TRAINING STANDARDS

National Electrotechnology Training Package

Volume 4

Maintenance and Repair Units

UTE99 Electrotechnology Training Package

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Table of contents

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 NES201 (A to Z qualifier) D
Perform basic repair to electrical/electronic apparatus

Descriptor: Undertake basic repairs to electrical/electronic apparatus by following routines described in work instructions or apparatus manuals.

Specific unit outcomes

This is presented as a composite unit that has five 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 NES 201A B	Perform basic repair to electrical/electronic apparatus *(Computer systems)*
UTE NES 201B C	Perform basic repair to electrical/electronic apparatus *(Electrical)*
UTE NES 201C B	Perform basic repair to electrical/electronic apparatus *(Electronics)*
UTE NES 201E C	Perform basic repair to electrical/electronic apparatus *(Refrigeration & a/conditioning)*
UTE NES 201F B	Perform basic repair to electrical/electronic apparatus *(Data communications)*

Elements		Performance criteria	
201.1	Prepare carry out basic repair work	201.1.1	Repair work is prepared to ensure *OH&S policies and procedures* are followed
		201.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved
		201.1.3	*Apparatus* maintenance schedules and specifications are checked against *requirements*
		201.1.4	Materials needed to complete the work are obtained in accordance with *established procedures*
		201.1.5	T*ools and testing devices* needed to carry out the work are checked for correct operation and safety
201.2	Carry out basic	201.2.1	*OH&S policies and procedures* are followed

Elements		Performance criteria	
	repair work	201.2.2	*Circuits* are checked as being isolated where necessary using specified testing procedures
		201.2.3	*Apparatus* is repaired in accordance with *established procedures* and repair routines
		201.2.4	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
201.3	Inspect and notify completion of work	201.3.1	Final inspections are undertaken to ensure the repair of *apparatus* conforms to *requirements*
		201.3.2	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
- (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*.

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, 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

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 (3rd 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

Category: Computer systems (A)

Specialisation: Computer assembly

PC testing and modification – basic.

Introduction: laboratory familiarisation; electrical and mechanical safety; identification and use of hand tools

Skills: microcomputer familiarisation; digital component identification; socket type integrated circuit removal and insertion; cable troubleshooting and repair; using technical service data

Instruments: introduction to the Digital Multimeter; in-circuit voltage measurements; continuity and resistance measurements

Computer peripherals.

Introduction to peripherals: definition; types/models/classes; terminology; interfacing techniques

Visual display units: types; applications; basic block diagram; detailed block diagram; colour standards

Printers: types; uses; printing quality; basic block diagram; detailed block diagram; connectivity; configuration

Other peripherals: types; applications; configuration

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

Graphical user interface.

The graphical user interface environment: mouse; icons; windows; menus; drop-down menus; pointer icons; dialogue boxes; command buttons; check boxes; option switches; list boxes; test boxes; scrolling; background and foreground

Mouse operations: selecting icons; selecting menu choices; selecting a group of items; selecting a block of text; opening windows; starting programs; dragging

Using a graphical disk management program to manage files and directories: creating and removing directories; creating, copying, deleting, moving and renaming files

Re-sizing windows: starting programs; making programs inactive; reactivating programs

Running multiple applications

Using keystroke alternatives to mouse operations

Accessing and using manuals, third party references and on-line help

Category: Electrical (B)

Specialisation: Appliances electrical

Domestic appliance principles.

Overview of appliance servicing industry: manufacturers; retailers; authorised service agents; appliance service companies; appliance industry association – code of practice

Introduction to the Major appliances: washing machines, clothes dryers, dishwashers, refrigerators, freezers, air conditioners, electrical and gas cookers and heaters; codes statutory requirements, regulations; manufacturer and company requirements, warranty; OH&S

Basic operating principles: clothes washer, heater fill pre-soak and soak options, wash, rinse, spin; clothes dryers, tumbling, heating, lint control; dishwasher, rinse, wash, detergent, heater, rinse, drain; refrigerator, freezer, air conditioner, cooling, heating, defrost, drain (basic refrigeration cycle); electric heaters and cookers, hot plates and elements, temperature controllers, timers; gas heaters and cookers, ignition, burner temperature controllers, timers; gas heaters and cookers, ignition, burner temperature controllers, regulators, flue and ventilation

Basic function of components: timer, temperature controllers, motors, speed controllers, reverse action, transmission, switches, solenoids, filters, fans, burners, regulators, ignition, elements, balancing mechanisms, compressors, agitators

Service and parts manuals: purpose; types; procedures

Domestic clothes washers, dish washers and clothes dryers.

