics; shunt regulator circuit; regulator specifications; line/load regulation; series resistor calculations; applications

Three-terminal regulators: characteristics and specifications; connection diagram; circuit stability requirements; reverse voltage protection methods

Dual polarity supplies: need for dual polarity; basic IC dual polarity regulator

Basic power supply protection: fuses; VDR's; LCR networks

Power control systems.

Methods of power control and phase angle control

Pulsed power control: bimetal thermostat heaters; half-wave/full-wave control - duo temperature soldering irons; series resistor control – continuously variable

Power control devices, symbols and specification and in-circuit operation: operation of typical half-wave and full wave power control circuits; limitations

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Cells and batteries.

Primary cells: definition; basic composition and construction; common types; terminal voltage; typical applications; storage, handling and disposal

Secondary cells: definition; basic composition and construction; common types; terminal voltage; typical applications; storage, handling and disposal

Cell configurations: series; parallel; terminal voltage; battery capacity

Secondary batteries: charge/discharge process; charge condition monitoring; internal resistance; commissioning procedures

Storage battery banks: applications; charging methods; change over/on line methods; ventilation requirements; types of batteries; capacities; routine maintenance; handling procedures; first aid requirements

Transducers.

Types of transducers and their applications: thermistor (NTC and PTC); light dependent resistor (LDR); photo-transistor; opto-coupler; speaker –electro magnetic, dynamic, Piezzo; magnetic pick up cartridge; light emitting diode; strain gauge; hall effect device; thermocouple; Peltier effect device; Piezzo electric device; microphone

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Substations: purpose; location; layout

Overhead and underground systems: relative merits; applications; planning; installation

Electrical heating.

Temperature: heat energy; specific heat capacity; heat transfer; thermal conductivity; electrical equivalent (kWh) of heat energy

Control of heating: manual; automatic control; electronic and other forms of heat control

Heating process: water heating; space heating; cooking; industrial process heating

Specialisation: Maritime installation

Electrical wiring and equipment.

Standards: purpose; standards bodies; applications

Using standards: terms; numbering systems; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Wiring requirements - high current.

Mains and submains: using AS3008.1; installation conditions; current carrying capacity; voltage drop

Final subcircuits: number of points; maximum demand; protection; installation conditions; cable selection

Control and protection: requirements; switchboard equipment (arrangement, CT metering, links, circuit protection and control, fault protection)

Hazardous areas: classifications; wiring systems; methods of explosion protection; fault protection

Special installations requirements: theatres and halls; controlled atmosphere rooms; caravans and caravan parks; boating marinas

Electrical installation safety testing.

Legislated regulations: regulations; responsibilities; testing requirements

Testing installations: insulation; earthing continuity; polarity; transposition of earth and neutral; identification of circuit conductors; operation of installation; operation of RCDs

Documentation: reporting tests; minimum requirements

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Marine electrotechnology.

Marine electrical layouts: main switchboard; emergency switchboard; shore supply; interconnections between them; important components and instruments; indicating lights; meters

Alternators: constructions; voltage; regulation; characteristic excitation; AVR systems

Paralleling: auto and manual synchronising and paralleling of alternators including machines of different capacities; operation of synchronising equipment

Switchboards: operation; testing and maintenance of ACB, MCCB and MCB including opening and closing systems; arcing control; procedure for removal

Marine lighting systems

Batteries: layout of ships battery system; connections; types of batteries; maintenance and safety aspects

UPS systems: operating principles; power management and fault diagnosis

Cathodic protection: types; operating parameters and corrosion factors

Safety: components; regulations and safe practices for tankers with hazardous cargoes

Management: plant performance evaluation; commissioning new systems and electrical surveys

Specialisation: Mining

Electrical wiring and equipment.

Standards: purpose; standards bodies; applications

Using standards: terms; numbering systems; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Wiring requirements - high current.

Mains and submains: using AS3008.1; installation conditions; current carrying capacity; voltage drop

Final subcircuits: number of points; maximum demand; protection; installation conditions; cable selection

Control and protection: requirements; switchboard equipment (arrangement, CT metering, links, circuit protection and control, fault protection)

Hazardous areas: classifications; wiring systems; methods of explosion protection; fault protection

Special installations requirements: theatres and halls; controlled atmosphere rooms; caravans and caravan parks; boating marinas

Electrical installation safety testing.

Legislated regulations: regulations; responsibilities; testing requirements

Testing installations: insulation; earthing continuity; polarity; transposition of earth and neutral; identification of circuit conductors; operation of installation; operation of RCDs

Documentation: reporting tests; minimum requirements

Electrical drawings and their interpretation.

Purpose and use of block, circuit and wiring diagrams

Use of drawing symbols and Australian Standard 1102

Electrical diagram conventions

Use and construction of switching charts

One-way, two-way and multi-position control of lighting circuits

Circuit wiring methods using sheathed cables and looping terminals

The features purpose and use of site and floor plans and details and standard drawings

Locating the position of electrical services from architectural drawings

Interpretation of wiring and schematic diagrams.

Construction and operation of relays, contactors and starters

Contact ratings of contactors

Power and control circuits

Control circuit symbols and drawing conventions

Conversion of wiring diagrams to ladder diagrams

Control circuit components and their operation

Selection of circuit components from manufacturers' catalogues

Basic control circuit wiring: push-button on-off control; remote stop-start operation; timer circuits; circuits with interlocks; jogging (inching) circuits (non-latching); press safety circuits

Fault-finding techniques

Advanced circuit design techniques: documenting circuit design; modifying circuits

Application of programmable controllers in circuit design

Drawing interpretation and sketching.

Technical drawing standards appropriate to the industry sector, conventions and specifications to AS 1100, with strong emphasis on interpretation: sheet types, title block information, materials parts list, revision table, grid referencing scales, line types – visible outlines, hidden outlines, dimensioning lines, centre lines; orthogonal projection of views – 3rd angle (detail and assembly drawings); mechanical conventions; fabrication conventions; three dimensional view drawings – axonometric, isometric, oblique; sectioning standards and conventions – whole, part; engineering drawing symbols, components and equipment – mechanical, electrical, electronic, computer, instrument, refrigeration; dimensioning – orthogonal, isometric; layout and plans; geometric tolerance interpretation (straightness, flatness, squareness, parallelism and concentricity only); engineering abbreviations; drawing interpretation techniques – detail drawings, orthogonal projection (3^{rd} angle only) and three dimensional, assembly drawings and three dimensions exploded (e.g. as in equipment manuals)

Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3^{rd} angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

Transformers.

Core construction and winding styles used in transformers

Principles of operation of single-wound and double-wound and single phase transformers

The characteristics of the four basic types of transformers

Insulation resistance, continuity, winding identification, polarity marks

Lighting.

Lighting concepts: terms and units; inverse square law; essential factors to produce visual comfort

Luminaires: types; maintenance of luminaires; use of reflectors and/or diffusers

Lamp types: incandescent, gas discharge and high voltage; characteristics, circuit connections and special features; miscellaneous lamp types; auxiliary control; light dimming; RF interference; common faults; testing of circuits; fault-finding

Special lighting situations: special requirements/rules regarding security; safety and emergency lighting; use of standards appropriate to these situations

DC machines.

DC machine principles: generated emf, lap and wave windings; control of output voltage; armature reaction; commutation; interpoles and compensating windings; back emf, torque and speed; losses and efficiency

DC machine types and connections: permanent magnet; separately excited; shunt, series, compound and series universal; reversal

DC machine characteristics and applications for shunt, series and compound: excitation/voltage; speed/voltage; load voltage/load current; torque/load current; torque/speed; speed/load current; applications

DC motor starters: starting current; concept of current limitation; calculation of resistance for limiting starting current; operation of common types of starters

Specialised DC machines: tachogenerator; servomotors; stepper motors

Programmable controllers.

Introduction to control systems: block diagram of any control system (input, process, output); methods of control (relay, static logic, programmable); introduction to PLC systems; advantages and disadvantages of PLCs; block diagram of PLC system

Basic PLC operation: definitions, terminology and block diagram; scan cycle; basic programming rules; addressing for I/O; halt; run

Programming (using a hand programmer): flowcharts/steps to use when programming; clearing memory; ladder format; Boolean/mnemonic/statement list format; series circuits; parallel circuits; latching circuits; stack register operation; combination series/parallel circuits; inversion elements; timers (DOE); counters; monitor discrete I/O and timer/counter values; edit (insert and delete elements)

Connect discrete input and output devices to a PLC

Basic power supplies (D.C.).

Rectifier diode: P-N junction; silicon and germanium characteristics; diode specifications; terminal identification; diode ohm meter testing

Half wave rectifier: basic circuit; VAC/VDC relationship; peak inverse voltage; measurement and testing

Centre tapped full wave: basic circuit; VAC/VDC relationship; peak inverse voltage; measurement and testing

Bridge rectifier: basic circuit; VAC/VDC relationship; measurement and testing

Three phase rectifiers: half wave; full wave; waveforms; % ripple; calculations of V and I for resistive loads

Basic filter circuits: capacitor; inductive; L section; Pi section

Zener regulators: zener diode characteristics; shunt regulator circuit; regulator specifications; line/load regulation; series resistor calculations; applications

Three-terminal regulators: characteristics and specifications; connection diagram; circuit stability requirements; reverse voltage protection methods

Dual polarity supplies: need for dual polarity; basic IC dual polarity regulator

Basic power supply protection: fuses; VDR's; LCR networks

Power control systems.

Methods of power control and phase angle control

Pulsed power control: bimetal thermostat heaters; half-wave/full-wave control - duo temperature soldering irons; series resistor control – continuously variable

Power control devices, symbols and specification and in-circuit operation: operation of typical half-wave and full wave power control circuits; limitations of phase angle control and noise reduction methods; fault-finding and safety problems

Cells and batteries.

Primary cells: definition; basic composition and construction; common types; terminal voltage; typical applications; storage, handling and disposal

Secondary cells: definition; basic composition and construction; common types; terminal voltage; typical applications; storage, handling and disposal

Cell configurations: series; parallel; terminal voltage; battery capacity

Secondary batteries: charge/discharge process; charge condition monitoring; internal resistance; commissioning procedures

Storage battery banks: applications; charging methods; change over/on line methods; ventilation requirements; types of batteries; capacities; routine maintenance; handling procedures; first aid requirements

Transducers.

Types of transducers and their applications: thermistor (NTC and PTC); light dependent resistor (LDR); photo-transistor; opto-coupler; speaker –electro magnetic, dynamic, Piezzo; magnetic pick up cartridge; light emitting diode; strain gauge; hall effect device; thermocouple; Peltier effect device; Piezzo electric device; microphone

Mining electrical systems.

Mine reticulation: trailing cables; types; connection and disconnection; handling and storage; examination and testing

Electrical control and protection

Ventilation fans: types; installation; protection requirements; electrical interlocking

Static electricity: sources and containment

Gas sensing devices: types (methane, hydrogen sulphide, oxides of nitrogen, carbon monoxide, carbon dioxide

Battery powered vehicles: drive types, control, dynamic and regenerative braking; charging

Communication and control equipment

Mines winders and haulage systems

Codes of practice and safety

Specialisation: Plant servicing

Electrical wiring and equipment.

Standards: purpose; standards bodies; applications

Using standards: terms; numbering systems; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Wiring requirements - high current.

Mains and submains: using AS3008.1; installation conditions; current carrying capacity; voltage drop

Final subcircuits: number of points; maximum demand; protection; installation conditions; cable selection

Control and protection: requirements; switchboard equipment (arrangement, CT metering, links, circuit protection and control, fault protection)

Hazardous areas: classifications; wiring systems; methods of explosion protection; fault protection

Special installations requirements: theatres and halls; controlled atmosphere rooms; caravans and caravan parks; boating marinas

Electrical installation safety testing.

Legislated regulations: regulations; responsibilities; testing requirements

Testing installations: insulation; earthing continuity; polarity; transposition of earth and neutral; identification of circuit conductors; operation of installation; operation of RCDs

Documentation: reporting tests; minimum requirements

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Fault-finding techniques

Advanced circuit design techniques: documenting circuit design; modifying circuits

Application of programmable controllers in circuit design

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Lighting concepts: terms and units; inverse square law; essential factors to produce visual comfort

Luminaires: types; maintenance of luminaires; use of reflectors and/or diffusers

Lamp types: incandescent, gas discharge and high voltage; characteristics, circuit connections and special features; miscellaneous lamp types; auxiliary control; light dimming; RF interference; common faults; testing of circuits; fault-finding

Special lighting situations: special requirements/rules regarding security; safety and emergency lighting; use of standards appropriate to these situations

DC machines.

DC machine principles: generated emf, lap and wave windings; control of output voltage; armature reaction; commutation; interpoles and compensating windings; back emf, torque and speed; losses and efficiency

DC machine types and connections: permanent magnet; separately excited; shunt, series, compound and series universal; reversal

DC machine characteristics and applications for shunt, series and compound: excitation/voltage; speed/voltage; load voltage/load current; torque/load current; torque/speed; speed/load current; applications

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Three-terminal regulators: characteristics and specifications; connection diagram; circuit stability requirements; reverse voltage protection methods

Dual polarity supplies: need for dual polarity; basic IC dual polarity regulator

Basic power supply protection: fuses; VDR's; LCR networks

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Synchronous machines.

Principles of operation: construction details; cooling; excitation methods; effect of load alternator voltage; voltage regulation; ratings; parallel operation

Portable alternators: constructional details of common types; ratings

Three-phase synchronous motors: construction details; principles of operation; effect of load; effect of varying field excitation; starting methods; applications

Single-phase synchronous motors: common types; constructional details; applications

Concepts of Instrumentation.

Flow, temperature, pressure and other appropriate measurements

Appropriate terminology: span, range, accuracy, precision, errors, zero, reputability, sensitivity, hysteresis, etc. (select from AS1541)

Development of SI units, engineering and scientific notation, imperial and metric conversion using calculations, mm Hg, mm Hg, Pa (hPa, Kpa, Mpa etc.), inches water, PSI, etc. also non-standard SI units – kgcm2, etc.

Instrumentation standards (brief overview only): ISA (Instrumentation Society of America); ISO (International Standards Organisation); SAMA (Scientific Apparatus Manufacturers America); BSI (British Standards Institution); AS (Australian Standards); ANSI (American National Standards Symbols and Terminology); Manufacturer Calibration Standards; fluids in process piping colour coding

Identification and purpose of instruments measuring processes directly and those measuring indirectly

Signal transmission of two-wire, 20-100 kPa, 4-20 mA, 1-5V, other applicable standards

Principles of levers, links and calibration of indicator recorder instrument

Application of safety standards at all times (tools, lifting techniques, electrical safety and CPR, pressure lines, housekeeping)

Interpretation of appropriate graphs and tables associated with instrumentation

Specialisation: Process

Electrical wiring and equipment.

Standards: purpose; standards bodies; applications

Using standards: terms; numbering systems; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Wiring requirements - high current.

Mains and submains: using AS3008.1; installation conditions; current carrying capacity; voltage drop

Final subcircuits: number of points; maximum demand; protection; installation conditions; cable selection

Control and protection: requirements; switchboard equipment (arrangement, CT metering, links, circuit protection and control, fault protection)

Hazardous areas: classifications; wiring systems; methods of explosion protection; fault protection

Special installations requirements: theatres and halls; controlled atmosphere rooms; caravans and caravan parks; boating marinas

Electrical installation safety testing.

Legislated regulations: regulations; responsibilities; testing requirements

Testing installations: insulation; earthing continuity; polarity; transposition of earth and neutral; identification of circuit conductors; operation of installation; operation of RCDs

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Luminaires: types; maintenance of luminaires; use of reflectors and/or diffusers

Lamp types: incandescent, gas discharge and high voltage; characteristics, circuit connections and special features; miscellaneous lamp types; auxiliary

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Principles of levers, links and calibration of indicator recorder instrument

Application of safety standards at all times (tools, lifting techniques, electrical safety and CPR, pressure lines, housekeeping)

Interpretation of appropriate graphs and tables associated with instrumentation

Pressure measurement.

Pressure, density, height, force, area units: calculation of pressure required to support liquid columns; calculation of related values of pressure, force and area

Absolute, gauge and differential pressure scales and their interrelationship: reference point for scales; atmospheric pressure value using all common measurement units

Absolute, pressure measurement devices for sub-atmosphere range and typical application of these devices

Gauge pressure measurement by means of U-tube, single limb and inclined liquid columns: calculation of wet leg effects

Gauge pressure measurement by means of elastic deformation type gauges: Bourdon types (C/spiral/helix) and ranges

Other mechanical pressure elements: bellow, capsule, slack/stiff diaphragms: pressure gauge installations: tapping points, valves (isolation and bleed), loop seals, snubbers

Pressure calibration devices: pneumatic, hydraulic, electronic

Precautions in calibrating oxygen and chlorine gauges (no oil)

Use of a dead-weight tester to calibrate pressure gauges; gauge and mechanical recorder adjustments for span, zero and linearity; backlash, hysteresis, reputability

Electrical sensors for pressure measurements: capacitive, piezo, inductive, strain gauge; calibration adjustments for pneumatic and electrical type pressure measurement and signal transmission devices

Installation requirements for pressure measurement in liquid and gas systems, with and without sealing liquid; isolation, seal, vent, drain and bypass valves location and operation sequence

Temperature measurement.

Heat and temperature: Differentiation between heat and temperature, SI and non-SI temperature scales and units and conversions between scales

Non-electrical thermometers: the principles of operations characteristics and construction of liquid-in-gas, bi-metallic and filled system thermometers

Electrical thermometers: the laws and effects associated with electrical temperature primary elements; the principles of operations, characteristics and construction of thermometers, resistance thermometers (RTDs), thermistors, and semi-conductor and integrated circuit thermometers; compensation and protection devices and associated measuring circuits; circuit connections for average temperature and temperature differences should be able to be examined regarding installation and measuring circuit consideration which vary from the norm

Radiation thermometers: the laws governing radiation thermometers and the properties of a 'black body'; the theory of operation, characteristics and construction of disappearing filament, partial radiation and total thermometers; total and spectral emissivity

Other measurement techniques: the operation and characteristics of pyrometric cones, temperature sensitive pigments and liquid crystals (brief mention only)

Test equipment: the theory of operation, operation and use of Wheatstone bridges, millivolt potentiometers and other test equipment associated with temperature measurement

Errors: the errors specific to temperature measurement - these include thermal lag, fabrication heating conductive cooling and cavitation

Specialisation: Security

Electrical wiring and equipment.

Standards: purpose; standards bodies; applications

Using standards: terms; numbering systems; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Wiring requirements - high current.

Mains and submains: using AS3008.1; installation conditions; current carrying capacity; voltage drop

Final subcircuits: number of points; maximum demand; protection; installation conditions; cable selection

Control and protection: requirements; switchboard equipment (arrangement, CT metering, links, circuit protection and control, fault protection)

Hazardous areas: classifications; wiring systems; methods of explosion protection; fault protection

Special installations requirements: theatres and halls; controlled atmosphere rooms; caravans and caravan parks; boating marinas

Electrical installation safety testing.

Legislated regulations: regulations; responsibilities; testing requirements

Testing installations: insulation; earthing continuity; polarity; transposition of earth and neutral; identification of circuit conductors; operation of installation; operation of RCDs

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Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3^{rd} angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

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Programmable controllers.

Introduction to control systems: block diagram of any control system (input, process, output); methods of control (relay, static logic, programmable); introduction to PLC systems; advantages and disadvantages of PLCs; block diagram of PLC system

Basic PLC operation: definitions, terminology and block diagram; scan cycle; basic programming rules; addressing for I/O; halt; run

Programming (using a hand programmer): flowcharts/steps to use when programming; clearing memory; ladder format; Boolean/mnemonic/statement list format; series circuits; parallel circuits; latching circuits; stack register operation; combination series/parallel circuits; inversion elements; timers (DOE); counters; monitor discrete I/O and timer/counter values; edit (insert and delete elements)

Connect discrete input and output devices to a PLC

Basic power supplies (D.C.).

Rectifier diode: P-N junction; silicon and germanium characteristics; diode specifications; terminal identification; diode ohm meter testing

Half wave rectifier: basic circuit; VAC/VDC relationship; peak inverse voltage; measurement and testing

Centre tapped full wave: basic circuit; VAC/VDC relationship; peak inverse voltage; measurement and testing

Bridge rectifier: basic circuit; VAC/VDC relationship; measurement and testing

Three phase rectifiers: half wave; full wave; waveforms; % ripple; calculations of V and I for resistive loads

Basic filter circuits: capacitor; inductive; L section; Pi section

Zener regulators: zener diode characteristics; shunt regulator circuit; regulator specifications; line/load regulation; series resistor calculations; applications

Three-terminal regulators: characteristics and specifications; connection diagram; circuit stability requirements; reverse voltage protection methods

Dual polarity supplies: need for dual polarity; basic IC dual polarity regulator

Basic power supply protection: fuses; VDR's; LCR networks

Transducers.

Types of transducers and their applications: thermistor (NTC and PTC); light dependent resistor (LDR); photo-transistor; opto-coupler; speaker –electro magnetic, dynamic, Piezzo; magnetic pick up cartridge; light emitting diode; strain gauge; hall effect device; thermocouple; Peltier effect device; Piezzo electric device; microphone

Security systems.

Regulations applicable to the security industry

Design of domestic security system

Building construction

Mechanical detectors: pressure pads; trip wires; window tape; screens; switches; vibration

Electro-mechanical detectors: ultra sonic; microwave; glass break; smoke; active infra-red beams; passive infra red; strain system; electromagnetic; optical fibre cable

Batteries: types; applications; maintenance

Relays: types; applications

Security panels

Communication systems

Close circuit television (CCTV)

Locking devices

Lighting

Specialisation: Signalling (rail)

Electrical wiring and equipment.

Standards: purpose; standards bodies; applications

Using standards: terms; numbering systems; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Wiring requirements - high current.

Mains and submains: using AS3008.1; installation conditions; current carrying capacity; voltage drop

Final subcircuits: number of points; maximum demand; protection; installation conditions; cable selection

Control and protection: requirements; switchboard equipment (arrangement, CT metering, links, circuit protection and control, fault protection)

Hazardous areas: classifications; wiring systems; methods of explosion protection; fault protection

Special installations requirements: theatres and halls; controlled atmosphere rooms; caravans and caravan parks; boating marinas

Electrical installation safety testing.

Legislated regulations: regulations; responsibilities; testing requirements

Testing installations: insulation; earthing continuity; polarity; transposition of earth and neutral; identification of circuit conductors; operation of installation; operation of RCDs

Documentation: reporting tests; minimum requirements

Electrical drawings and their interpretation.

Purpose and use of block, circuit and wiring diagrams

Use of drawing symbols and Australian Standard 1102

Electrical diagram conventions

Use and construction of switching charts

One-way, two-way and multi-position control of lighting circuits

Circuit wiring methods using sheathed cables and looping terminals

The features purpose and use of site and floor plans and details and standard drawings

Locating the position of electrical services from architectural drawings

Interpretation of wiring and schematic diagrams.

Construction and operation of relays, contactors and starters

Contact ratings of contactors

Power and control circuits

Control circuit symbols and drawing conventions

Conversion of wiring diagrams to ladder diagrams

Control circuit components and their operation

Selection of circuit components from manufacturers' catalogues

Basic control circuit wiring: push-button on-off control; remote stop-start operation; timer circuits; circuits with interlocks; jogging (inching) circuits (non-latching); press safety circuits

Fault-finding techniques

Advanced circuit design techniques: documenting circuit design; modifying circuits

Application of programmable controllers in circuit design

Drawing interpretation and sketching.

Technical drawing standards appropriate to the industry sector, conventions and specifications to AS 1100, with strong emphasis on interpretation: sheet types, title block information, materials parts list, revision table, grid referencing scales, line types – visible outlines, hidden outlines, dimensioning lines, centre lines; orthogonal projection of views – 3rd angle (detail and assembly drawings); mechanical conventions; fabrication conventions; three dimensional view drawings – axonometric, isometric, oblique; sectioning standards and conventions – whole, part; engineering drawing symbols, components and equipment – mechanical, electrical, electronic, computer, instrument, refrigeration; dimensioning – orthogonal, isometric; layout and plans; geometric tolerance interpretation (straightness, flatness, squareness, parallelism and concentricity only); engineering abbreviations; drawing interpretation techniques – detail drawings, orthogonal projection (3^{rd} angle only) and three dimensional, assembly drawings and three dimensions exploded (e.g. as in equipment manuals)

Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3^{rd} angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

Transformers.

Core construction and winding styles used in transformers

Principles of operation of single-wound and double-wound and single phase transformers

The characteristics of the four basic types of transformers

Insulation resistance, continuity, winding identification, polarity marks

Lighting.

Lighting concepts: terms and units; inverse square law; essential factors to produce visual comfort

Luminaires: types; maintenance of luminaires; use of reflectors and/or diffusers

Lamp types: incandescent, gas discharge and high voltage; characteristics, circuit connections and special features; miscellaneous lamp types; auxiliary control; light dimming; RF interference; common faults; testing of circuits; fault-finding

Special lighting situations: special requirements/rules regarding security; safety and emergency lighting; use of standards appropriate to these situations

DC machines.