Codes and regulations: plumbing – water supply, drainage, back siphoning; electrical – insulating, earthing; OH&S

Types, construction, operation and applications: washing machines; clothes dryers; dishwashers

Installation and adjustments: manufacturers instructions and data; instruments and tools; customer advice; levelling; safety and pre-start checks; operational checks; adjustments

Repairs and parts replacement: cleaning of cabinets and components, removing rust and minor repairs to cabinets, touching up paint work; under supervision remove and replace of various mechanical items, belts, bearings, door locks, filters, hoses, pumps, float switch, clutch, brakes, dispensers, balance control, gaskets, lint screens

Domestic electrical heating appliances.

Codes and regulations: electrical – insulating, earthing; OH&S

Types, construction, operation and applications: space heaters; stoves; ovens

Installation requirements and adjustments: manufacturers instructions and data; instruments and tools; customer advice; levelling; safety and pre-start checks; operational checks; adjustments

Repairs and parts replacement: cleaning of cabinets and components, removing rust and minor repairs to cabinets, touching up paint work; under supervision remove and replace of various mechanical items, belts, bearings, door locks, filters, elements, thermostats, levelling feet

Specialisation: Coil windings

Machine assembly – electrical.

Hazardous situations: accidents – causes; how they happen; methods of prevention; equipment used for prevention

Hand and power tools: types; application; care; safe use

Production machinery: moving machinery; types; procedures; component identification; energy storage devices – safety procedures when handling, methods of safely discharging energy

Assembly and disassembly devices: surface and component protection – purpose, method of application, methods used; assembly procedures - safety, assembly to specifications, quality assurance; drive systems – various types, applications, methods of fitting; bearings – types, applications, fitting methods, removal methods

Electric motor components: stators; rotors; poles; armature; windings; housings; endshields

Connection and termination of windings: coil – termination, identification, winding; terminal box – layout; designation

Motor and machine components: assembly procedures; safety and precautions

Coil winding.

Winding procedures: selection of insulation material types, class, temperature rating and applications; stator insulation methods; selection of coil former sizing from stator iron and coil measurements; pin former manufacture; coil winding procedures; methods of connecting flexible leads to coils and fastening using various methods, e.g. tape one coil, tie other with twine; procedure for placing coils in position, and shaping coils; methods of securing coils in position using various methods, e.g. wedges, ties, clips

Rewinding procedures: data collection and recording; recording of coil connections using connection diagrams; winding stripping procedures;

measurement of wire size; coil insulation using various methods; coil former sizing from stator iron measurements; pin former manufacture; procedure for winding a set of coil groups; positioning of winding in stator in relation to endshield through bolt holes; placing of coils in stator and shaping; coil former sizing; placing of coils in slots and shaping; insulating and wedging; connection of coils and attachment of flexible leads; binding of coil overhangs using various methods, e.g. taping, typing

Coil winding testing and soldering.

Multimeters: types – analogue, digital; selection of purpose; circuit connectors; polarity; measurement voltages and currents

Multimeter tests: continuity; resistance

Power Supply: construction; operation; connection of components and circuit; disconnecting of components and circuit; precautions

Types of Insulation Tester: solid state; mechanical driven; purpose; statutory requirements

Test Procedures: components; instruments; test equipment; quality control

Hand Soldering: soldered connections; common materials; soldering process – heating, cooling

Soldering Tools: soldering irons; tips; solutions – some fluxes are long-term corrosive

Soldering: criteria – cleanliness, construction, soldering, drainage; preparation of components – solvents, scouring; maintenance of soldering; process; inspection and testing techniques – solvents; replating; scouring; rejection quality assurance

Extended Soldering Practice: soldering techniques, repairs

Specialisation: Illuminated signs

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

Use and care of lifting equipment.

Regulations: hoisting appliances - general requirements for safe operations, record of examination, examination and testing cranes, cranes, crane drivers and crane signals, record books; fork lift trucks - certificate to operate, training requirements, equipment requirements; manual handling of materials; electrical conductors

Estimation of mass: calculation of solids and hollow rectangular and round sections; mass tables; centre of gravity

Lifting loads and protection: safe working load and load limits; ropes – fibre constructions, properties of various fibres, usage, safety requirements, steel wire rope construction, lay, performing and post - performing, general use of wire rope, safety inspection; chains – types and grade, correct use of chains and hammer locks, care and maintenance of chains, inspection procedures; synthetic fibre slings – types, flat (web) round, maximum operating temperature, limitations, foreign matter, loss of strength static electricity, use, care and safety; calculation of SWL - wire rope slings, single and multiple sling assemblies, chain slings, single and multiple assemblies; lashing, controlling loads, sling attachment; sling accessories – care and maintenance, shackles, eye bolts, clamps, hooks, rings and links, spreader beams, inspection; safe lifting practice – drums, plate, machine components

Cranes and powered lifting equipment: crane types – gantry, cantilever, luffing, overhead travelling, mono-rail, mobile; working with mobile cranes – types and operation; operation of cranes – fixed and track mounted, operators responsibility, crane inspection, general safety; chain blocks and chain pulls – operation and safety procedures, inspection, correct use, application and limitations, maintenance; creeper winches – operation and safety procedures, applications and limitations, correct use, maintenance requirements; types of jacks -–screw, rack, hydraulic and porta packs, correct use, safety requirements; accessories – rigging screws, turn buckles, swivels, ridge sockets; bands and hitches

Crane signals: hand code; whistle code; two way radio

Fork lifts: safe operations; forks; pedestrian controlled pallet trucks; packing and stacking

Lifting special materials: slinging packing, vacuum and magnetic lifting devices

Packing and cribbing: positioning; construction

Specialisation: Operational support

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

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

Basic welding and cutting.

Brazing: process description; consumables; flame setting; joints; typical uses; safety; application; horizontal welding

Thermal cutting: principles of operation; process description; manual cutting; machine straight line cutting; gases: oxygen, acetylene, LPG; nozzles; cutting aids; machine cutting; cutting fault; safety; application, flame cut shapes and bevels

Manual metal arc welding: process description; equipment; consumables; typical uses; safety; application, fillet weld in the flat position

Hazardous locations; confined spaces; containers used for flammable materials; safety procedures and responsibilities

Specialisation: Renewable energy

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 renewable energy.

Non-technical issues: economic, social environmental and political issues; impact on renewable energy technology

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

Energy resources and technologies: solar, wind, hydro; terminology; measurable quantities, units and symbols; technologies and their applications

Biomass resources: terminology; common biofuels (types, energy contents, production, applications); resource assessment

Energy efficient building design: terminology; climate; thermal conductivity, thermal mass and insulation; solar heat gain, ventilation and glazing; shading and active solar systems

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

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

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

Specialisation: Fire Alarms

Introduction to Fire Alarm Installations

Introduction to fire alarm systems; purpose of fire alarm systems; preservation of life in addition to protection of buildings and equipment; operational principles of fire alarm systems; fire detection, role of panels and warning devices.

Control and indicating equipment; purpose of fire alarm panels; role of fire alarm panels including signal processing, warning device activation, fire brigade notification and control of other automated building systems such as smoke management; operational principles of fire alarm panels; performance requirements of the BCA and AS1670; types of fire alarm panels; types of fire alarm panels include conventional (collective) and addressable (analogue).

Warning devices; purpose of warning devices; role of warning devices including strobes and alarm sounders in notifying people of a fire hazard; types of visual warning devices; types of visual warning devices include strobes; operational principles of visual warning devices; performance aspects of differing types of visual warning devices including strobes; types of audible warning devices; types of audible warning devices include alarm sounders, tone generators (speakers) and bells; operational principles of audible warning devices; performance aspects of differing types of audible warning devices including alarm sounders, tone generators (speakers) and bells.

Smoke and heat detectors; purpose of heat and smoke detectors; role of heat and smoke detectors including detection of smouldering or flaming fires; types of smoke detectors; types of smoke detectors may include ionisation, photoelectric, optical beam, and aspirating detectors; operational principles of smoke detectors; performance aspects of differing types of smoke detectors including ionisation, photoelectric, optical beam or aspirating detectors; types of heat detectors: types of heat detectors may include point type heat detectors and linear (including optical fibre) heat detectors; operational principles of heat detectors; performance aspects of point type heat detectors and linear (including optical fibre) heat detectors.