DC machine principles: generated emf, lap and wave windings; control of output voltage; armature reaction; commutation; interpoles and compensating windings; back emf, torque and speed; losses and efficiency

DC machine types and connections: permanent magnet; separately excited; shunt, series, compound and series universal; reversal

DC machine characteristics and applications for shunt, series and compound: excitation/voltage; speed/voltage; load voltage/load current; torque/load current; torque/speed; speed/load current; applications

DC motor starters: starting current; concept of current limitation; calculation of resistance for limiting starting current; operation of common types of starters

Specialised DC machines: tachogenerator; servomotors; stepper motors

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Rail signal systems.

Need for rail signal systems, overall layout of systems, codes and requirements

Input devices and output devices interlocks, circuits, wiring systems used earthing of system components, protection of systems wiring and components

Category: Electronics (C)

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials, types, applications; techniques, marking out, cutting, bending, drilling/punching, soldering, cutting mitres

Assembly/disassembly techniques

Electrical theory.

Fundamental and derived units: basic units; SI derived units; multiples and sub-multiples

Power, work and energy: conservation of energy; torque; losses and efficiency; maximum efficiency of machines

Electrical characteristics of materials: conductors, insulators, semi-conductors; electric charge; electric current; electromotive force

The simple circuit: source, load, current path and control; open-circuit; short-circuit

Resistance: Ohm's law; determine V, I, R; power dissipation

Effects of current: physiological effects; principles of protection from physiological effects; conversion of electrical energy to other forms (heating,

light, magnetic, chemical)Sources of electrical energy - conversion of other forms to electrical energy

Using measuring instruments: handling measuring instruments; selecting an instrument; setting-up and connecting into circuits; reading scales and read-outs; setting up a CRO

Factors effecting resistance: length, csa and resistivity; temperature change; influence on practical circuits

Resistors: types and applications; value and rating

Series circuits (single source): determine V, I, R, P; Kirchhoff's Voltage Law; voltage dividerParallel circuits: determine V, I, R, P; Kirchhoff's Current Law; current divider

Series/parallel circuits: determine V, I, R, P; bridge networkResistance measurement: hazards; characteristics of instruments and loading effect; direct, volt-ammeter and bridge method; typical field instruments and applications

Capacitance: concept; units; time constant relationshipCapacitors: hazards; factors effecting capacitance; in series; in parallel; measuring/testing/hazards

Inductance: concept; units; time constant relationship

Inductors: factors effecting inductance

Single phase AC principles.

Sinusoidal alternating voltage and current: generation of a sinusoidal waveform; sinusoidal waveform characteristics; measuring and calculating values; phase relationships

Phasors: phase relationship terms; phasor representation conventions; phase relationships using phasors

Resistance in A.C. circuits: determine V, I, R, P; relationship between voltages and currents

Inductance in A.C. circuits: reactance; inductance in series; inductance in parallel; inductive components in power circuits and systems

Capacitance in A.C. circuits: reactance; capacitance in series; capacitance in parallel; capacitive components in power circuits and systems

AC circuits: impedance; relationship between resistive and reactive components; series, parallel and series-parallel RLC circuits; determine V, I, R, P in RLC circuits; phasor diagrams of RLC circuits

Resonance: conditions; resonance and frequency; effects on current

Ideal transformer: operating principles; primary and secondary voltage and current; applications

Wiring techniques.

Electrical/electronic safety testing: isolation; testing; tagging; earthing; appliance electrical safety testing

Standards pertinent to industry sector: purpose; standards bodies; applications

Cables: types, power, signal; terms; colour coding; structure; identification cables; cable applications

Wiring systems: wiring looms; enclosures and supports; selecting wiring systems

Connectors and terminations: requirements; connectors, types and applications, assembly/disassembly; terminating conductors, extension cords

Accessories and fixings appropriate to industry sector: applications; fixing devices and methods

Digital electronics.

Analogue and digital signal definition

Digital combinational circuit operation: binary numbering up to four variables; truth tables; Boolean representation; simplification of Boolean expressions; circuit implementation from Boolean expressions; logic probe/pulser usage for fault-finding

Hexadecimal, binary and decimal number systems and BCD code: hexadecimal numbering system and its BCD representation (up to two digits); binary to decimal conversion (16 bits max.); binary to hexadecimal conversion (16 bits max.); decimal to hexadecimal conversion (four hex digits max.); representation of alphanumeric characters using 7 BIT ASCII code

Electrostatic discharge precautions: effect of ESD; handling components; wrist straps, protective mats, anti-static bags examples of design using ESD techniques

Operation and characteristics of displays: LED displays; types; calculating current limiting resistors; LCD displays – types; drive requirements

Analysis of digital sub-systems – timing diagrams (decoders): operation - discrete components, 2 line; practical MSI devices and applications -2 line and 3 line devices; seven segment display decoder -binary and BCD; priority encoders; multiplexers – operation -discrete component, 2 line; truth table implementation using MSI devices up to eight inputs – folding not required; demultiplexers – operation -discrete component, 2 line input; practical MSI devices

Digital sub-systems examples using up to four MSI devices e.g. keyboards/display, data transfer – timing diagrams/data sheet usage to be emphasised: flop-flop operation – discrete and MSI, SR, D and JK; level and edge triggered flip-flops, synchronous and asynchronous inputs, flip-flop applications based on MSI devices for shift registers – serial and parallel loading and output, shift left, shift right; counters – based on D and JK flop-flops to a maximum of four states, ripple and counters synchronous; modulus counters, up/down counters, limitations on count speed, IC counters (MSI devices) –

presentable counters (up/down), cascading counters (include BCD applications), ring counters – advantages and types; astable and monostable multivibrators

Logic device terminal characteristics: logic levels, supply voltages; power dissipation; input/output drive currents and voltage levels; loading calculations; propagation delays; noise margins; switching speed limitations and speed/power product; open collector/drain outputs; tristate logic and buffers; interfacing of different logic families (include the use of pull-up, pull-down resistors); Schmitt trigger device input output; characteristics

Electronic hand soldering.

Quality concepts: introduction to electrical connections including mechanical, chemical and thermal; concepts of reliability, quality and process control

Preparation of printed circuit boards: assembly tools and equipment used; soldering tools and equipment; maintenance of soldering irons and tips; materials including solder and alloys, thermal bonding and metallurgical properties; flux types, resin flux and properties; cleaning materials (chemical and other); component types, identification and handling techniques; printed circuit board materials including the characteristics of copper cladded boards; visual inspection of printed circuit board assemblies prior to soldering; contamination of materials; standards and testing of cleanliness

Component mounting considerations: lead bending and stress relief of components; mounting of resistors, capacitors, diodes, transistors, integrated circuits and a selection of terminals; component lead termination methods, e.g. fully clinched, semi-clinched and unclinched (rigid lead)

Component mounting and soldering - principles of soft soldering: heat transfer, minimum and maximum heat loads for components and board materials, thermal shock and coefficient of expansion; filleting and heat bridging

Wetting, de-wetting and non-wetting: metallurgical bonding and the formation of inter metallic alloys

Manual soldering of bare copper and plated single and double-sided printed circuit boards (include consideration of layer interconnection using rivets, or through cladding)

Joint validation by visual inspection criteria and common joint non-conformances associated with single and double-sided printed circuit boards; the solder rework of single and double-sided printed circuit boards

Preparation of single and multi-strand insulated wire for lead termination

Terminating coaxial cable

Preparation and termination of coaxial cable by crimped and soldered connection

Reworking soldered connections: soldering of insulated wire to printed circuit board pads and pins; pierced, hooked and cup terminals

Effects and prevention of electrostatic discharge (ESD) and its effects on static sensitive components; precautions in the handling and use of static sensitive

components and the materials and techniques available to set up a static-free environment

Digital subsystems.

Digital to analogue conversion: typical applications; DA performance characteristics; types – summing type DA converter; R2R ladder DA converter

Analogue to digital conversion: typical applications; AD performance characteristics; types – digital ramp AD converter, successive approximation AD converter, dual slope AD converter, simultaneous (flash) AD converter

Advanced interfacing techniques: logic interface circuits; driving a load (sink and source) from a logic circuit; transistor switches; relays; opto input and output isolation, driver ICs; sensor interfacing

Programmable array devices: applications; types – PLA (programmable logic array), PAL (programmable array logic), PEEL (programmable electrically erasable logic); circuit operation; programming requirements

Resonance, filters and oscillators.

Frequency selective networks: low pass, high pass, band pass, band stop; symbols; resistor capacitor low pass and high pass networks; resistor inductor low pass and high pass networks; inductor capacitor networks; introduction to resonance; parallel L.C. networks; series L.C. networks; bandwidth, 'Q" factor, effective series and parallel resistance; impedance of series and parallel L.C. networks

Repetitive complex waveforms: definition of fundamental and harmonic; simple frequency analysis – square wave, triangular wave etc; effect of a high pass, low pass and band pass filter on complex wave; forms

Introduction to feedback: positive – definition, applications; negative – definition, applications

Oscillators: definition; application; types

Sine wave oscillators: barkhausen for sine wave oscillation; types – colpitts, clapp, hartley, crystal (single mode operation only); basic circuit diagram; relaxation

Communications fundamentals.

Basic communication systems: time and frequency – domain waveforms; modulation; baseband signal vs bandwidth; electromagnetic wave characteristics/spectrum; wavelength; commercial radio frequency spectrum users

Antennas and electromagnetic wave propagation characteristics: horizontal half wave antenna; vertical half and quarter wave antennae; polarisation; radiation patterns; EM wave propagation at MF, HF, VHF/UHF; polarisation

Modulation systems and requirements: double sideband full carrier amplitude modulation; single sideband suppressed carrier modulation; vestigial sideband modulation; frequency modulation; phase modulation

Amplitude modulation and demodulation: carrier power; sideband power; total power; bandwidth; modulation index; overmodulation; diode detector

Frequency modulation and demodulation: frequency deviation; modulation index; bandwidth; pre-emphasis and de-emphasis; phase modulation; frequency domain diagrams; frequency modulation detectors; limiter amplifier

Single conversion superheterodyne receivers: the TRF receiver; selectivity; sensitivity; AM superheterodyne receiver; frequencies within the AM receivers; superheterodyne advantages; image frequencies; FM superheterodyne receiver; frequencies within common IF frequencies; mixer input and output signals; measurement of sensitivity, selectivity and image rejection; relationships between fr, fo and fif

Receiver specialist circuits: simple AGC; delayed AGC; RF and audio derived AGC; limiter amplifiers; noise blankers; AFC; mute; squelch; RD and IF amplifiers; filters and bandwidth

Amplifier applications.

Coupling methods in multistage amplifiers: capacitance; transformer; direct; characteristics of each method; frequency response; stage gain

Negative feedback: voltage shunt feedback; voltage series feedback; current shunt feedback; current series feedback; effect of feedback on gain, bandwidth, distortion input/output resistance

Power amplifier principles: classes of amplification; conduction angle; efficiency

Transformer coupled power amplifiers: circuit schematics; class A; class B; reflected resistance; efficiency; bias requirements; thermal stability

Complimentary symmetry power amplifiers: quasi complimentary; circuit schematics; class B; class AB; efficiency; bias requirements; cross over distortion; thermal stability; DC balance

Specialisation: Communication - broadcast

Antennae installation and servicing.

Electro-magnetic waves, wavelength, reflection, refraction, diffraction, polarisation

Antennae: radiation and reception; electro-magnetic wave transmission including the induction and radiated fields

Use of manufacturers' data to select suitable antennae

Use of field strength meters

Optimum antennae placement

Minimising interference

Installation methods

Application of masthead amplifiers: distribution amplifier; splitters; termination

Modulation.

Multiplexing: time division multiplexing (TDM); frequency division multiplexing (FDM)

Specialised multiplexing: quadrature modulation (QUAM); compatible quadrature multiplexing (CQUAM); FM stereo multiplexing

Digital modulation: sampling theorem – bandwidth, filtering requirements; pulse code modulation (PCM); pulse width modulation (PWM); delta modulation; quantising noise; companding; aliasing

Spread spectrum techniques

Receivers.

Receiver block diagrams: single conversion image reception problems; FM dual conversion receiver; SSBSC receiver

RF amplifiers: purpose; BJTs as RF amplifiers; FETs as RF amplifiers; input and output coupling

Mixer stages: requirements; mixing techniques; noise figure and conversion gain; local oscillator injection; calculation of first order mixer output frequencies

Intermediate frequency (IF) amplifiers: choice of IF; input and output coupling; filters; limiter requirement with FM; limiter operation concepts; limiter performance

Demodulation: AM; FM

AGC systems: need for AGC; AGC in FM receivers; AGC for DSBSC receivers

Phase locked loops (PLL): PLL basics; loop frequency response and bandwidth; frequency synthesis basics

Transmitters.

DSBFC transmitters: operation; tuning and adjustment; testing

SSBSC transmitters: operation; tuning and adjustment; testing

Transmission lines and antennae.

Time domain reflectometry measurements: function of a transmission line; balanced and unbalanced lines; lumped constant model of a transmission line; velocity factor; surge impedance; characteristics impedance Z of a transmission line

Radio frequency characteristic of transmission lines: voltage and current distribution along a transmission line; SWR and VSWR; SWR bridge; slotted line

Losses in transmission lines: radiation loss; resistance loss; dielectric loss; relationship of losses to operating frequency

Radiation characteristics of antennae: E and H field directions in relation to the driven element the E as the reference field (polarisation); Hertz and Marconi antenna polar patterns; isotropic radiator as a reference; radiation efficiency; antenna gain

Directional antennae: Yagi-Uda parasitic array; broadside array; phrasing elements; log-periodic antenna; collinear antennae; non-resonant antennae

Antenna matching: resistance-reactance model of a shortened antenna; resistance-reactance model of whips and centre fed; matching antennae; loading components; baluns; quarter wave transformers; stub matching

UHF and microwave antennae – satellite and terrestrial: circular polarisation; helix antennae; parabolic dishes – horn feed and Cassegrain feed; gain of parabolic dish antennae

Specialisation: Communications - microwave

Introduction to microwave communications.

Microwave components: effects of stray and inherent inductance and capacitance; passive devices (chip components); PCB; printed components

Active devices: diodes (PIN, gunn, impatt, tunnel, step-recovery); transistors (bipolar, GaAs Fet, HEMT, MMIC); valves (triodes and tetrodes, magnetrons, TWT, klystrons); other devices (DRO, YIG, circulator, isolator, cavity resonator); safety practices

Transmission lines: coaxial cable (rigid, semi-rigid hardline, flexible); connectors (N type, TNC, SMA, B, C); waveguide (modes, coupling, bends and tees, attenuators and termination, directional couplers); microstrip and stripline; antennae

Propagation: free space and atmospheric losses; refraction; reflections; knife-edge diffraction; near-field absorption; satellite communications; linear, circular and cross polarisation

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Microwave devices.

Safety; microwave valve theory; magnetrons; klystrons; focussing coils (permanent and electromagnetic); gunn diodes; tunnel diodes; cross field amplifiers; travelling wave tube amplifier; solid state amplifier; local oscillator/reflex klystron; mixer stages; balanced mixers (magic Ts)

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Specialisation: Entertainment – audio - analogue

Sound and acoustics.

Theory of sound wave propagation: refraction; compression; frequency; wavelength; velocity of sound wave in air and other mediums

Sound: fundamental frequency; pitch; loudness; timbre; harmonic frequency; complex wave; decade; octave

Effect of the medium of sound waves: reflection; diffraction; refraction; echoes; attenuation

Characteristics of the human ear: basic autonomy; sensitivity of human ear; in signa; pressure level; interpret equal loudness contours curves

Mono and stereo sound: speaker phasing; echo and reverberation; methods of modifying reverberation time; causes and cures for acoustic feedback; effect of different sound delays in multiple speaker systems

Audio electronics.

Analysis of audio amplifier circuits: pre amplifiers; RIAA equalisation; passive and active tone control circuits; loudness circuits; power amplifiers integrated and discrete; DC stabilisation circuits; output current overload protection circuits; output DC protection circuits; negative feedback

Adjustment of power output stage bias

Definition and testing of: output power; damping factor; signal to noise ratio; stereo separation; distortion harmonic and intermodulation; frequency response and phase distortion; slew rate; transient response; tone control response; loudness control response

Location of faults in audio amplifiers: replacement of components; component data; circuit analysis and component location

Interpretation of specification for various equipment

Professional audio electronics.

Sketched plan and elevation drawings of the physical layout of auditorium audio system

Audio systems interfaces: balanced lines; phantom power for microphones; cables and connectors; patch panels; grounding and earthing techniques in complex systems

Architecture, gain structure, and block diagram and circuits of a multi channel mixing desk

Monitoring of audio signal levels by VU; definition of VU and standard levels for signals

Purpose, specification, and block diagrams of signal processing units: noise gates; compressors; limiters; graphic equalisers; parametric equalisers; active crossovers; power amplifiers using 100v/70v lines

Diagnosis and fault-finding techniques

AM and FM tuners.

Superheterodyne receiver concepts: circuit diagrams

Comparison of AM and FM: definition of terms; electromagnetic radiation

Signal requirements for AM reception: aerials; interference; mobile operation

Stereo FM reception: aerials; interference; mobile operation

Types of cables – balun

Frequency modulation and demodulation: pre and de emphasis; FM stereo encoding and decoding techniques; frequency distribution of encoded stereo signal; FM type stereo decoder

Principles of amplitude modulation and demodulation

Fault-finding

Tape recorders – audio.

Magnetic recording principles: magnetic materials – hard and soft – recording applications; use of magnetic tape – emulsions, backing storage, print-through; replay, record and erase heads; tape transport systems

Components and circuitry: single transport systems, speed stability; bias and erasure; cross talk, equalisation, head wear, multi-purpose vs dedicated heads, adjustments points; Dolby B noise reduction; dual tape systems

Tape transport fault-finding: mechanical components; electrical component involved in tape movement; component adjustment, removal, replacement and realignment

Heads: phasing vs frequency; frequency response vs tape speed; maximum output level vs tape speed; head contact, 'squealing'; head gap – compromise vs optimise – headwear, oxide build up

Audio path electronics: replay – noise and distortion, high frequency (HF) and low frequency (LF) equalisation; record head impedance, bias filters and traps, equalisation, input levels, record levels; signal level indication (meters)

Erase and bias: DC vs AC; bulk erasure; inadvertent erasure; erase bias oscillators, effect of waveform on noise and inter-modulation (IM) products; bias vs maximum output level dynamic range vs tape type/brand bias adjustment

Noise management: maximum output level dynamic range vs tape type/brand; Dolby B, S, C and dBx; noise system testing and alignment

Loud speakers and microphones.

Permanent magnet loudspeaker: construction and componentry

Infinite baffle: bass reflex; damping factor; woofer; mid range; tweeter; frequency response; efficiency

Crossover networks: CR low pass, high pass, and band pass filters; LR low pass, high pass and band pass filters; LCR filters; power dissipation

Sound wave reflection and absorption: furnishings and room shape; graphic equalisation; principles of surround sound (speaker phasing); speaker layouts in a domestic installations (simple stereo; surround sound and bass presence speaker; ideal listening positions); speaker layouts in professional installations (movie theatres; pop music concerts; live theatre; public address)

Microphones: types use for both domestic and professional applications; construction; principles of operation; principle of FM radio microphone; care and repair of microphones including the methods of lead connection and retention; set up of microphones for use in public address (public address applications –balanced lines, theatre applications, popular music concerts); use of graphic equalisation to minimise feedback effects

Fault-finding

Specialisation: Data communications

Organisation of resources.

Supply and storage of equipment and material; 3rd party supply; specifications; labour resources; standard installation times; required skill levels; site access and safety; safety measures for installation team; safety measures for customer; security considerations; liaising with 3rd parties; equipment supply; network facilities; cutover requirements; regulating bodies; organising cutover; acceptance trials

Computer awareness.

Describing software in common use including word processor, spreadsheet, accounting, database and communications software; computer system components; system and application software; computer system care and maintenance; loading and exiting from software; backup and restore procedures; viruses and anti-virus practices; computer terminology; commands to create, save and modify a word processed document; using the on-line help and software manuals for word processing; terms associated with single table databases; creating, saving and retrieving a single table database; modifying data in an existing database; querying a single database with at most two arguments; using on-line help and manuals for database; terminology associated with spreadsheets; entering labels and values; using simple formulas for summing and averaging; using on-line help and manuals for spreadsheets; previewing and printing spreadsheets; editing existing spreadsheets

Advanced communications.

The telecommunications system, its elements and the categories of information sources; frequency and wavelength; time and frequency domains; categories of transmission media; bands of frequencies; the concept of modulation and its application to the above media; the digital and analogue signal; multiplexing – a comparison of TDM and FDM; noise and interference; signal power in a communication system; the relationship of signal to noise and its effects of communication systems; estimating bandwidth requirements for various signals; key parameters effecting signal quality; "echo" in transmission systems; impedance mismatch; controlling system parameters; power ratio to Db, signal level and signal to noise ratio in systems; modulation and demodulation; practical transmitters and receivers; digital communications; practical digital systems

Installation for configuration for CPE.

Installation preparation and execution processes; communication skills; CPE system facilities; public switching network facilities; CPE equipment and system types available; practical/physical installation cabling and restrictions; cable preparation; importance of capacitances, versions and issues of system types; structure of CPE and external/add-on items such as voicemail and call accounting devices; importance of system specifications and limitations; estimating using "average installation times; standard items used in general installation; variables which affect installation; consequences of interrupting customer communication services; site restoration processes after CPE installation; administrative processes after CPE installation and site records; processes for the disposal of recovered material; minor installation and alteration key systems using system manuals; minor installation and alterations on PABX's using system manuals; interface cabling on key systems using system manuals; interface cabling on PABX's using system manuals; outline of radio-based CPE; outline of CPE cutover processes and procedures; installation warranty, manufacturer warranty, maintenance contracts and agreements; reasons for customer training; assessing appropriate customer training

Principles of CPE.

CPE equipment overview: types; differences; advantages

CPE test systems: types; facilities; operations; night service; programming procedures; remote diagnostics and maintenance

CPE cabling overview: PSTN vs ISDN; cabling differences in PABX and keysystems; least-coast-routing; ancillary equipment

Terminating and distributing: types of distribution points; terminating types; using systems manuals

CPE facilities overview: fail safe devices; call management; accounting

Safety

Recording requirements.

The nature and purpose of reports; selection of relevant information; organisation of information; summarising information; note taking awareness of the reader; structure of reports; appropriate language; planning; writing; editing

Network operations and facilities.

Switching systems within the network: PSTN (public switched telephone network); ISDN (integrated services digital network); mobiles; IN (intelligent network)

Network customer facilities: PSTN services; ISDN services

Network business services: analogy of PABX to business group; business group concept

Network testing and supervision facilities: command testing; command controlled test calls; test blocking; call path tracing; traffic supervision; blocking supervision; load supervision

Switching principles.

Switching principles: analogue; digital; information signals; line signals

Types of switching centres: electromechanical; processor controlled

Switching centre facilities

Switching centre block diagram and functions of the parts: AXE; S12

Supervisory tones

Connections: MDF; DDF

Testing of customer lines

Specialisation: Entertainment - audio - digital

Sound and acoustics.

Theory of sound wave propagation: refraction; compression; frequency; wavelength; velocity of sound wave in air and other mediums

Sound: fundamental frequency; pitch; loudness; timbre; harmonic frequency; complex wave; decade; octave

Effect of the medium of sound waves: reflection; diffraction; refraction; echoes; attenuation

Characteristics of the human ear: basic autonomy; sensitivity of human ear; in signa; pressure level; interpret equal loudness contours curves

Mono and stereo sound: speaker phasing; echo and reverberation; methods of modifying reverberation time; causes and cures for acoustic feedback; effect of different sound delays in multiple speaker systems

Audio electronics.

Analysis of audio amplifier circuits: pre amplifiers; RIAA equalisation; passive and active tone control circuits; loudness circuits; power amplifiers integrated and discrete; DC stabilisation circuits; output current overload protection circuits; output DC protection circuits; negative feedback

Adjustment of power output stage bias

Definition and testing of: output power; damping factor; signal to noise ratio; stereo separation; distortion harmonic and intermodulation; frequency response and phase distortion; slew rate; transient response; tone control response; loudness control response

Location of faults in audio amplifiers: replacement of components; component data; circuit analysis and component location

Interpretation of specification for various equipment

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Fault-finding

Compact disc players.

Introduction: overview of audio compact disc player standards; block diagram

System control (SYSCON): description of operation; flowcharts

Principles of optics: compact disc applications; types of laser optical units

Principles of control loops: block diagram; terminology; focus servo loop; spindle motor servo loop; radial tracking servo loop

Ancillary circuits: internal DC power supplies; remote control; subcode output; headphone output; keyboard input; display

Digital audio fundamentals.

Digital audio system: basic encoder block diagram, basic decoder block diagram

Digital signal processing – encoder: sampling theorem; A/D conversion; error correction, CIRC encoding, cross interleaving, control and parity; modulation, non return to zero inverted (NRZI), eight to fourteen (EFM)

Digital signal processing – decoder: EFM demodulation; de-interleaving; error correction; sample and hold; oversampling/digital filtering; low pass filters

Digital audio tape recorders.