Codes and standards; Australian Standards; relevant Australian Standards include AS1603, AS1668, AS1670, AS1851, AS3000 and AS4428; State Government Building Regulations; relevant Regulations include those referencing the Building Code of Australia; industry Codes of Practice; relevant Regulations include FPAA001; Code of Practice for the installation and maintenance of fire protection equipment; cabling requirements; relevant requirements include AS1670 and the Australian Communications Authority's (ACA) Cabling Provider Rules.

Fire Alarm Routine Testing

Fire alarm test equipment; heat testing equipment; smoke testing equipment; sound testing equipment.

Fire alarm testing; heat detector testing**;** smoke detector testing; system testing

Architectural drawings; fire alarm system symbols (Australia standards); floor plans drawing upgrades;

Site procedures and reporting; OH&S; test warning; reporting – routine & fault; documentation – routine & fault

Building Systems and Materials

Building structures; domestic: footing types, floor construction, internal and external walls, roofs; commercial: floor, walls and roof construction

Building materials; timber; concrete; brick/masonry; plasterboard; tiles; steel; paints

Architectural drawings; site plans; floor plans.

Manual handling techniques; safe manual handling for lifting, pushing, pulling and holding; state/territory regulations for safe manual handling

Category: Electronics (C)

Specialisation: Antennas

Television signal sources.

Theory of electro magnetic waves, wavelength, reflection, refraction, diffraction, polarisation

Use of radio spectrum from 10Khz to 12 Ghz

Propagation of EM waves for: medium frequencies; ground wave, attenuation, day night effects; high frequencies; effect of ionosphere, skip distance, fading day-night and seasonal effects; very high and ultra-high frequencies

Line of sight transmission, multiple path reception, troposphere, ducting and scatter

Theory of antennae, radiation and reception; EM wave transmission including the induction and radiated fields

Feed impedance, polar diagram, current and voltage distribution, polarisation of the half wave dipole and the quarter wave ground plane

Characteristics of specific TV receiving antennae (response, directivity, impedance, front to back ratio)

Characteristics of satellite dishes for TV reception (size, frequency, feed point, tracking)

Characteristics of cables for TV distribution (impedance, attenuation, return loss, screening efficiency)

Antennae gain and directivity

Multiple frequency antennae – TV channels 2, 7, 9, 10

Site surveys

Use of Manufactures' data to select suitable signal sources (antenna, satellite dish, cable)

Use of field strength meters

Optimum antennae or other signal source placement

Methods used to minimise interference

Characteristics of transmission lines – impedance, attenuation, velocity factor for co-axial cable

Transmission line matching, standing waves

Antennae to transmission line impedance, matching networks

Types of interference to RF signals including multiple path reception, power line interference

Adjacent channel interference

Reduction and rejection of interference

TV signal source components.

Typical TV distribution systems and standards (AS300, AS1367)

Signal distribution system fault diagnosis

Basic dB's

Amplifiers and power supplies

Basic amplifier theory – signal to noise ratio, gain

Calculations of cable and insertion losses

Directional couplers – purpose and operation

Splitters

Diplexers/multiplexer

Combiners

Encoder/decoders

Baluns

System losses

Types of cable and characteristics (attenuation, impedance, insertion loss)

RG6, 11 and 59

Types of connectors: F type; Belling lee; BNC; N type

Crimp connectors and tools

TV signal source and distribution component installation.

Work organisation: job planning; component selection; vehicle preparation; tool kits

Buildings: structures and layouts – hi-rise, domestic; building plans and schematics; power and communications cable layouts; product-building match; safety-around buildings; site security systems

Tools and equipment: work platforms; ladders

Cable laying: cable runs: cavity, surface, ceiling; conduit; positioning of cables – bend radius; where and how to tie cables (laying cables); cable support; cable layout plans and diagrams

Hardware: fixings and mountings - installation etc; standards - (knowledge of only) AS1367 and AS3000; hanging and fixing guide wires, masts

Specialisation: Automotive accessories

Automobile alarm systems.

Safety video: emergency

Soldering: types of solder; soldering tools

Measurement: voltage; current; resistance

Relays: types; applications

Mechanical detectors: switches; vibration

Reed switches: operation; installation

Electro-mechanical detectors: ultra sonic; proximity

Automobile sound systems.

Function and specifications of the following components in an automotive sound system: radio; integrated cassette player radio; integrated CD player radio; after market CD player or changer; graphic equaliser; after market amplifier; loudspeakers; sub-bass woofer; crossovers

The decibel: decibel reference to SPL; typical levels; legal dB limit for automotive sound equipment; effects of excessive SPL's on hearing; threshold of pain

Automotive sound system specifications: RMS and PMPO; power handling; distortion; frequency response; sensitivity; signal to noise ratio; compatibility

Power supply requirements: typical current consumption; power amplifier efficiency; load impedance vs power output; power output and supply current; interconnection cables; fuses

Interpretation of technical specifications: selection of compatible equipment; expected performance

Installation: positioning of items; mounting requirements; loudspeaker baffles and enclosures; loudspeaker phasing; earthing; cabling

Location of faults to: audio unit; cable; connections

Cellular phone and citizens band radio installation.

Equipment location: console or dash mount units – driver/passenger safety, ease of operation, hands free equipment; remote mounted units – vehicle safety standard, station wagon, car, utility, multi-purpose van, truck; Antenna – location vs performance, height restrictions, driver vehicle safety

Equipment installation: vehicle protection using mats and drop sheets; phone cradle fixing using screws, pop rivets or adhesives; microphone and speaker fixing using screws, pop rivers or adhesives; CB radio dash fixing; CB radio console fixing; CB radio cabin fixing; remote unit mounting plate fixing; corrosion and water entry prevention; service access; panel mounted antenna fixing; bracket mounted antenna fixing; on-glass mounted antenna fixing; interpreting manufactures instructions

Cable installation: safety precautions; vehicle power circuits; fusible links and vehicle fuses; power connection using crimp, soldering and splicing methods; chassis connections; cable crossing using loom tape or cable ties; cable routing; prevention of cable damage; pull-wire and cable snake techniques; auxiliary call alert wiring; coaxial cable handling; terminating coaxial cable connectors using soldering and crimp methods; interpreting manufactures instructions

unit testing and fault-finding: interrupt manufactures instructions; cellular phone programming; power cable testing with multimeter; antenna cable testing with multimeter; basic voltage standing wave radio (VSWR) measurement; place an outgoing call and check performance; place an incoming call and check performance; operate vehicle electrical equipment and check that installation work has not affected their correct operation; operate vehicle electrical equipment and check that their operation does not introduce noise into radio/phone installation; noise suppression

Customer education: demonstrate equipment operation; show location of all units; show location of relevant switches, connectors and fuses; provide customer with relevant handbooks and warranty details

Specialisation: Business equipment

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

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

Electromechanics of business machines.

Operating principles of motors: general, stepper, pulse

Relays

Solenoids

Clutches: magnetic, spring, tight and loose slip, friction, one way spring, torque – limited clutch

Tacho sensors

Chains and gearing

Pulleys and belt drives

Vacuum feeds

Feed rollers: pin drive, half roller

Separation pads

Equipment maintenance, anti static brushes, conductive/non conductive greases, correct use of oil

Specialisation: Component/equipment assembly

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 through hole soldering skills.

Identification of surface mount components: resistors, capacitors, metal electrode face (MELF); inductors; relays; switches; LEDS; connectors; small outline transistors (SOTS); small outline integrated circuits (SOICS); plastic leaded chip carriers (PLCCS); quad flat packs (QFPS); ball grid arrays (BGAS)

Operation and routine maintenance of soldering equipment: vacuum; de-soldering tools; soldering tweezers; solder pots; preheat plates; hot air/gas; pens; manual pick and place machines; PLCC and QFP removal tools; viewing and inspection devices

ANSI/J-STD-001A standard (PTH): PTH soldering (electronic assemblies); PTH work environment; PCB and component cleaning, soldering temperatures; lead forming; component placement; gold removal; acceptable/rejectable solder joints; post solder cleaning; three levels of the standards

Post solder inspection of PTH technology: visual, cleaning requirements; visual aids, lighting requirements

Flux, cleaning agents and solder paste: flux (resin/rosin, low residue, no clean); flux percentage in solder, wire and solder paste, cleaning agents (chemical, aqueous, aqueous additives); solder paste (hand dispensing; shelf life, manufacturers designators, dispensing methods, testing)

Advanced soldering skills.