Rotary head digital audio tape system (R-DAT): R-DAT and VCR (VHS system); drum mechanism and tape wrap; record erase/erase heads; cassette tape cartridge

Basic DAT specifications: tape format–rec/pb and pre-recorded, options; sampling frequency; quantisation bit number; transmission rate; subcode capacity; modulation system; error correction system; tracking system; drum rotations (rpm); tape specifications; head azimuth angle

Azimuth recording and modulation system: cross talk; overwrite (erasure); 8-10 modulation

Revision (if required); pulse code modulation; quantisation; reed solomon error correction

Signal format and processing: track format – 16 signal areas; PCM block format; sub-code block format; RF signal waveshape; sync signal system; time axis compression and expansion; error correction; signal processing circuitry (typical LSI's)

System control: microcomputer; data bus; reel; mechanism; level; remote

Servo control systems: servo control systems in play, fast forward and reverse modes; drum servo; FG and PF pulses; capstan servo; operation during record and playback; automatic track finding (ATF); reel servo; forward reverse operation; circuit diagrams, LSI chips; speed adjustment

Specialisation: Entertainment - electronic appliances

Microwave appliances.

Basic oven fundamentals: microwave cooking basics; properties of microwaves; biological effects of microwaves; fundamental microwave oven operation; safety considerations

Microwave oven performance: radiation leakage; power output measurement; oven leakage safety system; magnetron tests and measurements; interlocks; thermal cut outs and thermostats; stirrer cooling and turntable systems

Power control systems: high/low power selection; duty cycle control systems

"Auto-cook" facilities: temperature control cooking systems; humidity sensor cooking systems; infra red sensor cooking systems; convection microwave oven system

Control systems: basic block diagram; functions of each block; initialisation; pulse oscillator circuits; door signal check; keyboard and input matrix; buzzers and displays

Introduction to television.

Broadcast TV system: transmitter; camera; receiver; propagation; channel allocation – RF bandwidth, carrier frequencies

Australian standards: VHF; UHF; IF

Transmitter: block diagram of a current television transmitter showing – video and sound signal inputs, modulation – one line of video, vestigial sideband filter and PA (basic sync only); negative vestigial sideband modulation of video signal; frequency modulation of sound signal; monochrome step test pattern and modulation levels; grey scale test waveforms – system input, system output, signal waveform, percentage modulation

Camera: scanning principles; synchronisation; video signal

Receiver: simplified block diagram of typical television receiver; including the following as single blocks – RF input, tuner, IF, video, AGC, AFT, sync separation, scanning and EHT, generation, sound stages, video amplifier, blanking, DC lamps, luminance matrix, RGB drives and outputs, colour decoder, power supply, picture tube

TV picture tube: principles of operation; thermionic emission; electron gun; basic raster scanning; synchronisation; monochrome tubes – typical electrode voltages, drive waveforms, phosphor

Colour principles: signal format; forward and reverse compatibility; luminance signal; light and colour theory; visual perception; signals; colour bar test pattern; RGB; luminance; 3 tube colour cameras – simple block diagram, derivation of luminance and colour difference signals; principles of suppressed carrier quadrature amplitude modulation (QAM); vector diagram of primary and complimentary colours on NTSC line; principles of PAL encoding – swinging burst, diagram of primary and complimentary colours on the PAL line; frequency interleaving; block diagram of a simplified PAL encoder (integrated into transmitter block diagram)

VHF and UHF signal propagation and distribution: signal levels; characteristic impedance; test equipment; test patterns

Safety: TV picture tubes; high voltages; manual handling

Chrominance and luminance.

Chrominance and luminance signal processing: chroma signal; principles of PAL encoding; frequency interleaving; description and function of the 'colour burst'; the colour encoder; weighting; gamma correction; constant luminance; standard colour bar test pattern

Luminance signal processing in the receiver: video buffer; traps and filters; video amplifiers; frequency compensation; video output stages; brightness circuit; contrast circuit; black level clamps/DC restoration; retrace blanking; automatic beam current limiting

Chrominance signal processing in the receiver: chroma decoder; subcarrier regeneration; chroma signal processing; final matrix/output; typical circuits

Fault-finding

Scanning and deflection.

The sync separator: composite sync information; level clipping; vertical sync pulse derivation; horizontal sync pulse derivation

Horizontal oscillators: oscillator types; AFC principles; operation of a simple two diode AFC circuit; driver circuits

Horizontal output stage operation: horizontal scanning sawtooth current; flyback transformer; resonant tuning; EHT generation; scan derived D.C. power supplies

Safety: overvoltage and x-ray protection; automatic beam current limiting sensing: safe measurement of EHT voltages; safe EHT discharge

Vertical output stage: trapezoidal deflection waveform; vertical oscillator types; linear sawtooth waveform generation; complimentary symmetry output stages; linearity correction feedback loops

Digital countdown deflection systems: block diagram; horizontal deflection system; vertical deflection system

Raster distortion reduction: pincushion distortion; "S" correction; E-W pincushion correction; N-S pincushion correction

Fault-finding

Power supplies – TV and VCR.

Transformerless TV power supplies: regulation; rectifiers; hot chassis design; isolation transformers; RFI considerations; ripple effects

Series regulated TV/VCR power supplies: operation; protection; preset controls

Switch mode power supply: variable duty cycle type; variable frequency type; series switching regulators; shunt switching regulators; SOPS switching regulators; synchronised SMPS

SMPS control circuitry: protection; kick start circuits; slow start circuits; variable duty cycle control; VCO type control; current overload sense and control; overvoltage protection; optocouplers with SMPS/SOPS

Self-oscillating power supplies: series SOPS; shunt SOPS; shunt synchronised SMPS

SMPS and SOPS fault-finding: waveform measurements; preset controls; regulation testing

Fault-finding

Television and VCR installation.

Television and VCR installation: tuning televisions; adjustment of customer and technician controls

TV system faults: the switch on process; generic fault-finding procedures and techniques; location of faults to functional block; location of functional block on typical schematics; visual inspection; simple repairs; safety procedures when working with televisions

Safety procedures

Television RF stages.

The television tuner: tuner functions; the RF amplifier; the mixer; the oscillator; AFT; tuner types; antenna isolating circuits

Tuning Systems: simple tuning; voltage synthesis tuning (VST); frequency synthesis tuning (FST)

Vision I. F. amplifiers: IF amplifier operation; IF response; vestigial sideband compensation; SAW Filter

Vision detectors: simple square law detector; square law detector and colour transmission; synchronous demodulators

AGC: AGC operation; peak level AGC; gated AGC; synctip AGC; forward/reverse AGC; delayed AGC

Specialisation: Entertainment - video

Television antenna systems.

TV signal reception: inadequate/optimum/excessive signal level; multipath transmission; interference

TV antennae: types; operating characteristics; TV antenna terminology; multiple antennae

Transmission lines: types; characteristic impedance; attenuation; bandwidth; standing waves

Antenna distribution systems: identical and adjacent channel interference; masthead/distribution amplifiers; diplexors; triplexors; splitters and couplers; "T" networks and existing loop wired networks; practical small distribution system design; field strength meters; attenuators; VCR output injection

Satellite receivers: block diagram; operating characteristics

Antenna fault-finding

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Specialisation: Scanning systems - radar

Data communications fundamentals.

Data communication standards; basic elements of data communication system; transmission modes – simplex, half and full-duplex; transmission techniques; voice transmission fundamentals; interfacing devices and standards; OSI seven layer model; modem fundamentals; modem modulation techniques; integrated services digital network (ISDN); packet switching services, X.25

Radar principles and applications.

Purpose and uses: mnemonic; environment conditions; design factors that affect performance

Safety aspects: warning labels; conditions that result from electric shock; high voltages; RF radiation; radioactive valves; toxic substances; waveguides; CRT

Electromagnetic wave propagation: transverse waves; transmission lines; impedance matching; standing waves; energy losses

Waveguides: limiting factors; coupling; waveguide parts and types; resonant cavity characteristics; cavity tuning; waveguide shutters; impedance matching; magic T waveguide section; joint waveguide

Pulse forming circuits: four basic types; multivibrators

Typical radar transmitter: types; high-power oscillator; master timing unit; pulse forming network; modulators; switching – thyratrons; master oscillator power amplifier type

Typical radar transmitter: typical block diagram; receiver parameters; heterodyning; mixers; local oscillators; AFC; IF amplifier; diode detector; frequency response; paralysis; fast time circuit; instantaneous AGC; STC; logarithmic receiver

Types of display: inputs required; CRT; deflection; focusing; A-scan display; brilliance control; planned position indicator display (PPI); deflection; rotation synchronisation; raster scan deflection; composite video; raster scan

Types of antenna: RF radiation process; half-wave dipole; parabolic reflectors; cosecant squared reflector; energy feeding devices; cassegrain antenna; dielectric lens; metal plate lens; slotted waveguide radiators; squint angle; measure radiation pattern

Calculations: maximum and minimum theoretical range; true bearing; relative bearing; bearing conversions; slant range; ground range; height

Microwave devices: oscillators; amplifiers; additional RF devices

Continuous wave radars: use

Doppler effect: description

Moving target indicator: function; operation using pulse-to-pulse; PRF agility; frequency agility

Tracking radar: monopulse radar; manually lock onto a target; automatic search and track targets

Secondary radar system (IFF): principles – uses; pulse train

Fault-finding

Radar and sonar displays.

Safety; CRT principles – EHT, focussing, deflection; PPI displays/A-scope/B-scope; LCD displays – colour, monochrome; touch screens – magnetic field, infra red; raster scan – operation, removal, disposal, dangers of phosphors; plasma display; high voltage DC power supplies; NMEA 0183; GPS; data transmission techniques – RS232, RS422; gyro synchro; LED displays; digital processing of radar information (centroiding etc); video distribution and switching

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Principles of underwater sound transmission.

Propagation; doppler; sound speed of water – temperature, pressure/depth, salinity, biological interference, impurities in water; isothermal/exothermal layers; reflection; refraction; convergence zones; surface duction; deep sound channels/VLF

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Sonar systems principles.

Safety; fish finders; oceanography; exploration; echo sounding; block diagram of sonar systems – transmitter, receiver, amplifiers, displays; types of transmission – Omni, steered, phased, CW/FM, AM; underwater communications; beam forming/arrays; frequency – range, applications, classification; beam steering; active/passive; recording devices – tape, pen, chart, disk

Sonar transducers.

Theory; types; construction; mounting; medium – salt water, fresh water, castor oil; testing – impedance, phase relationship; arrays – transducer, staves, elements, piezo electric; hydrophones

Category: Instrumentation (D)

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials, types, applications; techniques, marking out, cutting, bending, drilling/punching, soldering, cutting mitres

Assembly/disassembly techniques

Electrical theory.

Fundamental and derived units: basic units; SI derived units; multiples and sub-multiples

Power, work and energy: conservation of energy; torque; losses and efficiency; maximum efficiency of machines

Electrical characteristics of materials: conductors, insulators, semi-conductors; electric charge; electric current; electromotive force

The simple circuit: source, load, current path and control; open-circuit; short-circuit

Resistance: Ohm's law; determine V, I, R; power dissipation

Effects of current: physiological effects; principles of protection from physiological effects; conversion of electrical energy to other forms (heating,

light, magnetic, chemical)Sources of electrical energy - conversion of other forms to electrical energy

Using measuring instruments: handling measuring instruments; selecting an instrument; setting-up and connecting into circuits; reading scales and read-outs; setting up a CRO

Factors effecting resistance: length, csa and resistivity; temperature change; influence on practical circuits

Resistors: types and applications; value and rating

Series circuits (single source): determine V, I, R, P; Kirchhoff's Voltage Law; voltage divider Parallel circuits: determine V, I, R, P; Kirchhoff's Current Law; current divider

Series/parallel circuits: determine V, I, R, P; bridge network Resistance measurement: hazards; characteristics of instruments and loading effect; direct, volt-ammeter and bridge method; typical field instruments and applications

Capacitance: concept; units; time constant relationship Capacitors: hazards; factors effecting capacitance; in series; in parallel; measuring/testing/hazards

Inductance: concept; units; time constant relationship

Inductors: factors effecting inductance

Single phase AC principles.

Sinusoidal alternating voltage and current: generation of a sinusoidal waveform; sinusoidal waveform characteristics; measuring and calculating values; phase relationships

Phasors: phase relationship terms; phasor representation conventions; phase relationships using phasors

Resistance in A.C. circuits: determine V, I, R, P; relationship between voltages and currents

Inductance in A.C. circuits: reactance; inductance in series; inductance in parallel; inductive components in power circuits and systems

Capacitance in A.C. circuits: reactance; capacitance in series; capacitance in parallel; capacitive components in power circuits and systems

AC circuits: impedance; relationship between resistive and reactive components; series, parallel and series-parallel RLC circuits; determine V, I, R, P in RLC circuits; phasor diagrams of RLC circuits

Resonance: conditions; resonance and frequency; effects on current

Ideal transformer: operating principles; primary and secondary voltage and current; applications

Wiring techniques.

Electrical/electronic safety testing: isolation; testing; tagging; earthing; appliance electrical safety testing

Standards pertinent to industry sector: purpose; standards bodies; applications

Cables: types, power, signal; terms; colour coding; structure; identification cables; cable applications

Wiring systems: wiring looms; enclosures and supports; selecting wiring systems

Connectors and terminations: requirements; connectors, types and applications, assembly/disassembly; terminating conductors, extension cords

Accessories and fixings appropriate to industry sector: applications; fixing devices and methods

Drawing interpretation and sketching.

Technical drawing standards appropriate to the industry sector, conventions and specifications to AS 1100, with strong emphasis on interpretation: sheet types, title block information, materials parts list, revision table, grid referencing scales, line types – visible outlines, hidden outlines, dimensioning lines, centre lines; orthogonal projection of views – 3rd angle (detail and assembly drawings); mechanical conventions; fabrication conventions; three dimensional view drawings – axonometric, isometric, oblique; sectioning standards and conventions – whole, part; engineering drawing symbols, components and equipment – mechanical, electrical, electronic, computer, instrument, refrigeration; dimensioning – orthogonal, isometric; layout and plans; geometric tolerance interpretation (straightness, flatness, squareness, parallelism and concentricity only); engineering abbreviations; drawing interpretation techniques – detail drawings, orthogonal projection (3^{rd} angle only) and three dimensional, assembly drawings and three dimensions exploded (e.g. as in equipment manuals)

Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3^{rd} angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

Digital electronics.

Analogue and digital signal definition

Digital combinational circuit operation: binary numbering up to four variables; truth tables; Boolean representation; simplification of Boolean expressions; circuit implementation from Boolean expressions; logic probe/pulser usage for fault-finding

Hexadecimal, binary and decimal number systems and BCD code: hexadecimal numbering system and its BCD representation (up to two digits); binary to decimal conversion (16 bits max.); binary to hexadecimal conversion (16 bits max.); decimal to hexadecimal conversion (four hex digits max.); representation of alphanumeric characters using 7 BIT ASCII code

Electrostatic discharge precautions: effect of ESD; handling components; wrist straps, protective mats, anti-static bags examples of design using ESD techniques

Operation and characteristics of displays: LED displays; types; calculating current limiting resistors; LCD displays – types; drive requirements

Analysis of digital sub-systems – timing diagrams (decoders): operation - discrete components, 2 line; practical MSI devices and applications -2 line and 3 line devices; seven segment display decoder -binary and BCD; priority encoders; multiplexers – operation -discrete component, 2 line; truth table implementation using MSI devices up to eight inputs – folding not required; demultiplexers – operation -discrete component, 2 line input; practical MSI devices

Digital sub-systems examples using up to four MSI devices e.g. keyboards/display, data transfer – timing diagrams/data sheet usage to be emphasised: flop-flop operation – discrete and MSI, SR, D and JK; level and edge triggered flip-flops, synchronous and asynchronous inputs, flip-flop applications based on MSI devices for shift registers – serial and parallel loading and output, shift left, shift right; counters – based on D and JK flop-flops to a maximum of four states, ripple and counters synchronous; modulus counters, up/down counters, limitations on count speed, IC counters (MSI devices) – presentable counters (up/down), cascading counters (include BCD applications), ring counters – advantages and types; astable and monostable multivibrators

Logic device terminal characteristics: logic levels, supply voltages; power dissipation; input/output drive currents and voltage levels; loading calculations; propagation delays; noise margins; switching speed limitations and speed/power product; open collector/drain outputs; tristate logic and buffers; interfacing of different logic families (include the use of pull-up, pull-down resistors); Schmitt trigger device input output; characteristics

Amplifiers.

Small signal amplifier use: ideal small amplifier characteristics – input and output resistance, current gain, voltage gain; practical amplifier characteristics; voltage gain measurement; amplifier selection given system requirements and loads; bandwidth measurement

For ideal and practical operational amplifier: input/output impedance; open loop gain; gain-bandwidth product; ideal and practical comparator; inverting/non-inverting amplifiers, measurements and calculations

BJT and FET symbols: PNP, NPN; JFET; MOSFET; device characteristics BJT and JFET; biasing – need for circuit types; calculation and measurement of bias conditions; DC stability for BJT and JFET circuits; Quiescent point selection for BJT and JFET

Data sheet usage for BJT, JFET and MOSFET: small signal characteristics for single stage BJT and JFET circuits; fault conditions for single stage BJT and JFET circuits

Coupling and bypass capacitors: applications for single stage BJT and JFET circuit; frequency response, effect of coupling and bypass capacitors – measurement only; factors effecting selection – based on practical demonstration

Electronic hand soldering.

Quality concepts: introduction to electrical connections including mechanical, chemical and thermal; concepts of reliability, quality and process control

Preparation of printed circuit boards: assembly tools and equipment used; soldering tools and equipment; maintenance of soldering irons and tips; materials including solder and alloys, thermal bonding and metallurgical properties; flux types, resin flux and properties; cleaning materials (chemical and other); component types, identification and handling techniques; printed circuit board materials including the characteristics of copper cladded boards; visual inspection of printed circuit board assemblies prior to soldering; contamination of materials; standards and testing of cleanliness

Component mounting considerations: lead bending and stress relief of components; mounting of resistors, capacitors, diodes, transistors, integrated circuits and a selection of terminals; component lead termination methods, e.g. fully clinched, semi-clinched and unclinched (rigid lead)

Component mounting and soldering - principles of soft soldering: heat transfer, minimum and maximum heat loads for components and board materials, thermal shock and coefficient of expansion; filleting and heat bridging

Wetting, de-wetting and non-wetting: metallurgical bonding and the formation of inter metallic alloys

Manual soldering of bare copper and plated single and double-sided printed circuit boards (include consideration of layer interconnection using rivets, or through cladding)

Joint validation by visual inspection criteria and common joint non-conformances associated with single and double-sided printed circuit boards; the solder rework of single and double-sided printed circuit boards

Preparation of single and multi-strand insulated wire for lead termination

Terminating coaxial cable

Preparation and termination of coaxial cable by crimped and soldered connection

Reworking soldered connections: soldering of insulated wire to printed circuit board pads and pins; pierced, hooked and cup terminals

Effects and prevention of electrostatic discharge (ESD) and its effects on static sensitive components; precautions in the handling and use of static sensitive components and the materials and techniques available to set up a static-free environment

Concepts of instrumentation.

Flow, temperature, pressure and other appropriate measurements

Appropriate terminology: span, range, accuracy, precision, errors, zero, reputability, sensitivity, hysteresis, etc. (select from AS1541)

Development of SI units, engineering and scientific notation, imperial and metric conversion using calculations, mm Hg, mm Hg, Pa (hPa, Kpa, Mpa etc.), inches water, PSI, etc. also non-standard SI units – kgcm2, etc.

Instrumentation standards (brief overview only): ISA (Instrumentation Society of America); ISO (International Standards Organisation); SAMA (Scientific Apparatus Manufacturers America); BSI (British Standards Institution); AS (Australian Standards); ANSI (American National Standards Symbols and Terminology); Manufacturer Calibration Standards; fluids in process piping colour coding

Identification and purpose of instruments measuring processes directly and those measuring indirectly

Signal transmission of two-wire, 20-100 kPa, 4-20 mA, 1-5V, other applicable standards

Principles of levers, links and calibration of indicator recorder instrument

Application of safety standards at all times (tools, lifting techniques, electrical safety and CPR, pressure lines, housekeeping)

Interpretation of appropriate graphs and tables associated with instrumentation

Pressure measurement.

Pressure, density, height, force, area units: calculation of pressure required to support liquid columns; calculation of related values of pressure, force and area

Absolute, gauge and differential pressure scales and their interrelationship: reference point for scales; atmospheric pressure value using all common measurement units

Absolute, pressure measurement devices for sub-atmosphere range and typical application of these devices

Gauge pressure measurement by means of U-tube, single limb and inclined liquid columns: calculation of wet leg effects

Gauge pressure measurement by means of elastic deformation type gauges: Bourdon types (C/spiral/helix) and ranges

Other mechanical pressure elements: bellow, capsule, slack/stiff diaphragms: pressure gauge installations: tapping points, valves (isolation and bleed), loop seals, snubbers

Pressure calibration devices: pneumatic, hydraulic, electronic

Precautions in calibrating oxygen and chlorine gauges (no oil)

Use of a dead-weight tester to calibrate pressure gauges; gauge and mechanical recorder adjustments for span, zero and linearity; backlash, hysteresis, reputability

Electrical sensors for pressure measurements: capacitive, piezo, inductive, strain gauge; calibration adjustments for pneumatic and electrical type pressure measurement and signal transmission devices

Installation requirements for pressure measurement in liquid and gas systems, with and without sealing liquid; isolation, seal, vent, drain and bypass valves location and operation sequence

Fluid flow.

Law and characteristics of fluid flow, Bernoulli's theorem, conservation of energy, Reynold's numbers, turbulent and laminar flows, S.I. units

Operation of quantity meters: oval meters. gear meters, reciprocating piston, rotating disc, gas meter

Operation and characteristics of differential head flow rate meters which includes the orifice plate, venturi tube and annular: dall tube, flow nozzle, pitot tube

Characteristics: flow/DP relationship, pressure losses and effects of laminar flow or excessive turbulence on the accuracy of the meter

Construction of typical examples of P flow rate meter: materials, shapes of orifice, gas and liquid drains, tapping points and mounting position of DP transmitter and pipe work

Operation and characteristics of flow rate meters: turbine meter vortex meter and magnetic flow meter

Operation and characteristics of shapes of flumes and weirs

Construction and installation of flumes and weirs; sources of error

Square root extraction in reference to DP meters, integration of low rate, mass flow computations (coriolis effect) from flow rate and other measurements

Temperature measurement.

Heat and temperature: Differentiation between heat and temperature, SI and non-SI temperature scales and units and conversions between scales

Non-electrical thermometers: the principles of operations characteristics and construction of liquid-in-gas, bi-metallic and filled system thermometers

Electrical thermometers: the laws and effects associated with electrical temperature primary elements; the principles of operations, characteristics and construction of thermometers, resistance thermometers (RTDs), thermistors, and semi-conductor and integrated circuit thermometers; compensation and protection devices and associated measuring circuits; circuit connections for average temperature and temperature differences should be able to be examined regarding installation and measuring circuit consideration which vary from the norm

Radiation thermometers: the laws governing radiation thermometers and the properties of a 'black body'; the theory of operation, characteristics and construction of disappearing filament, partial radiation and total thermometers; total and spectral emissivity

Other measurement techniques: the operation and characteristics of pyrometric cones, temperature sensitive pigments and liquid crystals (brief mention only)

Test equipment: the theory of operation, operation and use of Wheatstone bridges, millivolt potentiometers and other test equipment associated with temperature measurement

Errors: the errors specific to temperature measurement - these include thermal lag, fabrication heating conductive cooling and cavitation

Interpretation drawing.

Symbols: electrical; electronic; instrument

Types of drawing: schematic; single line; wiring; process flow; process loop diagrams

Projection and dimensions

Interpretation of manufacturers data

Quantity take off and parts list

Process control.

Open and closed loop system, identifying final element, process measuring, transmitter, converter, controller, controller setpoint, process, process signal

Control terminology: set point; offset; deviation; gain; proportional band; integral (reset); derivative (rate preact); process variable; feedback; conversion of gain to PB and vice verse; integral (repeats/min and min/repeat); process characteristics (process lag, resistive lag, capacitive, deadtime); on/off control; proportional control (amplitude, time); proportional plus integral control; proportional plus integral plus derivative control; reset wind-up

Response of systems to controller parameter (PI and D) changes and load change

Process control systems.

Operation of controller types: hierarchy

Applications: on/off control; proportional; integral; derivative; direct – reverse action; local – remote set points; ratio; output limits: anti – reset windup; alarms; self tuning; adaptive gain

Typical alignment methods

System response to changes

Selection of controller type, action and modes

Effect of loop and process characteristics

Typical programming and tuning methods: open loop; closed loop

Feedforward: feedforward vs feedback; need for feedforward; difficulties in application; feedforward with feedback trim

Cascade control: need; application to processes; problems with multi-cascading

Ratio control: need for ratio control; application to processes

Batch control: need; specific requirements needed in controller; reset windup; use of PLCs

Installation methods and techniques for loop calibration

Effects of control value characteristics on loop: characterisation; sizing and rangeability; cavitation, flashing and noise; control valve selection considerations

Transmitters and converters.

Pneumatics: principles of flapper nozzles, pneumatic transmitters

Supplementary pneumatic loop equipment: computing relays, lead/lag units, high and low selectors, air to current and high and low selectors, air to current and current to air converters, square root extractors, integrators, regulators, multipliers and dividers

Electronics: electronic transmitters, analogue computing, integrators, high and low signal selector, signal converters

Transducers I to P, P to I converters, analogue to digital and digital to analogue converters, RTD/I, mV/mA, frequency to I, square root extractors and integrators

Linear variable differential transformers

Intrinsic safety

Zener barriers

Explosion/flame proof enclosure

Specialisation: Control

Programmable controllers.

Introduction to control systems: block diagram of any control system (input, process, output); methods of control (relay, static logic, programmable); introduction to PLC systems; advantages and disadvantages of PLCs; block diagram of PLC system

Basic PLC operation: definitions, terminology and block diagram; scan cycle; basic programming rules; addressing for I/O; halt; run

Programming (using a hand programmer): flowcharts/steps to use when programming; clearing memory; ladder format; Boolean/mnemonic/statement list format; series circuits; parallel circuits; latching circuits; stack register operation; combination series/parallel circuits; inversion elements; timers (DOE); counters; monitor discrete I/O and timer/counter values; edit (insert and delete elements)

Connect discrete input and output devices to a PLC

Density/level measurement.

Definitions: density; relative density (sg); factors effecting density (effect of depth and density on pressure in liquids, Archimedes principle, calculations of pressure in various fluids)

Measuring devices: float type (open and closed tanks); sight gauges; air pure (bubble pipe); differential pressure cells; SMART transmitters; 1:1 repeater; level repeater; diaphragm box; electronic hydrostatic head; ultrasonic; capacitance; resistance; nucleonic

Calculation of range, span, elevation and suppression; calibrate electronic and pneumatic differential pressure cell transmitters to suit level or density application; configure a differential pressure transmitter

Connection into a two wire system; connection of pneumatic systems

Control valves.

Control valve body trims: body types; trim types; inherent and dynamic flow characteristics of characterised trim valves; inherent and dynamic flow characteristics of fixed characteristics valves; bonnets

Control valve terminology and calculations: control valves rating and sizing

Spring opposed diaphragm actuators: actuator characteristics

Valve positioners: applications of valve positioners; valve positioner types; calibration/adjustment

Self acting control valves: operation; performance characteristics of self-acting control valves; installation; calibration/adjustment

Piston actuators/power cylinders: types of piston actuators; characteristics of piston actuators; applications of piston actuators; testing and maintenance; calculation of thrust force of advance and retract strokes; installation and accessories

Position controllers (positioners) for use with piston actuators/power cylinders: types and application; characterised actuation; calibration/adjustment

Directional control valves (pilot operators) for piston actuators: types/porting arrangements; applications; actuation methods; air supply and lubrication

Industrial processes.

Types of processes and process quantities

Heat exchangers

Boiler and furnace control

Water treatment

Instrument air systems

Reactors

Distributive control systems (DCS).

DCS Concepts: definition of DCS; types

DCS architecture: information collection (historical, management; control (programmable, dedicated); communication (data highway, data control, interfacing); storage (disk, tape, solid state); interaction (I/O, VDU, M/A station); interface (operations, engineering)

DCS configuration: types of function blocks; function codes; control algorithms

Specialisation: Measurement

Density/level measurement.

Definitions: density; relative density (sg); factors effecting density (effect of depth and density on pressure in liquids, Archimedes principle, calculations of pressure in various fluids)

Measuring devices: float type (open and closed tanks); sight gauges; air pure (bubble pipe); differential pressure cells; SMART transmitters; 1:1 repeater; level repeater; diaphragm box; electronic hydrostatic head; ultrasonic; capacitance; resistance; nucleonic

Calculation of range, span, elevation and suppression; calibrate electronic and pneumatic differential pressure cell transmitters to suit level or density application; configure a differential pressure transmitter

Connection into a two wire system; connection of pneumatic systems

Telemetry.

Telemetry systems

Advantages and limitations of analogue, digital, pneumatic and fibre optic types

Standards pertaining to telemetering including the International Standard CCI TT V24

Standard signal in common use

Analogue signal converters, signal conditioners, isolators, lighting protection, barrier modules to hazardous areas, analogue multiplexers, transmitters and receivers

Comparison or analogue and digital signals including accuracy and discrimination

Digital word and message structures

Series used in fibre optic systems, physical construction of fibre for light transmission, types of fibre and cladding

Types and characteristics of light sources

Types and characteristics of light detectors

Safety procedures in handling fibre and light sources

Types of transmission lines and links

Digital data links and database lines. RS232, RS422, transmission rates and signals acceptable for use

Indicators and recorders.

Pneumatic indicator mechanism including the flapper and nozzle system

Types of displays

Current signals, interface resistors and offset voltage supplies

Potentionmetric indicators and voltage signals

Cathode ray tubes (CRT) as an indicators

Connection of typical indicators and precautions to ensure accuracy

Recorder charts and recorder architecture

Recorder chart drives

Recorder pens and pen drives including pneumatic, potentiometric, moving coil and moving iron multipoint, hot wire and hot point pens

Ranging and calibration of recorders and indicators

Microprocessor based indicators/recorders

Disk/tape storage and recording of data

Gas analysis.

Combustion theory: analyser types (reagent analysers, electrolytic analysers); oxygen analysers (paramagnetic - magnetic, dumbbell, zirconia oxide); thermal conductivity analyser; thermal reaction analysers; infra-red

Humidity: types of; types of detectors - hygrometers (organic (hair), wet and dry bulb – psychrometer, sling psychrometer, assmann psychrometer); dew point; conductive (lithium chloride); coulmetric method

Water analysis.

Terminology/types: pH; conductivity; selection; redoc (ORP); turbidity/opacity

Sensing elements: construction; operation; test electrodes; design limitations; calibration

Measuring circuits

Installation considerations

Test equipment

Scientific analysis.

Electromagnetic radiation: spectrum; transmission and absorption

Refraction: lenses; dispersion and prisms; filters, coloured and interference; diffraction gratings

Absorption spectrometers: single and double beam; visible, ultra-violet and infra-red

Emission spectrometers: flame; arc and spark; sampling

Atomic absorption spectrometers: hollow cathode lamps; choppers

Gas chromatography: carrier gas; columns; sampling; detection

Sample preparation: separation of samples; (centrifuge, preparative chromatographs); fraction collection; automatic sampling devices

Load cells and weight measurement.

Definitions: force and weight

Lever principles: mechanical lever; spring balance scales; load cell

Factors effecting weighing system performance: temperature; vibration; ambient conditions

Load cell selection and installations of assemblies

Principles of strain gauge measurement tension and compression and materials used

Principles of operation and application of: mechanical lever scales; hydraulic and pneumatic load cells; inductive weight sensors; linear voltage differential transformers (LVDT)

Weight feeders – mechanical and scale operated: methods of weighing materials in motion; conveyor belt weighing systems, (construction, weigh span, methods of loading, factors effecting accuracy, calibration)

Nuclear radiation sensors: isotopes; application; safety precaution

Category: Refrigeration and air conditioning (E)

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials, types, applications; techniques, marking out, cutting, bending, drilling/punching, soldering, cutting mitres

Assembly/disassembly techniques

Electrical theory.

Fundamental and derived units: basic units; SI derived units; multiples and sub-multiples

Power, work and energy: conservation of energy; torque; losses and efficiency; maximum efficiency of machines

Electrical characteristics of materials: conductors, insulators, semi-conductors; electric charge; electric current; electromotive force

The simple circuit: source, load, current path and control; open-circuit; short-circuit

Resistance: Ohm's law; determine V, I, R; power dissipation

Effects of current: physiological effects; principles of protection from physiological effects; conversion of electrical energy to other forms (heating,

light, magnetic, chemical)Sources of electrical energy - conversion of other forms to electrical energy

Using measuring instruments: handling measuring instruments; selecting an instrument; setting-up and connecting into circuits; reading scales and read-outs; setting up a CRO

Electrical concepts and applications.

DC resistive circuits: series; parallel; series parallel; measurement of V, I and R; calculation of R, V, I, and P

Capacitance: concept; unit; time constant; capacitors – basic construction and types

Magnetism: magnetic and non magnetic materials; magnetic field patterns; force between magnetic fields; applications

Electromagnetism: magnetic field around a current-carrying conductor and solenoid; force between current-carrying conductors; applications

Electromagnetic induction: induced EMF; inductance, concept, unit, time constant, applications

AC principles: sine waves; frequency; amplitude; peak voltage; peak to peak voltage; RMS voltage; single phase; three phase; generation of AC voltages; circuit measurement; earthing; electrical supply system

Transformers: construction; principles of operation; primary and secondary voltage and current; applications

Motors: motor action; generator action; DC motors; AC motors; applications

Electrical safety testing: regulations

Wiring techniques.

Electrical/electronic safety testing: isolation; testing; tagging; earthing; appliance electrical safety testing

Standards pertinent to industry sector: purpose; standards bodies; applications

Cables: types, power, signal; terms; colour coding; structure; identification cables; cable applications

Wiring systems: wiring looms; enclosures and supports; selecting wiring systems

Connectors and terminations: requirements; connectors, types and applications, assembly/disassembly; terminating conductors, extension cords

Accessories and fixings appropriate to industry sector: applications; fixing devices and methods

Refrigeration procedures.

Tubing: types; tubing; annealing

Use of dry nitrogen

Bending methods spring bending tools (lever type) measurement and marking out gain correction

Flaring: types of block; types of flare nut

Pipework: expanding; tube expanders; swaging; recognition of fittings and threads; thread sealants

Silver brazing: joint preparation; fluxes

Job preparation refrigerant isolation/pump down; protection of cabinets from flame brazing in tight corners; use of mirrors pressure testing

Gauges: types; care and maintenance

Valves: service; shredder; piercing

Gauges: fitting; purging; reading; using P.T. chart

Gaskets: types of material; thickness; measuring and marking out

Appliance motors and circuits.

Dangers and safety precautions: identify causes; predict electrical hazards; safe working practices; earthing and insulation; polarity and insulation; handling PCBs; isolation, testing and tagging; appliance electrical safety testing; AS3000; AS3100 series; AS3300 series; other relevant codes

Alternating current: single and three supply; impedance, inductive and capacitive; reactance; power and power factor

Single phase appliance motors: shaded pole; synchronous; universal series; standard split phase; capacitor start, induction run; capacitor start, capacitor run; permanently split; terminal identification; rotation reversal; speed control; typical applications; electrical symbols and circuits; manufacturers specification tables; testing; faulting

Single phase appliance motor starters and overloads: centrifugal switch; current relay; potential relay; solid state relay; over-current protection; over-temperature protection; applications; electrical symbols and circuits; testing; fault-finding

Three phase motors: three phase induction motors; delta and star connection; terminal identification; rotation reversal; typical applications; electrical symbols and circuits; testing; fault-finding

Three phase motor direct-on-line starters and protection devices: DOL motor starters; fuses and circuits breakers; thermal overloads; magnetic overloads; under and over voltage relays; electronic; timers

System control.

Standard symbols used in electrical circuits: control terminology; electrical symbols; electrical diagrams – block, wiring, circuit, control, power

Components of basic control circuits: relays (starting); relays (control); thermostats; pressure controls; humidistats; flow switches; proportional controls (mod motors); contactors; installation, setting and testing controls; test equipment; safety instruction

Three phase motor starting methods (power and control circuits): D.O.L; primary resistance; star delta; auto transformer; part winding; solid state (soft starting)

Operating refrigeration/air conditioning plants: safety instruction; ozone conservation instruction; components for removal/installation

Use/application of timers: defrosting; plant cycling; starts, limiting; transition

Methods for anticipating control settings: design conditions-comfort storage; ambient conditions; pressure/temperature relationships

Air conditioning controls.

Control system fundamentals

Circuit diagrams: air conditioning circuit diagrams

Types of control systems: electrical; electronic; pneumatic

Fluid flow control: sensors; actuators; control systems

Energy management: running costs; capacity control; economiser system; night purge; thermal storage

Commissioning procedures

Specialisation: Commercial air conditioning

Maintain and service air handling plant.

Filter cleaning methods: cleaning water nozzles, drain trays; humidifiers; electrical and water requirements; condensate and drainage points; cooling coils; electrostatic air filters

Identify sludge, scale water contaminates: replacement of cleaning of air filters, water nozzles, ball float; air quantity; location; dust – VAV systems

Accumulated moisture: drainage; terminal units; spray coils

Responsibilities under the ACT: regulators and standards; AS3666, AS1851, AS, AS1470, AS1657, AS1715 and AS2865, ordinance 70, AS1668 part 1; disinfectants; fever – humidifies, portia; fire dampers; patten AS3665 rust prevention

Installation and commissioning of air handling plant.

Introduction: benefits; reasons for training

Safety: water supply and drainage requirements; electrical requirements; special site requirements; location and securing of equipment

Reading manufacturer's drawings and specifications: methods of assembly; fixing; running test

AS3666, AS1851, AS, AS1470, AS1657, AS1715 and AS2865, ordinance 70,: local authority requirements; relevant legislation; legal obligations; development/building approvals

Specialisation: Commercial refrigeration

Merchandising and display cabinets.

Types and construction: deep freeze meat, dairy, fruit and vegetables; multi deck display type; single deck, well type and island cases; glass door/reach-in merchandiser

Components and features: condensing units; refrigerant controls; evaporators and fans; defrosting method and mullions; drain facilities and drain heaters; air distribution and air flow curtains; cabinet air temperature, velocity and direction lighting

Layouts and installation

System and defrost controls: operating conditions; alarm systems; thermostats and pressure controls; defrost timers and controllers; electrical control circuits

Multiple Systems: multiple compressors; multiple evaporators; heat reclaim systems; multi-temperature accessories; controls and sequencing

Commissioning service and maintenance

Post mix and dairy products and refrigeration systems.

Dispensing application: name various types of post mix dispensers, soft ice cream dispenser and milk vats, plate cooling; list typical applications; commercial considerations

Operating cycle: type; water quality, sludge, scale, contaminates; operating temperatures; water nozzles, ball float; storage temperatures; location; refrigeration systems

Responsibilities under the Act: regulators and standards; cleaning; electrical and water requirements; condensate and drainage points

Installation requirements: electrical; water supply; drainage; refrigeration service, fault-finding, maintenance requirements

Commercial ice making systems.

Applications: name various types e.g. cube, flake, cylinder; continuous, intermittent

Operation: operating cycle, harvest cycle; type of ice, clear, opaque; water quality, sludge, scale, water contaminates; operating temperatures; water nozzles, ball float; ice storage; location; refrigerating systems

Responsibilities under the Act: regulators and standards; cleaning; electrical and water requirements; condensate a drainage point

Installation requirements: connecting services, electrical, water supply, drainage; operating conditions; controls; circuit diagrams, electrical, water, drainage, refrigeration; service; fault-finding; maintenance requirements

Specialisation: Domestic appliances

Service clothes washers and clothes dryers.

Codes and regulations: plumbing – water supply drainage, back siphoning; electrical insulating, earthing; manufacturers data

Types and applications: types of washing machines – automatic washers, top load and front load, wringer washers, twin tub washers; application and significant differences: types of clothes dryers – tumble, application

OH&S: OH&S act; manufacturers data; test instruments; tools; service report, customer advice; electrical testing, motors, controllers; timers, operational and safety thermostats; mechanical testing, safety locks, soiled clothes, out of balance, not draining, or filling noisy

Repair/replace faulty components: access to appliance; confirm fault diagnosis; disconnect services, water, electricity; select components from manufacturers data service vehicle, supplier; removal and replacement of electrical controls, motors, capacitors, thermostats, switches, heaters, lead, plug, timer, wiring; removal and replacement of various mechanical items, belts, bearing, door locks, filters, hoses, pumps, float switch, clutch, brakes, dispenser levelling feet, balance control, gaskets, lint screens – adhesives and water sealant, cleaning of cabinets and components, removing rust and minor repairs to cabinets, touching up paint work

Test: set operational and safety controls; check electrical components; operate system and adjust cycle controls etc; carry out leak tests

Service report: information and advice to equipment owners; equipment labels; service report; documentation

Service refrigerators, freezers and room air conditioners.

Codes and regulations: rating; location; ventilation; dangers and safety precautions; predict electrical hazards; safe working practices; earthing and insulation; testing and making safe

Types, operational features, application and installation requirements: refrigerators, freezers – single door, two door, all refrigerator, combination cabinet, cool water and ice dispensing, chest freezer; air conditioners – window mounted, wall mounted, roof mounted (drop in), split unit, portable

Fault-finding: test instruments and equipment; safety electrical, ventilation; electrical circuit – interpretation of wiring diagrams, sequence of operation, relevant electrical symbols, fuses, making safe, earthing, flash back, fans and fan motors, controllers, time clocks

Service: access to the appliance; confirm fault diagnosis; obtain required components; disconnect services to the appliance; remove faulty component; repair or replace component; reassemble; reconnect services

Safety: set operational and safety controls; check electrical components; operate appliance and adjust cycle controls; carry out leak test; check water supply and drainage leaks

Service reports: information and advice to equipment owners; equipment labels; service reports; documentation

Specialisation: Hotel/club refrigeration

Beverage dispensers.

Types of construction: hotel/club dispensing; balanced beer dispensing

Components and features: operating principles; condensing units; evaporating control; refrigerant control; safety features; hygiene awareness

Layout and installation: location of equipment; installation considerations

System and control methods: operation – conditions; thermostat, pressure controls and evaporator pressure regulating valve, solenoid valves; electrical and piping circuits

Commission: determine design operating conditions; check and adjust controls

Servicing: normal and abnormal operation; fault-finding charts – maintenance charts; repair and replacement of parts; maintenance

Post mix and dairy products and refrigeration systems.

Dispensing application: name various types of post mix dispensers, soft ice cream dispenser and milk vats, plate cooling; list typical applications; commercial considerations

Operating cycle: type; water quality, sludge, scale, contaminates; operating temperatures; water nozzles, ball float; storage temperatures; location; refrigeration systems

Responsibilities under the Act: regulators and standards; cleaning; electrical and water requirements; condensate and drainage points

Installation requirements: electrical; water supply; drainage; refrigeration service, fault-finding, maintenance requirements

Commercial ice making systems.

Applications: name various types e.g. cube, flake, cylinder; continuous, intermittent

Operation: operating cycle, harvest cycle; type of ice, clear, opaque; water quality, sludge, scale, water contaminates; operating temperatures; water nozzles, ball float; ice storage; location; refrigerating systems

Responsibilities under the Act: regulators and standards; cleaning; electrical and water requirements; condensate a drainage point

Installation requirements: connecting services, electrical, water supply, drainage; operating conditions; controls; circuit diagrams, electrical, water, drainage, refrigeration; service; fault-finding; maintenance requirements

Specialisation: Industrial refrigeration

Industrial refrigeration.

Applications: blast freezers; food production; wine/beer production; abattoirs; bulk food storage and markets

Refrigerants: types and applications; codes and regulations; safety and handling

Components: compressors; evaporators; metering devices; auxiliary equipment

Industrial systems: liquid recirculation; dry expansion and flooded; eutectic solutions; continuous ice making; freezing; air blast; liquid immersion; surface contact; chillers

Servicing: testing; commissioning; maintenance; fault-finding and repairs

Commercial ice making systems.

Applications: name various types e.g. cube, flake, cylinder; continuous, intermittent

Operation: operating cycle, harvest cycle; type of ice, clear, opaque; water quality, sludge, scale, water contaminates; operating temperatures; water nozzles, ball float; ice storage; location; refrigerating systems

Responsibilities under the Act: regulators and standards; cleaning; electrical and water requirements; condensate a drainage point

Installation requirements: connecting services, electrical, water supply, drainage; operating conditions; controls; circuit diagrams, electrical, water, drainage, refrigeration; service; fault-finding; maintenance requirements

Compound systems.

Applications

Refrigerants

Special low temperature components: compressor problems; suction pressures; compressor ratios; discharge temperatures; capacity; P.H. diagrams

Low temperature systems (application): two stage; cascade; indirect

Typical low temperature systems (construction): operation; accumulators; solenoid valves; oil separators; intercoolers; RMDs; press regulators; brines; pumps

Advantages of low temperature systems: comparison; characteristics; calculations

Specialisation: Transport refrigeration and air conditioning

Transport/marine refrigeration.

Construction of refrigeration containers: insulation; vapour barriers; systems including containers with their own units, pre-chilled, liquid nitrogen systems, marine holds, marine cold rooms, rail car refrigerated storage, aircraft refrigerated containers, refrigerated pantechnicons and transport storage depots; preparation and storage requirements for transporting refrigerated food products; legislation, security and insurance aspects; electrical power sources; maintenance procedures and fault-finding techniques

Automotive air conditioning.

Heat, pressure and temperature; heat flow; heat transfer; pressure temperature relationships vapour compression; cycle conditioning of refrigerants throughout cycle

Compressors (auto); evaporators (auto); condensers (auto); refrigerant controls (auto); receiver dryer (auto); fitting service gauges; service valves; reclaim units; CFC regulation; vacuum pumps – evacuation; refrigerant contaminants; graduated charging cylinders; liquid charging; vapour charging; thermostats; relays; electro magnetic clutches; basic control circuits; P.O.A. valves; H.P. and L.P. switches; thermistors; pressure testing; leak detecting (halide, electronic, soap bubbles); condenser and evaporators temperature differences; restrictions; compressor valve efficiency; filter driers and strainers; TX valve faults; air filters (heavy equipment)

Specialisation: Vending equipment refrigeration

Merchandising and display cabinets.

Types and construction: deep freeze meat, dairy, fruit and vegetables; multi deck display type; single deck, well type and island cases; glass door/reach-in merchandiser

Components and features: condensing units; refrigerant controls; evaporators and fans; defrosting method and mullions; drain facilities and drain heaters; air distribution and air flow curtains; cabinet air temperature, velocity and direction lighting

Layouts and installation

System and defrost controls: operating conditions; alarm systems; thermostats and pressure controls; defrost timers and controllers; electrical control circuits

Multiple Systems: multiple compressors; multiple evaporators; heat reclaim systems; multi-temperature accessories; controls and sequencing

Commissioning service and maintenance

Post mix and dairy products and refrigeration systems.

Dispensing application: name various types of post mix dispensers, soft ice cream dispenser and milk vats, plate cooling; list typical applications; commercial considerations

Operating cycle: type; water quality, sludge, scale, contaminates; operating temperatures; water nozzles, ball float; storage temperatures; location; refrigeration systems

Responsibilities under the Act: regulators and standards; cleaning; electrical and water requirements; condensate and drainage points

Installation requirements: electrical; water supply; drainage; refrigeration service, fault-finding, maintenance requirements

Drink vending cabinets.

Types and construction: glass door; coin operated

Components and features: condensing units; refrigerant controls; evaporators and fans; defrosting method and mullions; electronic controls; drain facilities and drain heaters; air distribution and air-flow curtains; cabinet air temperature, velocity and direction; accessories; lighting

Installation requirements: location; access and obstructions; power supply and electrical services

System and defrost controls: operating conditions; thermostats and pressure controls; defrost timers and controllers; electrical control circuits

Commission, Service and Maintain: check and adjust control devices; determine correct air flows; leak testing; normal and abnormal operation; basic servicing techniques

Category: Data communications (F)

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials; techniques (marking out, cutting, bending, drilling/punching, joining, cutting meters)

Fitting techniques: dismantling; assembling

Electrical theory.

Fundamental and derived units: basic units; SI derived units; multiples and sub-multiples

Power, work and energy: conservation of energy; torque; losses and efficiency; maximum efficiency of machines

Electrical characteristics of materials: conductors, insulators, semi-conductors; electric charge; electric current; electromotive force

The simple circuit: source, load, current path and control; open-circuit; short-circuit

Resistance: Ohm's law; determine V, I, R; power dissipation

Effects of current: physiological effects; principles of protection from physiological effects; conversion of electrical energy to other forms (heating,

light, magnetic, chemical)Sources of electrical energy - conversion of other forms to electrical energy

Using measuring instruments: handling measuring instruments; selecting an instrument; setting-up and connecting into circuits; reading scales and read-outs; setting up a CRO

Factors effecting resistance: length, csa and resistivity; temperature change; influence on practical circuits

Resistors: types and applications; value and rating

Series circuits (single source): determine V, I, R, P; Kirchhoff's Voltage Law; voltage dividerParallel circuits: determine V, I, R, P; Kirchhoff's Current Law; current divider

Series/parallel circuits: determine V, I, R, P; bridge networkResistance measurement: hazards; characteristics of instruments and loading effect; direct, volt-ammeter and bridge method; typical field instruments and applications

Capacitance: concept; units; time constant relationshipCapacitors: hazards; factors effecting capacitance; in series; in parallel; measuring/testing/hazards

Inductance: concept; units; time constant relationship

Inductors: factors effecting inductance

Electromagnetism.

Magnetism: field patterns; magnetic induction and screening; applications

Electromagnetism: magnetic field around a current-carrying conductor; Fleming's right-hand rules; forces between current carrying-conductors

Magnetic quantities: units (magnetomotive force, magnetising force, flux density, reluctance); permeability

Magnetisation curve: magnetic characteristics of materials; saturation and hysteresis; comparing magnetic materials

Induced voltage: factors required to induce an emf; forces acting on a conductor

Inductance: concept; unit; factors effecting inductance; self-inductance and mutual inductance

Application of electromagnetic principles: generator action; motor action; applications; unwanted effects

Single phase AC principles.