ANSI/J-STD-001A standard (SMT): SMT devices; PCB and component cleaning; soldering temperatures; lead forming; component placement; gold removal; acceptable/rejectable solder joints; post solder cleaning; three levels of the standards

SMT Soldering - component removal; PCB cleaning; PCB inspection; component preparation; lead cleaning; lead forming; component placement; solder application; post solder cleaning

Post Solder Inspection of SMDs: visual; cleaning requirements; visual aids; lighting requirements; electronic testing

BGAS removal and replacement: preheat requirements; top heat; removal; ball replacement; PCB cleaning and inspection; BGA replacement; BGA solder reflow; PCB cleaning

Post solder inspection of BGAs: visual; cleaning requirements; visual aids; lighting requirements; electronic testing

Repair of printed wiring boards.

PWB conductor repair

Substrate repair: substrate blister and delamination

PWB warpage

PWB conductor pattern repair: pad repair; pad replacement; track repair; track alteration; track replacement; conformal coatings - types ; removal and replacement

Specialisation: 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

Category: Refrigeration and air conditioning (E)

Specialisation: Appliances refrigeration

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

Appliance Refrigerants.

Properties for refrigerants in current use

Causes of contamination in the systems

Procedures for working with refrigerants; reclaiming/recovering refrigerants; pressure testing systems; dealing with contamination in refrigeration systems; evacuating systems; detecting refrigerant leaks; charging refrigerant

Properties of refrigeration oils in current use

Refrigeration system components.

Compressor types: reciprocating, rotary, centrifugal, scroll

Condenser types: air cooled – static and forced

Evaporator types: bare pipe, plate and forced draft

Flow control types: capillary, restrictors, hot gas and reverse cycle valves

Category: Data communications (F)

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

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

UTE NES202 (A to Z qualifier) D Assemble/disassemble electrical/electronic components

Descriptor: Assemble electrical/electronic components and disassemble electrical/electronic components.

Specific unit outcomes

This is presented as a composite unit that has five 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 NES 202A B	Assemble/disassemble electrical/electronic components *(Computer systems)*
UTE NES 202B C	Assemble/disassemble electrical/electronic components *(Electrical)*
UTE NES 202C B	Assemble/disassemble electrical/electronic components *(Electronics)*
UTE NES 202E C	Assemble/disassemble electrical/electronic components *(Refrigeration & a/conditioning)*
UTE NES 202F B	Assemble/disassemble electrical/electronic components *(Data communications)*

Elements		Performance criteria	
202.1	Plan and prepare to assemble/ disassemble electrical/electronic components	202.1.1	Assemble/disassemble components is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		202.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		202.1.3	Components are checked against job *requirements*
		202.1.4	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*

Elements		Performance criteria	
		202.1.5	*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
		202.1.6	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*
202.2	Assemble/ disassemble electrical/electronic components	202.2.1	*OH&S policies and procedures* are followed
		202.2.2	*Circuits* are checked as being isolated where necessary using specified testing procedures
		202.2.3	Unplanned events or conditions are responded to in accordance with *established procedures*
		202.2.4	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		202.2.5	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
202.3	Inspect and notify completion of work	202.3.1	Final inspections are undertaken to ensure the assembled electrical/electronic components conforms to *requirements*
		202.3.2	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
- (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.
- 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 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

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’.

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*.

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, 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

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 (3rd 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

Category: Computer systems (A)

Specialisation: Computer assembly

PC testing and modification – basic.

Introduction: laboratory familiarisation; electrical and mechanical safety; identification and use of hand tools

Skills: microcomputer familiarisation; digital component identification; socket type integrated circuit removal and insertion; cable troubleshooting and repair; using technical service data

Instruments: introduction to the Digital Multimeter; in-circuit voltage measurements; continuity and resistance measurements

Computer peripherals.

Introduction to peripherals: definition; types/models/classes; terminology; interfacing techniques

Visual display units: types; applications; basic block diagram; detailed block diagram; colour standards

Printers: types; uses; printing quality; basic block diagram; detailed block diagram; connectivity; configuration

Other peripherals: types; applications; configuration

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

Graphical user interface.