Sinusoidal alternating voltage and current: generation of a sinusoidal waveform; sinusoidal waveform characteristics; measuring and calculating values; phase relationships

Phasors: phase relationship terms; phasor representation conventions; phase relationships using phasors

Resistance in A.C. circuits: determine V, I, R, P; relationship between voltages and currents

Inductance in A.C. circuits: reactance; inductance in series; inductance in parallel; inductive components in power circuits and systems

Capacitance in A.C. circuits: reactance; capacitance in series; capacitance in parallel; capacitive components in power circuits and systems

AC circuits: impedance; relationship between resistive and reactive components; series, parallel and series-parallel RLC circuits; determine V, I, R, P in RLC circuits; phasor diagrams of RLC circuits

Resonance: conditions; resonance and frequency; effects on current

Ideal transformer: operating principles; primary and secondary voltage and current; applications

Wiring techniques.

Isolation and tagging

Standards: purpose; standard bodies; applications

Using standards: terms; numbering system; sections and clauses

Cables: terms; colour coding; structure; identification cables; cable applications

Wiring systems: enclosures and supports; selecting wiring systems; segregation; physical positioning

Terminations: requirements; terminating conductors; extension cords

Accessories and fixings: applications; licencing for explosive powered tools; fixing devices and methods

Installation and configuration for CPE 1.

Installation preparation and execution processes; communication skills; CPE system facilities; public switching network facilities; CPE equipment and system types available; practical/physical installation cabling and restrictions; cable preparation; importance of capacitances, versions and issues of system types; structure of CPE and external/add-on items such as voicemail and call accounting devices; importance of system specifications and limitations; estimating using “average” installation times; standard items used in general installation; variables which affect installation; consequences of interrupting customer communication services; site restoration processes after CPE installation; administrative processes after CPE installation and site records; processes for the disposal of recovered material; minor installation and alterations on key systems using system manuals; Minor installation and alterations on PABX’s using system manuals; interface cabling on key systems using system manuals; interface cabling on PABX’s using system manuals;

outline of radio-based CPE; outline of CPE cut-over processes and procedures; installation warranty, manufacturer warranty, maintenance contracts and agreements; reasons for customer training; assessing appropriate customer training

Principles of CPE 1.

CPE equipment overview: types; differences; advantages

CPE test systems: types; facilities; operations; night service; programming procedures; remote diagnostics and maintenance

CPE cabling overview: PSTN vs. ISDN; Cabling differences in PABX and key-systems; least-cost-routing; ancillary equipment

Terminating and distributing: types of distribution points; terminating types; using systems manuals

CPE facilities overview: fail safe devices; call management; accounting

Safety

Network operations and facilities.

Switching systems within the network: PSTN (Public Switched Telephone Network); ISDN (Integrated Services Digital Network); mobiles; IN (Intelligent Network)

Network customer facilities: PSTN Services; ISDN Services

Network business services: analogy of PABX to business group; business group concept

Network testing and supervision facilities: command testing; command controlled test calls; test blocking; call path tracing; traffic supervision; blocking supervision; load supervision

Switching principles.

Switching principles: analogue; digital; information signals; line signals

Types of switching centres: electromechanical; processor controlled

Switching centre facilities

Switching centre block diagram and functions of the parts: AXE; S12

Supervisory tones

Connections: MDF; DDF

Testing of customer lines

Testing equipment.

Cable performance parameters: short circuit, open circuit, foreign battery, DC continuity; characteristic impedance and impedance regularity; NEXT (near end crosstalk) and FEXT (far end crosstalk); attenuation per unit length; shunt

capacitance per unit length; loop resistance per unit length; impulse noise and average noise

Range of tests and their purpose

Standard colour coding of sockets and termination modules and standards connectors used with twisted pair, coaxial cable and optical fibre

Equipment types-principles of operation, uses: cable and pair locater; continuity testers; megger; multimeters; MTDR; category 5 testers; OTDR; O/F light source and power meter; techniques to ensure accuracy and repeatability; instrument suitability and accuracy; calibration procedures; conformity to AS3902

Sampling to AS1199

Compliance testing: category 5 compliance to AS3080-95. IS11801 and TSB67; optical fibre cabling to AS3080-95 and IS11801; coaxial cable to IEEE802.3

Third party testing

Documentation

DC power supplies.

Power supply applications: power supply block diagram (not switch mode); waveform measurements; use of laboratory power supply

Ideal and practical diodes: Ge and Si diodes; current limiting resistors; half-wave and full-wave rectifier circuits – Si diodes; average voltages for half-wave and full-wave rectifier circuits

Capacitive filtering: ripple voltages; based on load variations; based on capacitor choice

Zener diode applications

Three terminal regulators

Power supply faults and repair

Local area networks.

LAN concepts; cabling arrangements; standards; network operating systems; LAN access control methods; LAN network components – PCs, file servers, network printer; LAN management; wide area networks; LAN internet working; TCP/IP concepts; virtual LANs; network maintenance and fault-finding

Standards and Regulations – Telecommunications.

Australian Communication Authority (ACA): role; Telecommunication Act 1997

Cabling provider rules, regulations, standards, codes: cabling provider rules; regulations; AS standards; other technical standards; codes; labelling; Certified Components List (CCL)

Registration: mandatory (open, restricted, lift); voluntary; competency requirements and training for registration

Telecommunications cables and installation methods.

Telecommunication cable types, construction, characteristics and applications

Cable identification, labelling and documentation (plans and drawing)

Cable installation: hazards; cable damage prevention; cable dispensers

Building construction: domestic buildings; commercial buildings

Fixing devices

Cable enclosures: types; fixing; regulations

Distribution boxes and back mounts: systems; termination boundaries and devices

Electrical connections: hazards; regulations

Cable preparation and terminations

Hauling mechanisms: indoor; outdoor; methods

Drawing interpretation and sketching.

Technical drawing standards appropriate to the industry sector, conventions and specifications to AS 1100, with strong emphasis on interpretation: sheet types, title block information, materials parts list, revision table, grid referencing scales, line types – visible outlines, hidden outlines, dimensioning lines, centre lines; orthogonal projection of views – 3rd angle (detail and assembly drawings); mechanical conventions; fabrication conventions; three dimensional view drawings – axonometric, isometric, oblique; sectioning standards and conventions – whole, part; engineering drawing symbols, components and equipment – mechanical, electrical, electronic, computer, instrument, refrigeration; dimensioning – orthogonal, isometric; layout and plans; geometric tolerance interpretation (straightness, flatness, squareness, parallelism and concentricity only); engineering abbreviations; drawing interpretation techniques – detail drawings, orthogonal projection (3^{rd} angle only) and three dimensional, assembly drawings and three dimensions exploded (e.g. as in equipment manuals)

Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3rd angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

Telecommunications systems overview.

Principles and characteristics of sound

Transmission of sound

Telephone transmitters

Telephone receivers

Telephone circuits: components; operation of basic telephone; operation of basic facsimile machine; cables used, colour and termination types

Overview earthing and protection

Customer switching systems (CSS), interfaces and devices: System Distribution Frames (SDF)/Test Point Frames (TPF), power fail and line interface requirements (eg indial, rotary groups, extension and tie-line circuits)

Installation of CSS

Installation and termination requirements overview: ACA regulations and requirements; technical standards; programming of CSS

Hazards: electronic components and circuits; printed circuit boards; physical; static discharge; chemical

Telecommunications earthing and protection.

Telecommunication overvoltage protection system: operating principles; overvoltage and surge/spike suppression protection techniques; overvoltage protection devices; installation of overvoltage protection systems

Earthing protection system: MEN system; TELEX functional earth system; telecommunication system earthing; communication earth system; protective earth barriers for segregation, cable tray, duct and metal equipment enclosures

Electrical interference: types – RFI, EMI; sources of interference; techniques in reducing interference; earthing cable shields

Testing of systems: earth testing instruments; earth testing procedures

Earthing hazards: safety issues to be considered with earthing and bonding

Telecommunications structured cabling.

Category 5 structured cabling design principles

Category 5 structured cabling installation systems

Category 5 structured cabling performance requirements

Selecting cable and cabling hardware

Testing category 5 cabling

Local area network cabling systems

Coaxial cables

Coaxial cable installation systems

Twisted pair cable installation systems

Telecommunications optical fibre cabling.

Operating principles of fibre optical cable

Installation of fibre optical cable

Termination and splicing techniques

Transmission testing

Fault-finding

Testing according to requirements and OH&S guidelines

Application software.

Introduction to computers: types of computers; hardware identification; peripherals; common computer terminology

Introduction to computer operating systems: MS Windows – current versions; Windows NT; Macintosh; other operating systems

Computer usage: load and run a simple program; enter data; save data; retrieve data; manipulate data

Software applications: office support – word processing, database, spread sheet, graphics, record keeping (stores, bill back); communication – email, schedule, fax; networks; machine control

Specialisation: Fire protection

Building automation fire protection installation.

Purpose of automatic fire detection and alarm systems: preservation of life; protection of buildings and equipment

Standards and codes: general legislation and codes; specific legislation – Halon systems, ionisation smoke detectors; legal liability

Fire characteristics: principles of fire detection – fire growth; principles of fire suppression

Generic automatic fire detection and alarm system: overview of automatic fire detection and alarm system

Fire detection actuating devices: fire detector classification; detector patterns; detector types, principles of operation and performance; heat detectors – electro-pneumatic, fusible alloy, bimetallic, solid state, thermo-plastic; smoke detectors – ionisation, photo-electric, beam light obscuration, sampling light scatter

(aspirating); flame detectors – infra-red, ultra-violet, manual call points; special purpose detectors – flammable vapour/gas detectors, explosion detectors

Control and indicating equipment (CIE): fire panels; classification; types; principles of operation; installation; commissioning report as per AS 1670

Emergency warning and intercommunication system (EWIS): purpose; types; installation; codes and requirements; manufacturers' specifications and requirements – AS3000 series, AS1670, AS2220, AS1668

Alarms: local alarms – purpose, types, installation; transmitted alarms – purpose, types, installation; control outputs – purpose, types, installation; pump control – purpose, pump actuation; codes and requirements – manufacturers' specifications, manufacturers' requirements for handling; building codes Australia – AS1668, AS1670, AS1851

Suppression systems: sprinkler systems; sequence of operation; purpose of interfacing devices; special purpose gaseous, dry chemical, foam, explosion suppression; suppression actuating devices; purpose; sequence of operation; purpose of interfacing devices; types of interfacing devices; installation of interfacing devices; purpose of actuation devices; types of actuation devices; installation of actuation devices; codes and requirements – manufacturers' specifications, manufacturers' requirements for handling; building codes Australia – AS1670, AS1851, AS1668

Cabling: types of fire cables – mineral insulated metal sheathed cable (MIMS), radox cable, data cable, fibre optic cable; codes and requirements – manufacturers' specifications and requirements, AS3000 series, AS1670, ACA standards; installation of fire cables; detector selection – detector installation; detection systems – conventional, distributed, network; detection system installation; codes and requirements; manufacturers' specifications; manufacturers' requirements for handling; building codes Australia – AS1670, AS1851, AS3000

Specialisation: Networks

Telecommunications underground cabling.

Underground construction: man hole and pit; location; capacity; purpose; duct seal; conduit

Ducts: capacity (number of cables and size); types of ducts (concrete, plastic, earthen ware, metallic)

Cable types: cable types (optical fibre, plastic, lead, CATV, other); cable details (size, type, depth, duct and cable, amplifiers, existing joints); labelling cable

Hazards: dangerous gases; toxic fumes; sharpes; ventilation; maintenance of working environment; precautions

Working environment: light and ventilation; road way and footway guarding; debris; temporary cables/services; regulations (total fire ban, discharge of water, vehicle parking restrictions, tree lopping/trimming)

Mechanical and manual aids: mechanical aid; manual aid; storage; inspection

Telecommunications aerial cabling.

Safe working environment: protective suits; masks; safety boots; head protection; safety glasses; knee pads, gloves (plastic, rubber, leather), ear muffs; witches hats; flashing lights; guards; warning signs and tapes; traffic signs and vehicle positioning; weather conditions; pole voltage (high and/or low)

Soundness of pole: authority markings; tests (push, knock, visual, dig and visual); public and private property requirements

Safety practices: safety belt; safety line; ladder

Pole top rescue: personal safety; first aid techniques (heart lung resuscitation, emergency procedures)

Aerial construction: purpose and connection/fixing requirements; types of construction (power, telephony, broadband, cable TV); suspension types and systems; pole types (wood, concrete, steel, composite); regulations (ACA, power authorities, local council); standards and codes of practice

Cable plans: size; type; existing and new joints

Data communications.

Standards: elements of data communication system; transmission modes (simplex, half and full-duplex); transmission techniques; voice transmission fundamentals; interfacing devices and standards; OSI seven layer model; modem fundamentals; modem modulation techniques; integrated services digital network (ISDN); packet switching services, X.25

Network operating systems.

Network systems: mainframe; mini computers; microcomputers

WANs: protocols; protocol stacks; interconnectivity

LANs: protocols; terminal emulation

Operating systems: NT; UNIX; LINUX; Netware; Windows 95; other OS

Administration: duties; responsibilities; procedures; user access; managing and configuring attached devices

TCP/IP: protocols; services; IP addressing scheme; routing; OSI model relationship; network address; broadcast address; multicast; fragmentation; PPP implementation; bridging; network address translation

Equipment installation: driver loading; testing; troubleshooting

Specialisation: Security systems

Security systems.

Regulations applicable to the security industry

Design of domestic security system

Building construction

Mechanical detectors: pressure pads; trip wires; window tape; screens; switches; vibration

Electro-mechanical detectors: ultra sonic; microwave; glass break; smoke; active infra-red beams; passive infra red; strain system; electromagnetic; optical fibre cable

Batteries: types; applications; maintenance

Relays: types; applications

Security panels

Communication systems

Close circuit television (CCTV)

Locking devices

Lighting

Advanced security systems.

Fibre optics – applications, terminations, physical properties; intrinsically safe wiring – where needed, alternatives; modems – commands, uses

UTE NES107 (A to Z qualifier) A
Install explosion-protected equipment & wiring systems

Descriptor: Install *explosion-protected equipment* and *other items* in the circuit, including wiring.

Alignment: This unit aligns to the Competency Standard 'Electrical equipment in hazardous areas' CS-EEHA-001-1998, unit NEE 003.

Specific unit outcomes

This is a composite unit that can be achieved in any of seven *endorsements* related to explosion protection techniques. This is done because of the high degree of commonality in knowledge, process and function. Reporting the unit with the inclusion of one or more *endorsements* will identify the necessary applied skills related to workplace outcomes and at the same time reflects the work classification(s) generally understood by industry. The specific unit *endorsements* are:

UTE NES107T A	Install explosion-protected equipment & wiring systems *(Mixed explosion-protection techniques Ex mixed)*
UTE NES107U A	Install explosion-protected equipment & wiring systems *(Pressurised enclosure Ex p)*
UTE NES107V A	Install explosion-protected equipment & wiring systems *(Dust-exclusion ignition-proof Dip)*
UTE NES107W A	Install explosion-protected equipment & wiring systems *(Non-sparking Ex n)*
UTE NES107X A	Install explosion-protected equipment & wiring systems *(Intrinsic safety Ex i)*
UTE NES107Y A	Install explosion-protected equipment & wiring systems *(Increased safety equipment Ex e)*
UTE NES107Z A	Install explosion-protected equipment & wiring systems (*Flameproof enclosure Ex d)*

Elements		Performance criteria	
107.1	Prepare for installation of equipment and wiring	107.1.1	*OH&S policies and procedures* for preparing to work in a hazardous area are followed
		107.1.2	Types of explosion-protected equipment and wiring systems to be installed are verified from design documents
		107.1.3	Location in which specific items of equipment and circuits are to be installed is determined from design documents

Elements		Performance criteria	
		107.1.4	Explosion-protected equipment markings are checked to ensure they conform to design specifications and *certification documents*
		107.1.5	*Certification document* supplied with each item of equipment is collected for forwarding to appropriate personnel
		107.1.6	*Special tools, equipment* and *testing devices* needed to carry out the installation work are obtained and checked for correct operation and safety
107.2	Install the equipment and wiring systems	107.2.1	*OH&S policies and procedure* for working in a hazardous area are followed
		107.2.2	Equipment is installed to conform with design specifications, standards and within the limits specified by the equipment certification
		107.2.3	Equipment and wiring system components are dismantled where necessary and parts stored to protect them against loss or damage
		107.2.4	Equipment and wiring are installed in a manner that does not reduce the type of protection afforded by the equipment design
		107.2.5	Circuits are tested prior to connection to devices to ensure *resistance of earthing is sufficiently low*, installation resistance is safe and polarity and connections are correct and each circuit complies with *requirements*
107.3	Confirm that the installation is completed	107.3.1	Arrangements are made, in accordance with *requirements*, for an initial inspection to be carried out on the installation
		107.3.2	Appropriate action is taken to rectify non-conformances found during the initial inspection to ensure the installation complies with *requirements*
		107.3.3	The completed installations is documented in accordance with *requirements* and forwarded to personnel responsible for compiling the *verification dossier*

Range statement

General

Generic items in this unit are shown in italics, e.g. *established procedures*. The definition and scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Endorsements

Competency can be demonstrated in relation of the to any classified hazardous areas listed:

(T) Mixed explosion-protection techniques Ex mixed

(U) Pressurised enclosure Ex p

(V) Dust-exclusion ignition-proof DIP

(W) Non-sparking Ex n

(X) Intrinsic safety Ex i

(Y) Increased safety equipment Ex e

(Z) Flameproof enclosure Ex d

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating *consistent performance* for each element of the unit.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace.
- demonstrating an understanding of the underpinning knowledge and skills identified in the section, of this unit titled 'Underpinning knowledge'.

Competence must be demonstrated in relation to the explosion-protection techniques for which competency is sought. It is essential that the following aspects of competency be demonstrated:

- working safely in a potentially hazardous area in relation to, work permits and clearances, hazard monitoring and evacuation procedures, and plant and electrical isolation;
- handling and installing equipment and wiring in a manner that does not reduce the type of protection afforded by the equipment design;
- checking equipment against certification documents and design specifications;
- documenting installation completion.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of *plant, equipment,* tools, *accessories, components* and the like for the *category* undertaken within a unit of competency; autonomously and to requirements. Equivalent evidence from other sources is also acceptable.

Interdependent assessment of units

Competence in this unit should be assessed only after competency related to the installation of general electrical equipment and wiring systems has been achieved at *AQF* Certificate III level. Similar competency and qualifications relating to instrument and electronic equipment would be sufficient prerequisite where explosion-protected equipment operates at extra-low voltage.

Underpinning knowledge

Evidence of knowledge related to hazardous areas and to Ex mixed, Ex p, DIP Ex n, Ex i, Ex e and Ex d and any other technique relevant to a particular workplace is required. The following is a summary of knowledge related to hazardous areas:

Safe working requirements and procedures; definition of a hazardous area; conditions that lead to an explosion.; meaning of the terms "combustion", "detonation" and "propagation"; OH&S responsibilities; parties responsible for safety of hazardous areas; definition of classes and zones; identify classes, zones and groups from system design documentation; characteristics of an explosive atmosphere (LEL/UEL) and relationship to ignition energy; combustible properties of materials

The following is a summary of knowledge of explosion-protected equipment and applicable to an explosion-protection technique:

Method of explosion protection; mechanisms of explosion protection employed by a technique; interpretation of installation limitations specified in certification and approval documentation; requirements of electrical protection devices; application and limitations of equipment; identification of gas grouping and temperature class of equipment; parties responsible for certification/approval system; temperature limitations of wiring and equipment; limitations on non-metallic and specific alloy enclosures; interpretation of equipment marking; application, selection and use of fasteners; requirements for testing circuits; requirements for initial inspection of installations; standards and procedures for terminating and connecting cables; relationship between equipment, cables and glands; standards and requirements for the installation of equipment and wiring; selection and application of sealing compounds; actions and conditions that will void explosion-protection; standards for wiring systems in hazardous areas; requirements for establishing and maintaining hazardous area records (site dossier)

UTE NES108 A
Install overhead communications cables

Descriptor: Install cable support systems, cables and *accessories* used for communications purposes on poles and canteneries.

Alignment: Nil.

Elements		Performance criteria	
108.1	Plan and prepare for installation	108.1.1	Installation is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		108.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		108.1.3	Components necessary for undertaking installation are checked against job *requirements*
		108.1.4	Accessories are obtained in accordance with *established procedures* and to comply with *requirements*
		108.1.5	Location in which specific items of accessories, *apparatus* and circuits are to be installed is determined from job *requirements*
		108.1.6	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		108.1.7	*Tools, equipment* and *testing devices* needed to carry out the installation work are obtained in accordance with *established procedures* and checked for correct operation and safety
		108.1.8	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*
108.2	Install overhead communications cables	108.2.1	*OH&S policies and procedures* for installing electrical wiring systems are followed
		108.2.2	Overhead cables are installed in accordance with *requirements*, without damage or distortion to the surrounding environment or services
		108.2.3	*Accessories* are *terminated* and connected in accordance with *requirements*

Elements		Performance criteria	
		108.2.4	Unplanned events or conditions are responded to in accordance with *established procedures*
		108.2.5	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		108.2.6	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
108.3	Inspect and notify completion of work	108.3.1	Final inspections are undertaken to ensure the installed *wiring systems* conforms to *requirements*
		108.3.2	Work completion is *notified* in accordance with *established procedures*

Range statement

General

Generic items in this unit are shown in italics, e.g. *established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating *consistent performance* for each element of the unit.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace.

- demonstrating an understanding of the underpinning knowledge and skills identified in the section, of this unit titled 'Underpinning knowledge'.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

Assessment in this unit is related to the knowledge associated with other units within a qualification structure, where appropriate.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Telecommunications aerial cabling.

Safe working environment: protective suits; masks; safety boots; head protection; safety glasses; knee pads, gloves (plastic, rubber, leather), ear muffs; witches hats; flashing lights; guards; warning signs and tapes; traffic signs and vehicle positioning; weather conditions; pole voltage (high and/or low)

Soundness of pole: authority markings; tests (push, knock, visual, dig and visual); public and private property requirements

Safety practices: safety belt; safety line; ladder

Pole top rescue: personal safety; first aid techniques (heart lung resuscitation, emergency procedures)

Aerial construction: purpose and connection/fixing requirements; types of construction (power, telephony, broadband, cable TV); suspension types and systems; pole types (wood, concrete, steel, composite); regulations (ACA, power authorities, local council); standards and codes of practice

Cable plans: size; type; existing and new joints

UTE NES109 A
Install below ground communications cables

Descriptor: Install cable support systems, cables and *accessories* in conduits and tunnels under the surface of the ground.

Alignment: Nil.

Elements		Performance criteria	
109.1	Plan and prepare for installation	109.1.1	Installation is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		109.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		109.1.3	Components necessary for undertaking installation are checked against job *requirements*
		109.1.4	Accessories are obtained in accordance with *established procedures* and to comply with *requirements*
		109.1.5	Location in which specific items of accessories, *apparatus* and circuits are to be installed is determined from job *requirements*
		109.1.6	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		109.1.7	*Tools, equipment* and *testing devices* needed to carry out the installation work are obtained in accordance with *established procedures* and checked for correct operation and safety
		109.1.8	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*
109.2	Install below ground communications cables	109.2.1	*OH&S policies and procedures* for installing electrical wiring systems are followed
		109.2.2	Below ground cables are installed in accordance with *requirements*, without damage or distortion to the surrounding environment or services
		109.2.3	*Accessories* are *terminated* and connected in accordance with *requirements*

Elements		Performance criteria	
		109.2.4	Unplanned events or conditions are responded to in accordance with *established procedures*
		109.2.5	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		109.2.6	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
109.3	Inspect and notify completion of work	109.3.1	Final inspections are undertaken to ensure the installed *wiring systems* conforms to *requirements*
		109.3.2	Work completion is *notified* in accordance with *established procedures*

Range statement

General

Generic items in this unit are shown in italics, e.g. *established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating *consistent performance* for each element of the unit.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace.

- demonstrating an understanding of the underpinning knowledge and skills identified in the section, of this unit titled 'Underpinning knowledge'.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

Assessment in this unit is related to the knowledge associated with other units within a qualification structure, where appropriate.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Telecommunications underground cabling.

Underground construction: man hole and pit; location; capacity; purpose; duct seal; conduit

Ducts: capacity (number of cables and size); types of ducts (concrete, plastic, earthen ware, metallic)

Cable types: cable types (optical fibre, plastic, lead, CATV, other); cable details (size, type, depth, duct and cable, amplifiers, existing joints); labelling cable

Hazards: dangerous gases; toxic fumes; sharpes; ventilation; maintenance of working environment; precautions

Working environment: light and ventilation; road way and footway guarding; debris; temporary cables/services; regulations (total fire ban, discharge of water, vehicle parking restrictions, tree lopping/trimming)

Mechanical and manual aids: mechanical aid; manual aid; storage; inspection

UTE NES110 A
Install & maintain fluid measurement equipment

Descriptor: Install and maintain fluid measurement, transmission, convertor and final control equipment.

Elements		Performance criteria	
110.1	Plan and prepare for installation and maintenance of fluid measurement equipment	110.1.1	Installation and maintenance is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements.*
		110.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site.
		110.1.3	Installation and maintenance work is checked against job *requirements*.
		110.1.4	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements.*
		110.1.5	*Tools, equipment* and *testing devices* needed to carry out the work are obtained in accordance with *established procedures* and checked for correct operation and safety.
		110.1.6	Preparatory work is checked to ensure no unnecessary damage has occurred, minimal disruption has occurred and the work complies with *requirements.*
110.2	Install and maintain fluid measurement equipment, software and associated circuits.	110.2.1	*OH&S policies and procedures* are followed.
		110.2.2	*Circuits* are checked as being isolated where necessary using specified testing procedures.
		110.2.3	Installation and maintenance of *apparatus* and associated *circuits* is carried out in accordance with *requirements.*
		110.2.4	Installation and maintenance of *apparatus* and associated *circuits* is carried out without damage and minimal disruption to the building or services.
		110.2.5	Unplanned events or conditions are responded to in accordance with *established procedures.*

Elements		Performance criteria	
		110.2.6	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented.
		110.2.7	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
110.3	Inspect and notify completion of work	110.3.1	Final inspections are undertaken to ensure the installation and maintenance conforms to *requirements.*
		110.3.2	Work completion report(s) are completed and *notified* in accordance with *established procedures.*

Range statement

General

Generic items in this unit are shown in italics, e.g. *established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating *consistent performance* for each element of the unit.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace.
- demonstrating an understanding of the underpinning knowledge and skills identified in the section, of this unit titled ‘Underpinning knowledge’.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

Nil.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials, types, applications; techniques, marking out, cutting, bending, drilling/punching, soldering, cutting mitres

Assembly/disassembly techniques

Electrical theory.

Fundamental and derived units: basic units; SI derived units; multiples and sub-multiples

Power, work and energy: conservation of energy; torque; losses and efficiency; maximum efficiency of machines

Electrical characteristics of materials: conductors, insulators, semi-conductors; electric charge; electric current; electromotive force

The simple circuit: source, load, current path and control; open-circuit; short-circuit

Resistance: Ohm's law; determine V, I, R; power dissipation

Effects of current: physiological effects; principles of protection from physiological effects; conversion of electrical energy to other forms (heating, light, magnetic, chemical)Sources of electrical energy - conversion of other forms to electrical energy

Using measuring instruments: handling measuring instruments; selecting an instrument; setting-up and connecting into circuits; reading scales and read-outs; setting up a CRO

Factors effecting resistance: length, csa and resistivity; temperature change; influence on practical circuits

Resistors: types and applications; value and rating

Series circuits (single source): determine V, I, R, P; Kirchhoff's Voltage Law; voltage divider

Parallel circuits: determine V, I, R, P; Kirchhoff's Current Law; current divider

Series/parallel circuits: determine V, I, R, P; bridge networkResistance measurement: hazards; characteristics of instruments and loading effect; direct, volt-ammeter and bridge method; typical field instruments and applications

Capacitance: concept; units; time constant relationshipCapacitors: hazards; factors effecting capacitance; in series; in parallel; measuring/testing/hazards

Inductance: concept; units; time constant relationship

Inductors: factors effecting inductance

Circuit protection.

Earthing and earthing systems: reasons for earthing; AS3000 requirements for an effective earthing system; direct, MEN and ELCB - voltage operated earthing system; principles of operation of each earthing system; layouts of typical earthing of electrical installations; advantages of each earthing system

Circuit protection: causes and effects of excess circuit current and voltage; high level short circuit current - fault current; overload protection requirements; understand circuits protection terminologies relative to prospective fault current, discrimination, inverse and definite minimum time; methods of providing arc control in protection devices - both AC and DC; circuit protection devices, their operating parameters and ratings; voltage dependent circuit protection devices - surge protection

Supplementary earthing protection: isolation; operating principles of RCDs; circuit arrangement for RCDs, single and three phase

Basic power supplies (D.C.).

Rectifier diode: P-N junction; silicon and germanium characteristics; diode specifications; terminal identification; diode ohm meter testing

Half wave rectifier: basic circuit; VAC/VDC relationship; peak inverse voltage; measurement and testing

Centre tapped full wave: basic circuit; VAC/VDC relationship; peak inverse voltage; measurement and testing

Bridge rectifier: basic circuit; VAC/VDC relationship; measurement and testing

Three phase rectifiers: half wave; full wave; waveforms; % ripple; calculations of V and I for resistive loads

Basic filter circuits: capacitor; inductive; L section; Pi section

Zener regulators: zener diode characteristics; shunt regulator circuit; regulator specifications; line/load regulation; series resistor calculations; applications

Three-terminal regulators: characteristics and specifications; connection diagram; circuit stability requirements; reverse voltage protection methods

Dual polarity supplies: need for dual polarity; basic IC dual polarity regulator

Basic power supply protection: fuses; VDRs; LCR networks

Concepts of instrumentation.

Flow, temperature, pressure and other appropriate measurements

Appropriate terminology: span, range, accuracy, precision, errors, zero, repeatability, sensitivity, hysteresis, etc. (select from AS1541)

Development of SI units, engineering and scientific notation, imperial and metric conversion using calculations, mm Hg, mm Hg, Pa (hPa, Kpa, Mpa etc.), inches water, PSI, etc. also non-standard SI units – kgcm2, etc.

Instrumentation standards (brief overview only): ISA (Instrumentation Society of America); ISO (International Standards Organisation); SAMA (Scientific Apparatus Manufacturers America); BSI (British Standards Institution); AS (Australian Standards); ANSI (American National Standards Symbols and Terminology); Manufacturer Calibration Standards; fluids in process piping colour coding

Identification and purpose of instruments measuring processes directly and those measuring indirectly

Signal transmission of two-wire, 20-100 kPa, 4-20 mA, 1-5V, other applicable standards

Principles of levers, links and calibration of indicator recorder instrument

Application of safety standards at all times (tools, lifting techniques, electrical safety and CPR, pressure lines, housekeeping)

Interpretation of appropriate graphs and tables associated with instrumentation

Fluid density.

Definitions

Factors affecting density including; relative density, Pressure = density x gravity x height

Types of level detectors, including Float (open and closed tanks); displacement type; sight gauges; air purge (bubble pipe); differential pressure cells (electronic and pneumatic types use in open and closed tanks wet and dry legs); span elevation and suppression; SMART transmitters; 1:1 repeaters (application of); diaphragm box; electronic hydrostatic head; ultrasonic; capacitance; resistance; nucleonic, radar

Calculation of range, span, span elevation and suppression; calibrate electronic and pneumatic differential pressure cell transmitters to suit level or density application; calibrate a variety other types of level / density sensors as resources allow; configure a differential pressure transmitter for a level measurement situation

Connection into a two wire system; connection of pneumatic systems

Fluid flow.

Laws and characteristics of fluid flow; turbulent and laminar flows (brief review only); difference between gas and liquid flow

The construction, characteristics and operation of: oval meters, gear meters, reciprocating pistons, notating discs and gas meters; flow rate meters including the turbine, vortex, magnetic flow and Coriolis type meters. A range of shapes of flumes and weirs, a range of differential head flow rate meters which includes the orifice plate, venturi tube and annular. The construction and installation should include materials, shapes of orifice, gas and liquid drains, tapping points and mounting position of DP transmitter and pipe work

Control valves.

Control valve bodies, bonnet, trim and cage types; inherent and dynamic flow characteristics of characterised trim valves; inherent and dynamic flow characteristics of fixed characteristics valves

Control valve terminology and calculations: operating range/characteristics including leakage, rangeability and turndown, basic calculations and choked flow; Cv rating and sizing including: definition; equations; typical values for common valves; basic calculations; control valve selection using Cv ratings

Spring opposed diaphragm actuators: types and actions; actuator characteristics; actuator applications to suit; calibration adjustments and procedures; ancillary items

Valve positioners: applications of valve positioners; valve positioner types including motion balance, force balance, cam feedback, spring feedback, electro-pneumatic; calibration/adjustment of valve positioners including starting point and gain (stroke), split-ranging

Self acting control valves: operation of self-acting control valves including pressure regulating valves, temperature regulating valves; performance characteristics of self-acting control valves; installation of self-acting control valves; calibration/adjustment

Piston actuators/power cylinders: types of position; characteristics of piston; applications of piston actuators; testing and maintenance; calculation of thrust force of advance and retract strokes; installation and accessories

Position controllers (positioners): types and application; characterised actuation; calibration/adjustment

Directional control valves (pilot operations) for piston actuators: types/porting arrangements; applications; actuation methods; air supply and lubrication

Transmitters and converters.

Principles of flapper nozzles, pneumatic transmitters, supplementary pneumatic loop equipment eg. computing relays, lead/lag units, high and low selectors, air to current and current to air converters, square root extractors, integrators, regulators, multipliers and dividers

Electronic transmitters, analog computing, integrators, high and low signal selector, signal converters and transducers.

Manufacturers handbooks, maintenance procedures and calibration

Intrinsic safety including zener barriers and explosion/flame proof enclosure

UTE NES111 A
Assembly processes

Descriptor: Undertake assembly and fault identification and correction on printed circuit boards.

Elements		Performance criteria	
111.1	Prepare carry out basic assembly work	111.1.1	Assembly work is prepared to ensure *OH&S policies and procedures* are followed
		111.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved
		111.1.3	*Apparatus* maintenance schedules and specifications are checked against *requirements*
		111.1.4	Materials needed to complete the work are obtained in accordance with *established procedures*
		111.1.5	*Tools* and *testing devices* needed to carry out the work are checked for correct operation and safety
111.2	Carry out basic assembly work	111.2.1	*OH&S policies and procedures* are followed
		111.2.2	Assembly is checked to *requirements*
		111.2.4	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
111.3	Carry out corrections to process	111.3.1	*OH&S policies and procedures* are followed
		111.3.2	Assembly process is isolated where necessary using specified testing procedures
		111.3.3	Process is corrected in accordance with *established procedures* and repair routines
111.4	Inspect and notify completion of work	111.4.1	Final inspections are undertaken to ensure the repair of *apparatus* conforms to *requirements*
		111.4.2	Work completion is *notified* in accordance with *established procedures*

Range statement

General

Generic items in this unit are shown in italics, e.g. *established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating *consistent performance* for each element of the unit.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace.
- demonstrating an understanding of the underpinning knowledge and skills identified in the section, of this unit titled 'Underpinning knowledge'.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

Nil.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Common

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials, types, applications; techniques, marking out, cutting, bending, drilling/punching, soldering, cutting mitres

Assembly/disassembly techniques

Electrical theory.

Fundamental and derived units: basic units; SI derived units; multiples and sub-multiples

Power, work and energy: conservation of energy; torque; losses and efficiency; maximum efficiency of machines

Electrical characteristics of materials: conductors, insulators, semi-conductors; electric charge; electric current; electromotive force

The simple circuit: source, load, current path and control; open-circuit; short-circuit

Resistance: Ohm's law; determine V, I, R; power dissipation

Effects of current: physiological effects; principles of protection from physiological effects; conversion of electrical energy to other forms (heating, light, magnetic, chemical)

Sources of electrical energy - conversion of other forms to electrical energy

Using measuring instruments: handling measuring instruments; selecting an instrument; setting-up and connecting into circuits; reading scales and read-outs; setting up a CRO

Factors effecting resistance: length, csa and resistivity; temperature change; influence on practical circuits

Resistors: types and applications; value and rating

Series circuits (single source): determine V, I, R, P; Kirchhoff's Voltage Law; voltage divider

Parallel circuits: determine V, I, R, P; Kirchhoff's Current Law; current divider

Series/parallel circuits: determine V, I, R, P; bridge network

Resistance measurement: hazards; characteristics of instruments and loading effect; direct, volt-ammeter and bridge method; typical field instruments and applications

Capacitance: concept; units; time constant relationship

Capacitors: hazards; factors effecting capacitance; in series; in parallel; measuring/testing/hazards

Inductance: concept; units; time constant relationship

Inductors: factors effecting inductance

Wiring techniques.

Electrical/electronic safety testing: isolation; testing; tagging; earthing; appliance electrical safety testing

Standards pertinent to industry sector: purpose; standards bodies; applications

Cables: types, power, signal; terms; colour coding; structure; identification cables; cable applications

Wiring systems: wiring looms; enclosures and supports; selecting wiring systems

Connectors and terminations: requirements; connectors, types and applications, assembly/disassembly; terminating conductors, extension cords

Accessories and fixings appropriate to industry sector: applications; fixing devices and methods

Parts and component selection.

Part/component identification: name; basic function; mounting/fixing arrangements

Information about parts and components: catalogues (structure of reference books, different and common features)

Computer access (starting the computer and moving around the screens)

Telephone inquiry (knowing who to ask for and posing the right question)

Each of the above with respect to the following: part codes (alpha numeric numbers) and what they mean; manufacturers and manufacturers supply outlets; availability and delivery times; price, including discounts, tax and delivery costs; alternative parts

Ordering procedures: customer approval; supplier requirements; in-house requirements

Receiving/dispatch procedures: supplier requirements; in-house (enterprise) requirements; handling and storage

Drawing interpretation and sketching.

Technical drawing standards appropriate to the industry sector, conventions and specifications to AS 1100, with strong emphasis on interpretation: sheet types, title block information, materials parts list, revision table, grid referencing scales, line types – visible outlines, hidden outlines, dimensioning lines, centre lines; orthogonal projection of views – 3rd angle (detail and assembly drawings); mechanical conventions; fabrication conventions; three dimensional view drawings – axonometric, isometric, oblique; sectioning standards and conventions – whole, part; engineering drawing symbols, components and equipment – mechanical, electrical, electronic, computer, instrument, refrigeration; dimensioning – orthogonal, isometric; layout and plans; geometric tolerance interpretation (straightness, flatness, squareness, parallelism and concentricity only); engineering abbreviations; drawing interpretation techniques – detail drawings, orthogonal projection (3^{rd} angle only) and three dimensional, assembly drawings and three dimensions exploded (e.g. as in equipment manuals)

Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3^{rd} angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

Electronic hand soldering.

Quality concepts: introduction to electrical connections including mechanical, chemical and thermal; concepts of reliability, quality and process control

Preparation of printed circuit boards: assembly tools and equipment used; soldering tools and equipment; maintenance of soldering irons and tips; materials including solder and alloys, thermal bonding and metallurgical properties; flux types, resin flux and properties; cleaning materials (chemical and other); component types, identification and handling techniques; printed circuit board materials including the characteristics of copper cladded boards; visual inspection of printed circuit board assemblies prior to soldering; contamination of materials; standards and testing of cleanliness

Component mounting considerations: lead bending and stress relief of components; mounting of resistors, capacitors, diodes, transistors, integrated circuits and a selection of terminals; component lead termination methods, e.g. fully clinched, semi-clinched and unclinched (rigid lead)

Component mounting and soldering - principles of soft soldering: heat transfer, minimum and maximum heat loads for components and board materials, thermal shock and coefficient of expansion; filleting and heat bridging

Wetting, de-wetting and non-wetting: metallurgical bonding and the formation of inter metallic alloys

Manual soldering of bare copper and plated single and double-sided printed circuit boards (include consideration of layer interconnection using rivets, or through cladding)

Joint validation by visual inspection criteria and common joint non-conformances associated with single and double-sided printed circuit boards; the solder rework of single and double-sided printed circuit boards

Preparation of single and multi-strand insulated wire for lead termination

Terminating coaxial cable

Preparation and termination of coaxial cable by crimped and soldered connection

Reworking soldered connections: soldering of insulated wire to printed circuit board pads and pins; pierced, hooked and cup terminals

Effects and prevention of electrostatic discharge (ESD) and its effects on static sensitive components; precautions in the handling and use of static sensitive components and the materials and techniques available to set up a static-free environment

Printed circuit board assembly fault correction.

Manual screen printing: equipment; process; faults

Automated screen printing: equipment; process; faults

Automated insertion of surface mount components: equipment; process; faults

Reflow Soldering equipment: equipment; process; faults

Automated surface mount assembly

Documentation: product documentation; process documentation; materials audit

OH&S

Solder paste: composition; storage; preparation; testing

Manual solder paste deposition equipment: alignment; paste application; inspection

Automatic solder paste deposition equipment: preparation; operation; inspection

Automatic component placement systems: equipment; preparation; operation

Reflow ovens and solder reflow: principles; reflow ovens; operation

Cleaning: chemical; aqueous; advantages; disadvantages; rosin based flux removal; water soluble flux removal; non-washable components; cleanliness testing

Inspection: visual; electronic

UTE NES112 A
Install and maintain photovoltaic arrays

Descriptor: Size, install and connect free standing or roof-top mounted photovoltaic arrays and associated equipment. Maintenance is also included.

Elements		Performance criteria	
112.1	Plan and prepare for installation/ maintenance	112.1.1	Installation/maintenance is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		112.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		112.1.3	Photovoltaic array is obtained and checked in accordance with *established procedures* and to comply with *requirements*
		112.1.4	Location in which photovoltaic array is to be installed/maintained is determined from job *requirements*
		112.1.5	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		112.1.6	T*ools, equipment and testing devices* needed to carry out the installation/maintenance work are obtained in accordance with *established procedures* and checked for correct operation and safety
		112.1.7	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*
112.2	Install/maintain photovoltaic arrays	112.2.1	*OH&S policies and procedures* for installing/maintaining photovoltaic arrays are followed
		112.2.2	Photovoltaic arrays are installed/maintained in accordance with *requirements*, without damage or distortion to the surrounding environment or services
		112.2.3	Photovoltaic arrays are terminated and connected in accordance with *requirements*
		112.2.4	Unplanned events or conditions are responded to in accordance with *established procedures*
		112.2.5	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented

Elements		Performance criteria	
		112.2.6	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
112.3	Inspect and notify completion of work	112.3.1	Final inspections are undertaken to ensure the installed photovoltaic array conforms to *requirements*
		112.3.2	Work completion is *notified* in accordance with *established procedures*

Range statement

General

Generic items in this unit are shown in italics, *e.g. established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating *consistent performance* for each element of the unit.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace.
- demonstrating an understanding of the underpinning knowledge and skills identified in the section, of this unit titled ‘Underpinning knowledge’.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

This unit should be addressed only after competency in units UTE NES201 B, UTE NES202 B and UTE NES401 B in the specialisation of renewable energy
or
UTE NES106 A of this standard has been achieved.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Photovoltaic system installation techniques.

Types of roofing methods and construction; aspect and roofing angles; rafters and tile battens; cooling of photovoltaic modules and assisted ventilation; surface mounted systems; weatherproofing; safety barriers and other OH&S requirements for roof work; wiring and connecting; PV module connector systems; wind loadings

Frames & frame construction; fixing methods for different roof types; methods for tilt adjustment; orientation to north; mounting on non-north facing roof surfaces; aesthetic considerations; building integrated PV products

PV module blocking and bypass diode installation; minimising cable route length; location of regulators, inverters, d.c. control board and battery

Servicing of batteries, PV array and other components; isolation and safety; shutdown procedures; maintenance of vegetation

Renewable energy technologies.

Non-technical issues: current economic, social, environmental and political issues, impact on a renewable energy technology; topic review

Energy services/demand: terminology; energy, temperature, power, symbols, units; energy conversion and efficiency; domestic dwelling - energy services, energy source selection; primary energy and end use energy

Solar radiation resource: terminology; units, symbols, conversions; sun position, sun path diagrams; solar radiation on fixed and tracking collectors

Wind energy resource and technology: terminology, units, symbols; wind patterns (Australia); local terrain, wind speed, direction, turbulence, wind power; maps, data sheets, measuring instruments, wind energy conversion systems (WECS); characteristics; applications; specifications, sizing

Micro-hydro resource and technology: terminology, units, symbols; flow rates, heads, assessment; turbines; operating characteristics; control requirements; specifications

Biomass resource and technology: terminology; common biofuels – types, energy contents, production, applications; resource assessment

Solar thermal systems: terminology; components; applications; types of hot water systems; system features, orientation, tilt angles, placement; system selection, size, cost

Energy efficient building design: terminology; climate and thermal comfort; thermal conductivity of building elements; solar heat gain; ventilation; glazing; thermal mass; insulation; shading devices; siting of buildings; active solar systems

RAPS system configuration: configuration; components – functions, efficiencies; regulators, inverters, battery chargers, generators

Photovoltaic arrays: terminology; modules (types, efficiency, applications); IV curve; irradiance and temperature effects; blocking and bypass diodes; wiring diagrams, configurations; specification and sizing

Energy storage: terminology; types and methods; battery life, temperature effects, charge and discharge rate; precautions, maintenance, safety; stratification; boosting and equalising charges; specification, capacity, configuration; operating characteristics; types, sizes

Photovoltaic power systems.

PV modules: PV technology types; structure; operating principles; manufacturing methods; efficiency; spectral response; module life; cost

Electrical characteristics: terminology; equivalent circuit; I-V curves, load lines; operating point,; ratings and standards; effect of temperature and irradiance, shading; power output; daily energy output; derating factors

ELV voltage limits, identifying ELV and LV circuits in PV systems, ELV cable and protection sizing: allowable voltage drops; cable current carrying capacity; sizing methods; acceptable fuse and circuit breaker types; fuse and circuit breaker sizing for inverter systems

Schematic and wiring diagrams: PV power systems for various applications; PV water pumping system; architectural diagrams and schedule of equipment; earthing requirements for PV systems

Batteries: Battery types for stand-alone power systems; basic battery chemistry; cycling and temperature effects; stratification; sulphation; charging regimes; factors affecting life (design, operating conditions and maintenance); safe handling practices; specifications and sizing; disposal

PV system components: types, operation, selection and sizing of: inverters; Maximum Power Point Trackers (MPPTs); regulators; battery chargers; generating sets, metering, cabling, protection devices; mechanical tracking devices; industry guest speakers or industry visits

PV powered water pumping systems: selection and sizing of pumps, pipes, fittings; power requirements; motors, mechanical transmissions; array size; selection of complete systems

Basic lighting design: introduction to lighting standards; lamp types and properties; luminaires; effect of decor, wall colour and windows; energy efficiency considerations (type, positioning, switching configuration); lamp sizing principles

Loads types and inverters: electronic equipment (transformer supply; switching power supply); microwave ovens; light dimmers; motors (universal, induction); start-up surge demand; effects of modified square wave supply; lighting inverters;

DC measuring instruments; ammeters, shunts; voltmeters, multiplier resistors; true RMS meters; AC power and power factor; significance of low power factor; power factor correction (principle);

Stand-alone PV system design: system configurations and operation; design according to AS4509; system voltage selection, component selection and sizing; DC control board layout; installation requirements; maintenance; costings, rebates and incentive schemes, load assessment, selection, sizing

Grid connected systems: Testing and approval of inverters; Standards for grid connection of inverters; Islanding and anti-islanding function; Circuit configuration: (metering, isolation, connection with respect to RCDs); Signage;

Protection and isolation equipment for DC array circuits especially at LV; Systems with UPS capability: (inverter ratings, system configuration, battery types, ratings and sizing); Economic and other considerations: (sizing of PV array; metering, tariffs and electricity purchase arrangements; institutional, legislative and regulatory environment; rebates and incentive schemes)

System installation and commissioning: site locations (array, batteries, components); array mounting frames; battery room layout; installation requirements; generating sets; shut-down and power up procedures; commissioning of systems; testing faults installation and maintenance to AS4509 and other relevant standards

Electronic components in renewable energy systems.

Diodes: rectifier diodes (electrical characteristics, ratings, circuit symbol, example circuits - gating, flywheel diode, bypass and blocking diodes in PV arrays); LEDs, Zeners, Schottky diodes (characteristics, applications and circuit symbols)

Electronic concepts and terminology for selection of renewable energy system components: concept of rectification and concept of filtering and ripple; efficiency and sources of energy loss in electronic system components; switchmode circuits compared to linear: features/ advantages and disadvantages; Radio Frequency Interference (RFI) - causes and cures (basic); Pulse Width Modulation (PWM): principles, renewable energy applications; digital electronics: analog vs digital, representation of information in binary form, logic as the basis of digital circuits, D/A and A/D converters; DC/DC converters (concept and principles, R.E. applications); inverters (concept of inversion, block diagrams of inverter types, inverter waveforms, concept of harmonics); block diagrams of regulated and unregulated battery charger types; differential controllers; concept of hysteresis in switching components

Electronic devices terminology for renewable energy system components: transistors, MOSFETs, IGBTs, thyristors, SCRs, triacs, microprocessors and microcontrollers

AC load control: phase control, zero-voltage switching, devices for ac load control

Maintenance: Fault location and testing under the direction of an electronics technician; handling precautions for MOS circuits; PCB replacement; heat sink assemblies

Use of computers in commissioning, testing and maintenance: cabling, communications ports and protocols, modems, proprietary software

Programmable system components: logic trees; using menus to access parameter settings and information display

UTE NES113 A
Install and maintain a micro-hydro system

Descriptor: Install and maintain micro-hydro generator assemblies and systems

Elements		Performance criteria	
113.1	Plan and prepare for installation/ maintenance	113.1.1	Installation/maintenance is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		113.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		113.1.3	Micro-hydro system is obtained and checked in accordance with *established procedures* and to comply with *requirements*
		113.1.4	Location in which the micro-hydro system is to be installed is determined from job *requirements*
		113.1.5	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		113.1.6	T*ools, equipment and testing devices* needed to carry out the installation work are obtained in accordance with *established procedures* and checked for correct operation and safety
		113.1.7	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*
113.2	Install micro-hydro system	113.2.1	*OH&S policies and procedures* for installing micro-hydro system is followed
		113.2.2	Micro-hydro system is installed in accordance with *requirements*, without damage or distortion to the surrounding environment or services
		113.2.3	Micro-hydro system is terminated and connected in accordance with *requirements*
		113.2.4	Unplanned events or conditions are responded to in accordance with *established procedures*
		113.2.5	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented

Elements		Performance criteria	
		113.2.6	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
113.3	Inspect and notify completion of work	113.3.1	Final inspections are undertaken to ensure the installed micro-hydro system conforms to *requirements*
		113.3.2	Work completion is *notified* in accordance with *established procedures*

Range statement

General

Generic items in this unit are shown in italics, *e.g. established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating *consistent performance* for each element of the unit.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace.
- demonstrating an understanding of the underpinning knowledge and skills identified in the section, of this unit titled ‘Underpinning knowledge’.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

This unit should be addressed only after competency in unit UTE NES112 A of this standard has been achieved.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials, types, applications; techniques, marking out, cutting, bending, drilling/punching, soldering, cutting mitres

Assembly/disassembly techniques

Electrical theory.

Fundamental and derived units: basic units; SI derived units, mechanical, electrical; multiples and sub-multiples

Power, work and energy: conservation of energy; torque; losses and efficiency; maximum efficiency of machines

Electrical characteristics of materials: electric theory, conductors, insulators, semi-conductors; electric charge; electric current; electromotive force

The simple circuit: source of electrical energy, load, current path, control; open-circuit; short-circuit

Resistance: Ohm's law; determine V, I, R; power dissipation

Effects of current: physiological effects; principles of protection from physiological effects

Effects of current: conversion of electrical energy to other forms, heating, light, magnetic, chemical; principles of protection from damaging effects

Sources of electrical energy: conversion of other forms to electrical energy; chemical reaction; magnetism and rotational motion; light; heat; force

Using measuring instruments: handling measuring instruments; selecting an instrument; setting-up and connecting into circuits; reading scales and read-outs; setting up a CRO

DC resistive circuits: series; parallel; series parallel; measurement of V, I and R; calculation of R, V, I, and P

Capacitance; concept: unit; time constant; capacitors - basic construction and types

Magnetism: magnetic and non magnetic materials; magnetic field patterns; force between magnetic fields; applications

Electromagnetism: magnetic field around a current-carrying conductor and solenoid; force between current-carrying conductors; applications

Electromagnetic induction: induced EMF; inductance; concept; unit; time constant; applications

AC Principles: sine waves; frequency; amplitude; peak voltage; peak to peak voltage; RMS voltage; single phase; three phase; generation of AC voltages; circuit measurement; earthing; electrical supply system

Transformers: construction; principles of operation; primary and secondary voltage and current; applications

Motors: motor action; generator action; DC motors; AC motors; applications

Electrical safety testing: regulations

Wiring techniques.

Electrical/electronic safety testing: isolation; testing; tagging; earthing; appliance electrical safety testing

Standards pertinent to industry sector: purpose; standards bodies; applications

Cables: types, power, signal; terms; colour coding; structure; identification cables; cable applications

Wiring systems: wiring looms; enclosures and supports; selecting wiring systems

Connectors and terminations: requirements; connectors, types and applications, assembly/disassembly; terminating conductors, extension cords

Accessories and fixings appropriate to industry sector: applications; fixing devices and methods

Drawing interpretation and sketching.

Technical drawing standards appropriate to the industry sector, conventions and specifications to AS 1100, with strong emphasis on interpretation: sheet types, title block information, materials parts list, revision table, grid referencing scales, line types – visible outlines, hidden outlines, dimensioning lines, centre lines; orthogonal projection of views – 3rd angle (detail and assembly drawings); mechanical conventions; fabrication conventions; three dimensional view drawings – axonometric, isometric, oblique; sectioning standards and conventions – whole, part; engineering drawing symbols, components and equipment – mechanical, electrical, electronic, computer, instrument, refrigeration; dimensioning – orthogonal, isometric; layout and plans; geometric tolerance interpretation (straightness, flatness, squareness, parallelism and concentricity only); engineering abbreviations; drawing interpretation techniques – detail drawings, orthogonal projection (3^{rd} angle only) and three dimensional, assembly drawings and three dimensions exploded (e.g. as in equipment manuals)

Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3rd angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

Micro-hydro systems.

Suitability for micro-hydro system application

Site selection: environmental issues; available power; water flow; head

Water wheels

Water turbines: (Kaplin, Peltin, Francis, propeller, crossflow etc)

Characteristic curves and interpretation

Structural consideration: sluices, flumes, penstocks; screens and screening systems; plumbing operations

System design: site data analysis, energy demand; turbine selection; frictional losses; balance of system components

Control systems and actuators; flow regulation

Electrical generators: characteristics, matching to turbines type, regulation, choice of voltage and type (ac/dc); synchronous and asynchronous operation; voltage conversion/transformation and inversion

Safety issues

Renewable energy technologies.

Non-technical issues: current economic, social, environmental and political issues, impact on a renewable energy technology; topic review

Energy services/demand: terminology; energy, temperature, power, symbols, units; energy conversion and efficiency; domestic dwelling - energy services, energy source selection; primary energy and end use energy

Solar radiation resource: terminology; units, symbols, conversions; sun position, sun path diagrams; solar radiation on fixed and tracking collectors

Wind energy resource and technology: terminology, units, symbols; wind patterns (Australia); local terrain, wind speed, direction, turbulence, wind power; maps, data sheets, measuring instruments, wind energy conversion systems (WECS); characteristics; applications; specifications, sizing

Micro-hydro resource and technology: terminology, units, symbols; flow rates, heads, assessment; turbines; operating characteristics; control requirements; specifications

Biomass resource and technology: terminology; common biofuels – types, energy contents, production, applications; resource assessment

Solar thermal systems: terminology; components; applications; types of hot water systems; system features, orientation, tilt angles, placement; system selection, size, cost

Energy efficient building design: terminology; climate and thermal comfort; thermal conductivity of building elements; solar heat gain; ventilation; glazing; thermal mass; insulation; shading devices; siting of buildings; active solar systems

RAPS system configuration: configuration; components – functions, efficiencies; regulators, inverters, battery chargers, generators

Photovoltaic arrays: terminology; modules (types, efficiency, applications); IV curve; irradiance and temperature effects; blocking and bypass diodes; wiring diagrams, configurations; specification and sizing

Energy storage: terminology; types and methods; battery life, temperature effects, charge and discharge rate; precautions, maintenance, safety; stratification; boosting and equalising charges; specification, capacity, configuration; operating characteristics; types, sizes

Photovoltaic power systems.

PV modules: PV technology types; structure; operating principles; manufacturing methods; efficiency; spectral response; module life; cost

Electrical characteristics: terminology; equivalent circuit; I-V curves, load lines; operating point,; ratings and standards; effect of temperature and irradiance, shading; power output; daily energy output; derating factors

ELV voltage limits, identifying ELV and LV circuits in PV systems, ELV cable and protection sizing: allowable voltage drops; cable current carrying capacity; sizing methods; acceptable fuse and circuit breaker types; fuse and circuit breaker sizing for inverter systems

Schematic and wiring diagrams: PV power systems for various applications; PV water pumping system; architectural diagrams and schedule of equipment; earthing requirements for PV systems

Batteries: Battery types for stand-alone power systems; basic battery chemistry; cycling and temperature effects; stratification; sulphation; charging regimes; factors affecting life (design, operating conditions and maintenance); safe handling practices; specifications and sizing; disposal

PV system components: types, operation, selection and sizing of: inverters; Maximum Power Point Trackers (MPPTs); regulators; battery chargers; generating sets, metering, cabling, protection devices; mechanical tracking devices; industry guest speakers or industry visits

PV powered water pumping systems: selection and sizing of pumps, pipes, fittings; power requirements; motors, mechanical transmissions; array size; selection of complete systems

Basic lighting design: introduction to lighting standards; lamp types and properties; luminaires; effect of decor, wall colour and windows; energy efficiency considerations (type, positioning, switching configuration); lamp sizing principles

Loads types and inverters: electronic equipment (transformer supply; switching power supply); microwave ovens; light dimmers; motors (universal, induction); start-up surge demand; effects of modified square wave supply; lighting inverters;

DC measuring instruments; ammeters, shunts; voltmeters, multiplier resistors; true RMS meters; AC power and power factor; significance of low power factor; power factor correction (principle);

Stand-alone PV system design: system configurations and operation; design according to AS4509; system voltage selection, component selection and sizing; DC control board layout; installation requirements; maintenance; costings, rebates and incentive schemes, load assessment, selection, sizing

Grid connected systems: Testing and approval of inverters; Standards for grid connection of inverters; Islanding and anti-islanding function; Circuit configuration: (metering, isolation, connection with respect to RCDs); Signage; Protection and isolation equipment for DC array circuits especially at LV; Systems with UPS capability: (inverter ratings, system configuration, battery types, ratings and sizing); Economic and other considerations: (sizing of PV array; metering, tariffs and electricity purchase arrangements; institutional, legislative and regulatory environment; rebates and incentive schemes)

System installation and commissioning: site locations (array, batteries, components); array mounting frames; battery room layout; installation requirements; generating sets; shut-down and power up procedures; commissioning of systems; testing faults installation and maintenance to AS4509 and other relevant standards

Electronic components in renewable energy systems.

Diodes: rectifier diodes (electrical characteristics, ratings, circuit symbol, example circuits - gating, flywheel diode, bypass and blocking diodes in PV arrays); LEDs, Zeners, Schottky diodes (characteristics, applications and circuit symbols)

Electronic concepts and terminology for selection of renewable energy system components: concept of rectification and concept of filtering and ripple; efficiency and sources of energy loss in electronic system components; switchmode circuits compared to linear: features/ advantages and disadvantages; Radio Frequency Interference (RFI) - causes and cures (basic); Pulse Width Modulation (PWM): principles, renewable energy applications; digital electronics: analog vs digital, representation of information in binary form, logic as the basis of digital circuits, D/A and A/D converters; DC/DC converters (concept and principles, R.E. applications); inverters (concept of inversion, block diagrams of inverter types, inverter waveforms, concept of harmonics); block diagrams of regulated and unregulated battery charger types; differential controllers; concept of hysteresis in switching components

Electronic devices terminology for renewable energy system components: transistors, MOSFETs, IGBTs, thyristors, SCRs, triacs, microprocessors and microcontrollers

AC load control: phase control, zero-voltage switching, devices for ac load control

Maintenance: Fault location and testing under the direction of an electronics technician; handling precautions for MOS circuits; PCB replacement; heat sink assemblies

Use of computers in commissioning, testing and maintenance: cabling, communications ports and protocols, modems, proprietary software

Programmable system components: logic trees; using menus to access parameter settings and information display

DC and AC machines for small scale renewable energy systems.

DC machines: construction, components; DC generator excitation; permanent magnet; electronic commutation; characteristics of DC generator types, self excitation, rectifying failure to self excite; DC motor excitation; characteristics of DC motor types; direction of rotation; efficiency; applications in renewable energy; maintenance

Alternators: construction, components; excitation methods including brushless excitation; voltage control; speed, frequency, number of poles; rectification

Induction machines: construction, components; operating characteristics; single phase induction machines - types, characteristics including startup surge demand; induction generators: mains connected and self-excited; efficiency; applications in renewable energy systems

UTE NES114 A
Install and maintain a small wind energy conversion system

Descriptor: Install and maintain wind energy conversion systems up to 10kW

Elements		Performance criteria	
114.1	Plan and prepare for installation/ maintenance	114.1.1	Installation/maintenance is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		114.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		114.1.3	Wind energy conversion system is obtained and checked in accordance with *established procedures* and to comply with *requirements*
		114.1.4	Location in which the wind energy conversion system is to be installed is determined from job *requirements*
		114.1.5	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		114.1.6	T*ools, equipment and testing devices* needed to carry out the installation work are obtained in accordance with *established procedures* and checked for correct operation and safety
		114.1.7	Rigging personnel are employed where necessary
		114.1.8	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*
114.2	Install wind energy conversion system	114.2.1	*OH&S policies and procedures* for installing wind energy conversion system is followed
		114.2.2	Wind energy conversion system is installed in accordance with *requirements*, without damage or distortion to the surrounding environment or services
		114.2.3	Wind energy conversion system is connected in accordance with *requirements*
		114.2.4	Unplanned events or conditions are responded to in accordance with *established procedures*
		114.2.5	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented

Elements		Performance criteria	
		114.2.6	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
114.3	Inspect and notify completion of work	114.3.1	Final inspections are undertaken to ensure the installed wind energy conversion system conforms to *requirements*
		114.3.2	Work completion is *notified* in accordance with *established procedures*

Range statement

General

Generic items in this unit are shown in italics, *e.g. established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating *consistent performance* for each element of the unit.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace.
- demonstrating an understanding of the underpinning knowledge and skills identified in the section, of this unit titled ‘Underpinning knowledge’.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

This unit should be addressed only after competency in unit UTE NES112 A of this standard has been achieved.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled ‘Interdependent assessment of units’.

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials, types, applications; techniques, marking out, cutting, bending, drilling/punching, soldering, cutting mitres

Assembly/disassembly techniques

Electrical theory.

Fundamental and derived units: basic units; SI derived units, mechanical, electrical; multiples and sub-multiples

Power, work and energy: conservation of energy; torque; losses and efficiency; maximum efficiency of machines

Electrical characteristics of materials: electric theory, conductors, insulators, semi-conductors; electric charge; electric current; electromotive force

The simple circuit: source of electrical energy, load, current path, control; open-circuit; short-circuit

Resistance: Ohm's law; determine V, I, R; power dissipation

Effects of current: physiological effects; principles of protection from physiological effects

Effects of current: conversion of electrical energy to other forms, heating, light, magnetic, chemical; principles of protection from damaging effects

Sources of electrical energy: conversion of other forms to electrical energy; chemical reaction; magnetism and rotational motion; light; heat; force

Using measuring instruments: handling measuring instruments; selecting an instrument; setting-up and connecting into circuits; reading scales and read-outs; setting up a CRO

DC resistive circuits: series; parallel; series parallel; measurement of V, I and R; calculation of R, V, I, and P

Capacitance; concept: unit; time constant; capacitors - basic construction and types

Magnetism: magnetic and non magnetic materials; magnetic field patterns; force between magnetic fields; applications

Electromagnetism: magnetic field around a current-carrying conductor and solenoid; force between current-carrying conductors; applications

Electromagnetic induction: induced EMF; inductance; concept; unit; time constant; applications

AC Principles: sine waves; frequency; amplitude; peak voltage; peak to peak voltage; RMS voltage; single phase; three phase; generation of AC voltages; circuit measurement; earthing; electrical supply system

Transformers: construction; principles of operation; primary and secondary voltage and current; applications

Motors: motor action; generator action; DC motors; AC motors; applications

Electrical safety testing: regulations

Wiring techniques.

Electrical/electronic safety testing: isolation; testing; tagging; earthing; appliance electrical safety testing

Standards pertinent to industry sector: purpose; standards bodies; applications

Cables: types, power, signal; terms; colour coding; structure; identification cables; cable applications

Wiring systems: wiring looms; enclosures and supports; selecting wiring systems

Connectors and terminations: requirements; connectors, types and applications, assembly/disassembly; terminating conductors, extension cords

Accessories and fixings appropriate to industry sector: applications; fixing devices and methods

Drawing interpretation and sketching.

Technical drawing standards appropriate to the industry sector, conventions and specifications to AS 1100, with strong emphasis on interpretation: sheet types, title block information, materials parts list, revision table, grid referencing scales, line types – visible outlines, hidden outlines, dimensioning lines, centre lines; orthogonal projection of views – 3rd angle (detail and assembly drawings); mechanical conventions; fabrication conventions; three dimensional view drawings – axonometric, isometric, oblique; sectioning standards and conventions – whole, part; engineering drawing symbols, components and equipment – mechanical, electrical, electronic, computer, instrument, refrigeration; dimensioning – orthogonal, isometric; layout and plans; geometric tolerance interpretation (straightness, flatness, squareness, parallelism and concentricity only); engineering abbreviations; drawing interpretation techniques – detail drawings, orthogonal projection (3^{rd} angle only) and three dimensional, assembly drawings and three dimensions exploded (e.g. as in equipment manuals)

Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3rd angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

Wind energy conversion systems.

Characterises of wind: terminology; major global wind circulations; formation of major wind flows; local wind systems and patterns; extreme winds, wind shear; velocity profiles

Wind speed analysis: terminology; wind speed, direction; measurement of wind speeds and direction; calibration of anemometers; analysis of meteorological bureau data including wind speed data

Site selection: topography and vegetation; surface roughness, isolated obstacles; temperature inversion effects; speed-up effects; power transmission distance; environmental (visual, noise)

Wind energy conversion systems (WECS): lift and drag types; characteristics; categories; materials, construction; system configurations and components; control strategies

Selection of suitable WECS: analysis of site data, WECS selection; commercial WECS; energy output; optimum tower height; balance of system components; capital, costs, effectiveness

Installation and maintenance: mechanical (tower selection, tower raising, lightning protection; electrical (transmission voltage, cables, lightning and general circuit protection, battery room design; maintenance and safety

Renewable energy technologies.

Non-technical issues: current economic, social, environmental and political issues, impact on a renewable energy technology; topic review

Energy services/demand: terminology; energy, temperature, power, symbols, units; energy conversion and efficiency; domestic dwelling - energy services, energy source selection; primary energy and end use energy

Solar radiation resource: terminology; units, symbols, conversions; sun position, sun path diagrams; solar radiation on fixed and tracking collectors

Wind energy resource and technology: terminology, units, symbols; wind patterns (Australia); local terrain, wind speed, direction, turbulence, wind power; maps, data sheets, measuring instruments, wind energy conversion systems (WECS); characteristics; applications; specifications, sizing

Micro-hydro resource and technology: terminology, units, symbols; flow rates, heads, assessment; turbines; operating characteristics; control requirements; specifications

Biomass resource and technology: terminology; common biofuels – types, energy contents, production, applications; resource assessment

Solar thermal systems: terminology; components; applications; types of hot water systems; system features, orientation, tilt angles, placement; system selection, size, cost

Energy efficient building design: terminology; climate and thermal comfort; thermal conductivity of building elements; solar heat gain; ventilation; glazing; thermal mass; insulation; shading devices; siting of buildings; active solar systems

RAPS system configuration: configuration; components – functions, efficiencies; regulators, inverters, battery chargers, generators

Photovoltaic arrays: terminology; modules (types, efficiency, applications); IV curve; irradiance and temperature effects; blocking and bypass diodes; wiring diagrams, configurations; specification and sizing

Energy storage: terminology; types and methods; battery life, temperature effects, charge and discharge rate; precautions, maintenance, safety; stratification; boosting and equalising charges; specification, capacity, configuration; operating characteristics; types, sizes

Photovoltaic power systems.

PV modules: PV technology types; structure; operating principles; manufacturing methods; efficiency; spectral response; module life; cost

Electrical characteristics: terminology; equivalent circuit; I-V curves, load lines; operating point,; ratings and standards; effect of temperature and irradiance, shading; power output; daily energy output; derating factors

ELV voltage limits, identifying ELV and LV circuits in PV systems, ELV cable and protection sizing: allowable voltage drops; cable current carrying capacity; sizing methods; acceptable fuse and circuit breaker types; fuse and circuit breaker sizing for inverter systems

Schematic and wiring diagrams: PV power systems for various applications; PV water pumping system; architectural diagrams and schedule of equipment; earthing requirements for PV systems

Batteries: Battery types for stand-alone power systems; basic battery chemistry; cycling and temperature effects; stratification; sulphation; charging regimes; factors affecting life (design, operating conditions and maintenance); safe handling practices; specifications and sizing; disposal

PV system components: types, operation, selection and sizing of: inverters; Maximum Power Point Trackers (MPPTs); regulators; battery chargers; generating sets, metering, cabling, protection devices; mechanical tracking devices; industry guest speakers or industry visits

PV powered water pumping systems: selection and sizing of pumps, pipes, fittings; power requirements; motors, mechanical transmissions; array size; selection of complete systems

Basic lighting design: introduction to lighting standards; lamp types and properties; luminaires; effect of decor, wall colour and windows; energy efficiency considerations (type, positioning, switching configuration); lamp sizing principles

Loads types and inverters: electronic equipment (transformer supply; switching power supply); microwave ovens; light dimmers; motors (universal, induction); start-up surge demand; effects of modified square wave supply; lighting inverters;

DC measuring instruments; ammeters, shunts; voltmeters, multiplier resistors; true RMS meters; AC power and power factor; significance of low power factor; power factor correction (principle);

Stand-alone PV system design: system configurations and operation; design according to AS4509; system voltage selection, component selection and sizing; DC control board layout; installation requirements; maintenance; costings, rebates and incentive schemes, load assessment, selection, sizing

Grid connected systems: Testing and approval of inverters; Standards for grid connection of inverters; Islanding and anti-islanding function; Circuit configuration: (metering, isolation, connection with respect to RCDs); Signage; Protection and isolation equipment for DC array circuits especially at LV; Systems with UPS capability: (inverter ratings, system configuration, battery types, ratings and sizing); Economic and other considerations: (sizing of PV array; metering, tariffs and electricity purchase arrangements; institutional, legislative and regulatory environment; rebates and incentive schemes)

System installation and commissioning: site locations (array, batteries, components); array mounting frames; battery room layout; installation requirements; generating sets; shut-down and power up procedures; commissioning of systems; testing faults installation and maintenance to AS4509 and other relevant standards

Electronic components in renewable energy systems.

Diodes: rectifier diodes (electrical characteristics, ratings, circuit symbol, example circuits - gating, flywheel diode, bypass and blocking diodes in PV arrays); LEDs, Zeners, Schottky diodes (characteristics, applications and circuit symbols)

Electronic concepts and terminology for selection of renewable energy system components: concept of rectification and concept of filtering and ripple; efficiency and sources of energy loss in electronic system components; switchmode circuits compared to linear: features/ advantages and disadvantages; Radio Frequency Interference (RFI) - causes and cures (basic); Pulse Width Modulation (PWM): principles, renewable energy applications; digital electronics: analog vs digital, representation of information in binary form, logic as the basis of digital circuits, D/A and A/D converters; DC/DC converters (concept and principles, R.E. applications); inverters (concept of inversion, block diagrams of inverter types, inverter waveforms, concept of harmonics); block diagrams of regulated and unregulated battery charger types; differential controllers; concept of hysteresis in switching components

Electronic devices terminology for renewable energy system components: transistors, MOSFETs, IGBTs, thyristors, SCRs, triacs, microprocessors and microcontrollers

AC load control: phase control, zero-voltage switching, devices for ac load control

Maintenance: Fault location and testing under the direction of an electronics technician; handling precautions for MOS circuits; PCB replacement; heat sink assemblies

Use of computers in commissioning, testing and maintenance: cabling, communications ports and protocols, modems, proprietary software

Programmable system components: logic trees; using menus to access parameter settings and information display

DC and AC machines for small scale renewable energy systems.

DC machines: construction, components; DC generator excitation; permanent magnet; electronic commutation; characteristics of DC generator types, self excitation, rectifying failure to self excite; DC motor excitation; characteristics of DC motor types; direction of rotation; efficiency; applications in renewable energy; maintenance

Alternators: construction, components; excitation methods including brushless excitation; voltage control; speed, frequency, number of poles; rectification

Induction machines: construction, components; operating characteristics; single phase induction machines - types, characteristics including startup surge demand; induction generators: mains connected and self-excited; efficiency; applications in renewable energy systems

UTE NES115 A
Install and maintain a grid connected inverter system

Descriptor: Install and maintain grid connected inverter assemblies and systems to interface a renewable energy system to the mains.

Elements		Performance criteria	
115.1	Plan and prepare for installation/ maintenance	115.1.1	Installation/maintenance is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		115.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		115.1.3	Inverter system is obtained and checked in accordance with *established procedures* and to comply with *requirements*
		115.1.4	Location in which the inverter system is to be installed is determined from job *requirements*
		115.1.5	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		115.1.6	T*ools, equipment and testing devices* needed to carry out the installation work are obtained in accordance with *established procedures* and checked for correct operation and safety
		115.1.7	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*
115.2	Install inverter system	115.2.1	*OH&S policies and procedures* for installing micro-hydro system is followed
		115.2.2	Inverter system is installed in accordance with *requirements*, without damage or distortion to the surrounding environment or services
		115.2.3	Inverter system is terminated and connected in accordance with *requirements*
		115.2.4	Unplanned events or conditions are responded to in accordance with *established procedures*
		115.2.5	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented

Elements		Performance criteria	
		115.2.6	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
115.3	Inspect and notify completion of work	115.3.1	Final inspections and tests are undertaken to ensure the installed inverter system conforms to *requirements*
		115.3.2	Work completion is *notified* in accordance with *established procedures*

Range statement

General

Generic items in this unit are shown in italics, *e.g. established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating *consistent performance* for each element of the unit.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace.
- demonstrating an understanding of the underpinning knowledge and skills identified in the section, of this unit titled ‘Underpinning knowledge’.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

This unit should be addressed only after competency in unit UTE NES106 A of this standard has been achieved.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Use of tools.

Identification and application of tools for: marking out a measuring; cutting; shaping; drilling; threading; tapping; finishing; dismantling/assembling

Tool use: hazards; safety procedures; techniques

Fabrication: materials, types, applications; techniques, marking out, cutting, bending, drilling/punching, soldering, cutting mitres

Assembly/disassembly techniques

Electrical theory.

Fundamental and derived units: basic units; SI derived units, mechanical, electrical; multiples and sub-multiples

Power, work and energy: conservation of energy; torque; losses and efficiency; maximum efficiency of machines

Electrical characteristics of materials: electric theory, conductors, insulators, semi-conductors; electric charge; electric current; electromotive force

The simple circuit: source of electrical energy, load, current path, control; open-circuit; short-circuit

Resistance: Ohm's law; determine V, I, R; power dissipation

Effects of current: physiological effects; principles of protection from physiological effects

Effects of current: conversion of electrical energy to other forms, heating, light, magnetic, chemical; principles of protection from damaging effects

Sources of electrical energy: conversion of other forms to electrical energy; chemical reaction; magnetism and rotational motion; light; heat; force

Using measuring instruments: handling measuring instruments; selecting an instrument; setting-up and connecting into circuits; reading scales and read-outs; setting up a CRO

DC resistive circuits: series; parallel; series parallel; measurement of V, I and R; calculation of R, V, I, and P

Capacitance; concept: unit; time constant; capacitors - basic construction and types

Magnetism: magnetic and non magnetic materials; magnetic field patterns; force between magnetic fields; applications

Electromagnetism: magnetic field around a current-carrying conductor and solenoid; force between current-carrying conductors; applications

Electromagnetic induction: induced EMF; inductance; concept; unit; time constant; applications

AC Principles: sine waves; frequency; amplitude; peak voltage; peak to peak voltage; RMS voltage; single phase; three phase; generation of AC voltages; circuit measurement; earthing; electrical supply system

Transformers: construction; principles of operation; primary and secondary voltage and current; applications

Motors: motor action; generator action; DC motors; AC motors; applications

Electrical safety testing: regulations

Wiring techniques.

Electrical/electronic safety testing: isolation; testing; tagging; earthing; appliance electrical safety testing

Standards pertinent to industry sector: purpose; standards bodies; applications

Cables: types, power, signal; terms; colour coding; structure; identification cables; cable applications

Wiring systems: wiring looms; enclosures and supports; selecting wiring systems

Connectors and terminations: requirements; connectors, types and applications, assembly/disassembly; terminating conductors, extension cords

Accessories and fixings appropriate to industry sector: applications; fixing devices and methods

Drawing interpretation and sketching.

Technical drawing standards appropriate to the industry sector, conventions and specifications to AS 1100, with strong emphasis on interpretation: sheet types, title block information, materials parts list, revision table, grid referencing scales, line types – visible outlines, hidden outlines, dimensioning lines, centre lines; orthogonal projection of views – 3rd angle (detail and assembly drawings); mechanical conventions; fabrication conventions; three dimensional view drawings – axonometric, isometric, oblique; sectioning standards and conventions – whole, part; engineering drawing symbols, components and equipment – mechanical, electrical, electronic, computer, instrument, refrigeration; dimensioning – orthogonal, isometric; layout and plans; geometric tolerance interpretation (straightness, flatness, squareness, parallelism and concentricity only); engineering abbreviations; drawing interpretation techniques – detail drawings, orthogonal projection (3^{rd} angle only) and three dimensional, assembly drawings and three dimensions exploded (e.g. as in equipment manuals)

Equipment and service manuals: flow charts; assembly/disassembly diagrams; schematic diagrams; block diagrams; trouble shooting guides

Freehand drawing skills appropriate to the industry sector: 3rd angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

Grid connected inverter systems.

Switching power control circuits: bipolar transistors as switches; FETS (structure, operation and symbol, major device ratings); IGBTs, pulse width modulation (PWM) in switch mode regulators; block diagram of switch mode regulators circuits; simple photovoltaic voltage regulator; other renewable energy applications; SCR's Triacs, SCSs and GTOs (symbols, operation and major device ratings); radio frequency interface (RFI) (cause and suppression methods)

Inverters: inverter bridge and half bridge; functions and types (output waveforms, use of PWM techniques, block diagram structure); function and block diagram of DC-DC converters; photovoltaic module IV curves; maximum power point tracking; harmonic content of inverter waveforms (significance in renewable energy systems, trouble shooting)

Grid connected systems: testing and approval of inverters; standards for grid connection of inverters; islanding and anti-islanding function

Circuit configuration: metering, isolation, connection with respect to RCDs; signage; protection and isolation equipment for DC array circuits especially at LV; systems with UPS capability - inverter ratings, system configuration, battery types, ratings and sizing

Economic and other considerations: estimation of PV array output; metering, tariffs and electricity purchase arrangements; institutional, legislative and regulatory environment; rebates and incentive schemes

Maintenance: fault location and testing under the direction of an electronics technician; handling precautions for MOS circuits; PCB replacement; heat sink assemblies

Use of computers in commissioning, testing and maintenance: cabling, communications ports and protocols, modems, proprietary software

Programmable system components: logic trees; using menus to access parameter settings and information display

UTE NES120 A
Install Consumer Video Systems

Descriptor: Installation of video systems that include equipment such as Televisions, Video Cassette Recorders, Digital Versatile Discs Set Top Boxes and the like.

Alignment: Nil

Elements		Performance criteria	
120.1	Plan and prepare the installation	120.1.1	Installation is planned and prepared to ensure *OH&S policies and procedures* are followed, and the work is appropriately sequenced in accordance with *requirements*
		120.1.2	Types and location of associated wiring and connections and *apparatus,* are identified from the manufacturers/supplies instructions
		120.1.3	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		120.1.4	*Tools, equipment and testing devices* needed for the installation are obtained in accordance with *established procedures* and checked for correct operation and safety
		120.1.5	Installation parameters for the system located and identified.
		120.1.6	Where applicable, all relevant regulatory and compliance information, statutory requirements and documentation are obtained prior to commencement of inspection
120.2	Install the video system	120.2.1	*OH&S policies and procedures* are followed
		120.2.2	*Circuits* are checked as being isolated where necessary using specified testing procedures
		120.2.3	System performance parameter comparison undertaken to ensure integration conforms to *requirements*
		120.2.4	Parts or connections of the installation or service that are removed in order to install the system are stored to protect against loss or damage and in accordance with *established procedures*

Elements		Performance criteria	
		120.2.5	System is installed to *requirements* , without damage or distortion to the surrounding environment or services.
		120.2.6	Unplanned events or conditions are responded to in accordance with *established procedures*
		120.2.7	Parts, and/or connections removed in the installation process are returned to pre-installation conditions in accordance with *established procedures*
		120.2.8	On-going checks of the quality of the work are undertaken in accordance with *established procedures*.
120.3	Inspect and notify completion of the work	120.3.1	Final inspections are undertaken to ensure the installation conforms to *requirements*
		120.3.2	Work completion is *notified* in accordance with *established procedures*.

Range statement

General

Generic items in this unit are shown in italics, *e.g. established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating *consistent performance* for each element of the unit.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace.
- demonstrating an understanding of the underpinning knowledge and skills identified in the section, of this unit titled 'Underpinning knowledge'.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

Nil

Underpinning knowledge

Occupational health and safety.

Occupational health and safety act: aims; acts; representatives; inspectors; offences

Personal safety: injuries and diseases in the workplace; repetitive strain injuries; manual handling procedures; handling of ladders; adequate lighting in the workplace; industrial radiation; chemical hazards; protective equipment; electrical hazards; thermal stress; exposure to excessive vibration; high level industrial noise

Workplace hazards: identification of potential workplace hazards; preventative measures

Working with electrically operated tools and equipment: nature of electric shock; causes of electrical accidents; working safely with electricity; safety items used in electrical environments

Rescue from a live electrical situation

Emergency first aid/resuscitation: procedures for performing emergency first aid and resuscitation for an electric shock victim; CPR

Video/entertainment systems.

Receivers: Installation; Setup; Operation

Antenna systems and selection: Satellite; Terrestrial; Cable

PVR, STB, Cable modems, MHP

Digital Versatile Disc Machines (DVD): Installation; Set up; Operation

Consumer Entertainment Systems: Installation; Set up; Operation

Remote Control Units: Operation; Multi-function units

Consumer Entertainment Products Interoperability; Interfacing; Interference;

System clashes; Audio level matching; Video terminations

Routing and segregation of cables

UTE NES121A
Enter and verify operating instructions in microprocessor equipped devices

Descriptor: This competency standard unit covers entering instructions in microprocessor-equipped devices (embedded system) with simple built-in programming function and verifying that the device operates as intended. It encompasses safe working practices, checking device installation, following written and oral instruction and procedures and completing necessary documentation.

Note:
Examples of devices are simple programmable relays, timers, temperature controllers, switches and basic detection devices for security and fire the like.

Elements		Performance criteria	
121.1	Prepare to enter operating instructions.	121.1.1	OHS procedures for a given work area are obtained and understood through established routines and procedures.
		121.1.2	Established OHS risk control measures and procedures in preparation for the work are followed.
		121.1.3	Safety hazards that have not previously been identified are reported and advise on risk control measures are sought from the work supervisor.
		121.1.4	Work supervisor or customers are consulted to determine which functions of the device are to be use and the parameter of each
		121.1.5	Tools, equipment and testing devices needed to carry out the work are obtained and checked for correct operation and safety.
		121.1.6	Device installation is checked for compliance with job specification and regulations where they apply.
121.2	Enter operating instructions.	121.2.1	Established OHS risk control measures and procedures for carrying out the work are followed.
		121.2.2	Circuits/machines/plant are checked as being isolated where necessary in strict accordance OHS requirements and procedures.

Elements		Performance criteria	
		121.2.3	The required status of each function of the device is entered and their parameters set in accordance with manufactures programming instructions.
		121.2.4	Entered data are checked as meeting those specified by the work supervisor or customer.
		121.2.5	Procedures for referring non-routine events to immediate supervisor for directions are followed.
		121.2.6	Tools, equipment and testing devices needed to carry out the work are obtained and checked for correct operation and safety.
121.3	Test device operation and report.	121.3.1	Device operation is tested in strict accordance OHS requirements and procedures.
		121.3.2	Operating anomalies are identified and corrected in accordance with established routines.
		121.3.3	OHS work completion risk control measures and procedures are followed.
		121.3.4	Work site is cleaned and made safe in accordance with established procedures.
		121.3.5	Work completion is reported and an appropriate person or persons notified in accordance with established routines.

Range statement

General

Generic items in this unit are shown in italics, *e.g. established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

This competency standard unit shall be demonstrated in relation to entering and verifying operating instruction in at least two types of microprocessor equipped devices with built-in icon-based programmable functions such as programmable relays, timers, temperature controllers, detection devices for security and fire and the like.

Currency in unit of competence

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Evidence for competence in this unit shall be considered holistically. Each element and associated performance criteria shall be demonstrated on at least two occasions in accordance with the "Assessment Guidelines". Evidence shall also comprise:

- A representative body of performance criteria demonstrated within the timeframes typically expected of the discipline, work function and industrial environment. In particular this shall incorporate evidence that shows a candidate is able to:
  - Implement Occupational Health and Safety workplace procedures and practices including the use of risk control measures as specified in the performance criteria and range; and
  - Apply sustainable energy principles and practices as specified in the performance criteria and range; and
  - Demonstrate an understanding of the essential knowledge and associated skills as described in the Underpinning Knowledge of this unit; and
  - Demonstrate an appropriate level of skills enabling employment; and
  - Conduct work observing the relevant Anti Discrimination legislation, regulations, polices and workplace procedures; and
- Demonstrated performance across a representative range of contexts from the prescribed items below:
  - Enter and verify operating instructions in microprocessor equipped devices as described in Range, and including:
    - A Understanding required operating functions and parameters.
    - B Identifying non-compliance conditions of device installation.
    - C Entering functions and parameters correctly.
    - D Correcting programming anomalies.
    - E Testing and verify device operation.
    - F Dealing with unplanned events by drawing on essential knowledge and skills to provide appropriate solutions incorporated in the holistic assessment with the above listed items.

Note:
Successful completion of relevant vendor training may be used to contribute to evidence on which competency is deemed. In these cases the alignment of outcomes of vendor training with performance criteria and critical aspects of evidence shall be clearly identified.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

Assessment in this unit is related to the knowledge associated with other units within a qualification structure, where appropriate.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled ‘Interdependent assessment of units’.

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.

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 give 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
- 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.

UTE NES122A
Position and terminate fire detection and warning system apparatus

Descriptor: This competency standard unit covers installing electronic fire detection and warning systems in buildings and premises. It encompasses, working safely and to standards, following oral and written instructions and procedures, securely placing and connecting fire detection system and warning, components, and applying customer relation protocols.

Elements		Performance criteria	
122.1	Prepare to assemble and set up basic fire detection and warning systems.	122.1.1	OHS procedures for a given work area are obtained and understood through established routines.
		122.1.2	Established OHS risk control measures in preparation for the work are followed.
		122.1.3	Safety hazards that have not previously been identified are reported and advise on risk control measures are sought from the work supervisor.
		122.1.4	The nature and location of the work is obtained from work supervisor or other appropriate person to establish the scope of work to be undertaken.
		122.1.5	Advice is sought from the work supervisor or other appropriate person to ensure the work is co-ordinated effectively with others.
		122.1.6	Sources of materials that may be required for the work are established in accordance with established routines.
		122.1.7	Tools, equipment and testing devices needed to carry out the work are obtained and checked for correct operation and safety.
122.2	Assemble and set up basic fire detection and warning systems.	122.2.1	Established OHS risk control measures for carrying out the work are followed.
		122.2.2	Circuits/machines/plant are checked as being isolated where necessary in strict accordance OHS requirements and procedures.
		122.2.3	Fire protection controller and detection and warning devices are located for optimum performance within limitation imposed by customers and regulations.

Elements	Performance criteria
	122.2.4 Accessories are installed straight and square in the required locations and within acceptable tolerances.
	122.2.5 Cables and conductors are terminated at accessories in accordance with manufacture's specifications and regulatory requirements.
	122.2.6 Procedures for referring non-routine events to immediate supervisor for directions are followed.
	122.2.7 Fire protection installation is carried out efficiently without unnecessary waste of materials or damage to apparatus, circuits or the surrounding environment and using sustainable energy practices.
122.3 Set up basic fire detection and warning systems.	122.3.1 OHS work completion risk control measures and procedures are followed.
	122.3.2 Work site is cleaned and made safe in accordance with established procedures.
	122.3.3 Fire protection system is documented in accordance with regulatory requirement and established routines.

Range statement

General

Generic items in this unit are shown in italics, *e.g. established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

This competency standard unit shall be demonstrated by installing at least two-fire alarm and warning systems. Installation shall include the following system components:

- Fire alarm system with at least one Control & Indicating panel, 50 input devices, 5 output device and 2 system interface controls on at least of the following: Analogue addressable system, addressable system and or conventional system.

- Fire warning system with at least one Control & Indicating panel, 50 speakers, 5 interface communication devices and 2 warning indicators

Note:
1. Input devices can be conventional, analogue or analogue addressable fire detectors, flow switch connections or switch connections and the like.
2. Output devices can be shutdown signal, door or system release controls, solenoid valve controls and the like.

3. System interface controls can be communication signals to remote Control and indicating equipment, Building monitoring systems, paging system, Colour graphics and or the like.
4. Interface communication devices can be Warden Incommunication phones, Remote PA inputs and the like.
5. Warning Indicators are flashing lights for hearing impaired persons, fire brigade building indication and the like.

Currency in unit of competence

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Evidence for competence in this unit shall be considered holistically. Each element and associated performance criteria shall be demonstrated on at least two occasions in accordance with the "Assessment Guidelines". Evidence shall also comprise:

- A representative body of performance criteria demonstrated within the timeframes typically expected of the discipline, work function and industrial environment. In particular this shall incorporate evidence that shows a candidate is able to:
  - Implement Occupational Health and Safety workplace procedures and practices including the use of risk control measures as specified in the performance criteria and range; and
  - Apply sustainable energy principles and practices as specified in the performance criteria and range; and
  - Demonstrate an understanding of the essential knowledge and associated skills as described in the Underpinning Knowledge of this unit; and
  - Demonstrate an appropriate level of skills enabling employment; and
  - Conduct work observing the relevant Anti Discrimination legislation, regulations, polices and workplace procedures; and
- Demonstrated performance across a representative range of contexts from the prescribed items below:
  - Position and terminate fire detection and warning system apparatus as described in Range: and including:

    A Reading and interpreting drawings showing apparatus/device locations and connection arrangements.

    B Placing and securing devices and accessories accurately.

C Maintaining fire integrity.

D Terminating cable and conductors correctly.

E Documenting installation.

F Dealing with unplanned events by drawing on essential knowledge and skills to provide appropriate solutions incorporated in the holistic assessment with the above listed items.

Note:
Successful completion of relevant vendor training may be used to contribute to evidence on which competency is deemed. In these cases the alignment of outcomes of vendor training with performance criteria and critical aspects of evidence shall be clearly identified.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

Assessment in this unit is related to the knowledge associated with other units within a qualification structure, where appropriate.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled ‘Interdependent assessment of units’.

Technical standards, regulations and codes for fire protection and warning systems

Evidence shall show an understanding of technical standards and regulations that apply to fire protection and warning systems to an extent indicated by the following aspects:

a) Regulation governing fire protection and warning system installations

b) Standards and Codes that apply to fire protection systems and equipment

Note:
1. Standards include Standards mandated under regulation or by an authority, deemed-to-comply standard and local service requirements.
2. Codes include those applicable to electrical safe working practices

c) Applying standards, regulations and codes to fire protection systems encompassing —

- Installation arrangement
- Certified/approved fire equipment
- Installation of fire equipment
- Testing and verification
- Final commissioning verifications

Fire detection and warning system and apparatus fundamentals

Evidence shall show an understanding of fire detection and warning systems to an extent indicated by the following aspects:

a) Purpose of fire alarm and warning systems.

b) Purpose and operating principles of fire detection and warning systems.

c) Operating principles and characteristic of the various types of fire alarm detectors.

d) Operating principles and characteristic of the various warning system components

e) Effective and ineffective locations for fire detection devices and common causes of false alarms.

f) Warning devices and their operating parameters

g) Common operational requirements and types of control and indicating equipment.

h) Common operation and types of field data gathering equipment

i) Common operation and interface connections to other systems.

j) Purpose and interface requirements to smoke hazard management system

Fire protection technologies

Evidence shall show an understanding of fire protection technologies to an extent indicated by the following aspects:

a) Life and safety concerns for fire protection.

b) Basic principles of combustion

c) Bi-products of combustion that can be detected

d) Basic principles of fire behaviour within and enclosure

e) Types of fire protection systems and the difference between automatic and passive systems and wet and dry systems.

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 give 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
- 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.

Fire protection equipment working practices

Evidence shall show an understanding of working safely on or around fire protection

equipment through the application of risk management principles and control measures for dealing with electrical, chemical and other 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 fire protection equipment encompassing

- Procedures for isolating/reinstating and disconnection and reconnection of supplies in excess of extra-low voltage

Note.
1. Isolation and disconnection and reconnection is required to be performed by an appropriately qualified and authorise persons.

- Arrangements for isolating/reinstating fire protection systems to inhibit back-to-base signals to monitoring station.
- Arrangements for isolating/reinstating fire protection systems to inhibit alarms operating fire protection suppression equipment
- Arrangements for isolating/reinstating sections or parts of a fire protection system to inhibit alarms during building maintenance or system testing.
- Interface arrangements to isolate control functions between different fire protection building service systems
- Documentation and licensing requirements for working on fire protection systems
- Identification of personal and environmental hazards in working on fire protection systems.
- Control measures used for dealing with the hazards related to fire protection systems

UTE NES123A
Enter and verify programs in preparation for commissioning fire protection systems

Descriptor: This competency standard unit covers programming fire protection systems that include multiple connected detection, warning and fire control devices and remote monitoring. It encompasses working safely, applying knowledge of fire protection scenarios, using fire protection standards and protocols, entering system instructions, testing functionality of fire protection components and system operation, and documentation of commissioning activities.

Elements		Performance criteria	
123.1	Prepare to enter operating instructions.	123.1.1	OHS procedures for a given work area are obtained and understood through established routines and procedures.
		123.1.2	Established OHS risk control measures and procedures in preparation for the work are followed.
		123.1.3	Safety hazards that have not previously been identified are reported and advise on risk control measures are sought from the work supervisor.
		123.1.4	The extent of programming work is determined from job specifications and in consultation with appropriate person(s).
		123.1.5	Tools, equipment and testing devices needed to carry out the work are obtained and checked for correct operation and safety.
		123.1.6	Device installation is checked for compliance with job specification and regulations where they apply.
123.2	Enter software operating instructions.	123.2.1	Established OHS risk control measures and procedures for carrying out the work are followed.
		123.2.2	Circuits/machines/plant are checked as being isolated where necessary in strict accordance OHS requirements and procedures
		123.2.3	The required status of each function of the device is entered and their parameters set in accordance manufactures programming instructions.

Elements		Performance criteria	
		123.2.4	Entered data are checked as meeting those specified by the work job specification.
		123.2.5	Methods for dealing with unexpected situations are decided on the basis of safety and required work outcomes.
		123.2.6	Programming is carried out efficiently without unnecessary waste of materials and energy or damage to apparatus, the surrounding environment or other services.
123.3	Test device operation and report.	123.3.1	Device operation is tested in strict accordance OHS requirements and procedures.
		123.3.2	Operating anomalies are identified and corrected in accordance with established routines.
		123.3.3	OHS work completion risk control measures and procedures are followed.
		123.3.4	Work site is cleaned and made safe in accordance with established procedures.
		123.3.5	Work completion is reported and an appropriate person or persons notified in accordance with established routines.

Range statement

General

Generic items in this unit are shown in italics, *e.g. established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

This competency standard unit shall be demonstrated in relation to entering and verifying programs in preparation for commissioning fire protection systems in at least two types of microprocessor fire protection control and indicating equipment. Programming shall include the following parameters:

- At least 50 input devices
- At least 20 output device
- At least 1 system interface control
- At least 2 logic timers
- System variables

Note:

1. Input devices can be conventional alarm zones, analogue or analogue addressable fire detectors, flow switch connections or switch connections and the like.

2. Output devices can be shutdown signal, door or system release controls, solenoid valve controls and the like.

3. System interface controls can be communication signals to remote Control and indicating equipment, Building monitoring systems, paging system, Colour graphics and or the like.

4. Logic times can be software programs that control the operation of non-latching detectors, timer periods before operation of fire system suppression systems and or the like.

5. System variables can be standard software functions that operate AS 1668 smoke detector controls, dual zone alarm configurations, alarm and fault global functions and the like.

Currency in unit of competence

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range Statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Evidence for competence in this unit shall be considered holistically. Each element and associated performance criteria shall be demonstrated on at least two occasions in accordance with the "Assessment Guidelines". Evidence shall also comprise:

- A representative body of performance criteria demonstrated within the timeframes typically expected of the discipline, work function and industrial environment. In particular this shall incorporate evidence that shows a candidate is able to:
  - Implement Occupational Health and Safety workplace procedures and practices including the use of risk control measures as specified in the performance criteria & range; and
  - Apply sustainable energy principles and practices as specified in the performance criteria and range; and
  - Demonstrate an understanding of the essential knowledge and associated skills as described in the Underpinning Knowledge of this unit; and
  - Demonstrate an appropriate level of skills enabling employment; and
  - Conduct work observing the relevant Anti Discrimination legislation, regulations, polices & workplace procedures; and
- Demonstrated performance across a representative range of contexts from the prescribed items below:

- Enter and verify programs in preparation for commissioning fire protection systems as described in Range: and including:

  A Understanding required operating functions and parameters.

  B Identifying non-compliance conditions of device installation.

  C Entering functions and parameters correctly.

  D Correcting programming anomalies.

  E Testing and verify device operation.

  F Program backups, version controls and documentation.

  G Dealing with unplanned events by drawing on essential knowledge and skills to provide appropriate solutions incorporated in the holistic assessment with the above listed items.

Note:
Successful completion of relevant vendor training may be used to contribute to evidence on which competency is deemed. In these cases the alignment of outcomes of vendor training with performance criteria and critical aspects of evidence shall be clearly identified.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of activities and where required support the outcomes of other units within a qualification structure.

Interdependent assessment of units

Assessment in this unit is related to the knowledge associated with other units within a qualification structure, where appropriate.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of

evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled 'Interdependent assessment of units'.

Fire protection systems programming methods

Evidence shall show an understanding of fire protection systems programming methods to an extent indicated by the following aspects:

a) Vender programming codes and functions encompassing

- input/output instruction
- variable
- timers
- limitations of vender software

b) Program loading methods using a personal computer

c) Program testing methods

d) Program back up, version control and documentation requirements

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 give 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
- 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.

Fire protection equipment working practices

Evidence shall show an understanding of working safely on or around fire protection equipment through the application of risk management principles and control measures for dealing with electrical, chemical and other 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 fire protection equipment encompassing

- Procedures for isolating/reinstating and disconnection and reconnection of supplies in excess of extra-low voltage

Note.
1. Isolation and disconnection and reconnection is required to be performed by an appropriately qualified and authorise persons.

- Arrangements for isolating/reinstating fire protection systems to inhibit back-to-base signals to monitoring station.

- Arrangements for isolating/reinstating fire protection systems to inhibit alarms operating fire protection suppression equipment
- Arrangements for isolating/reinstating sections or parts of a fire protection system to inhibit alarms during building maintenance or system testing.
- Interface arrangements to isolate control functions between different fire protection building service systems
- Documentation and licensing requirements for working on fire protection systems
- Identification of personal and environmental hazards in working on fire protection systems.
- Control measures used for dealing with the hazards related to fire protection systems