The graphical user interface environment: mouse; icons; windows; menus; drop-down menus; pointer icons; dialogue boxes; command buttons; check boxes; option switches; list boxes; test boxes; scrolling; background and foreground

Mouse operations: selecting icons; selecting menu choices; selecting a group of items; selecting a block of text; opening windows; starting programs; dragging

Using a graphical disk management program to manage files and directories: creating and removing directories; creating, copying, deleting, moving and renaming files

Re-sizing windows: starting programs; making programs inactive; reactivating programs

Running multiple applications

Using keystroke alternatives to mouse operations

Accessing and using manuals, third party references and on-line help

Category: Electrical (B)

Specialisation: Appliances electrical

Domestic appliance principles.

Overview of appliance servicing industry: manufacturers; retailers; authorised service agents; appliance service companies; appliance industry association – code of practice

Introduction to the Major appliances: washing machines, clothes dryers, dishwashers, refrigerators, freezers, air conditioners, electrical and gas cookers and heaters; codes statutory requirements, regulations; manufacturer and company requirements, warranty; OH&S

Basic operating principles: clothes washer, heater fill pre-soak and soak options, wash, rinse, spin; clothes dryers, tumbling, heating, lint control; dishwasher, rinse, wash, detergent, heater, rinse, drain; refrigerator, freezer, air conditioner, cooling, heating, defrost, drain (basic refrigeration cycle); electric heaters and cookers, hot plates and elements, temperature controllers, timers; gas heaters and cookers, ignition, burner temperature controllers, timers; gas heaters and cookers, ignition, burner temperature controllers, regulators, flue and ventilation

Basic function of components: timer, temperature controllers, motors, speed controllers, reverse action, transmission, switches, solenoids, filters, fans, burners, regulators, ignition, elements, balancing mechanisms, compressors, agitators

Service and parts manuals: purpose; types; procedures

Domestic clothes washers, dish washers and clothes dryers.

Codes and regulations: plumbing – water supply, drainage, back siphoning; electrical – insulating, earthing; OH&S

Types, construction, operation and applications: washing machines; clothes dryers; dishwashers

Installation and adjustments: manufacturers instructions and data; instruments and tools; customer advice; levelling; safety and pre-start checks; operational checks; adjustments

Repairs and parts replacement: cleaning of cabinets and components, removing rust and minor repairs to cabinets, touching up paint work; under supervision remove and replace of various mechanical items, belts, bearings, door locks, filters, hoses, pumps, float switch, clutch, brakes, dispensers, balance control, gaskets, lint screens

Domestic electrical heating appliances.

Codes and regulations: electrical – insulating, earthing; OH&S

Types, construction, operation and applications: space heaters; stoves; ovens

Installation requirements and adjustments: manufacturers instructions and data; instruments and tools; customer advice; levelling; safety and pre-start checks; operational checks; adjustments

Repairs and parts replacement: cleaning of cabinets and components, removing rust and minor repairs to cabinets, touching up paint work; under supervision remove and replace of various mechanical items, belts, bearings, door locks, filters, elements, thermostats, levelling feet

Specialisation: Coil windings

Machine assembly – electrical.

Hazardous situations: accidents – causes; how they happen; methods of prevention; equipment used for prevention

Hand and power tools: types; application; care; safe use

Production machinery: moving machinery; types; procedures; component identification; energy storage devices – safety procedures when handling, methods of safely discharging energy

Assembly and disassembly devices: surface and component protection – purpose, method of application, methods used; assembly procedures - safety, assembly to specifications, quality assurance; drive systems – various types, applications, methods of fitting; bearings – types, applications, fitting methods, removal methods

Electric motor components: stators; rotors; poles; armature; windings; housings; endshields

Connection and termination of windings: coil – termination, identification, winding; terminal box – layout; designation

Motor and machine components: assembly procedures; safety and precautions

Coil winding.

Winding procedures: selection of insulation material types, class, temperature rating and applications; stator insulation methods; selection of coil former sizing from stator iron and coil measurements; pin former manufacture; coil winding procedures; methods of connecting flexible leads to coils and fastening using various methods, e.g. tape one coil, tie other with twine; procedure for placing coils in position, and shaping coils; methods of securing coils in position using various methods, e.g. wedges, ties, clips

Rewinding procedures: data collection and recording; recording of coil connections using connection diagrams; winding stripping procedures;

measurement of wire size; coil insulation using various methods; coil former sizing from stator iron measurements; pin former manufacture; procedure for winding a set of coil groups; positioning of winding in stator in relation to endshield through bolt holes; placing of coils in stator and shaping; coil former sizing; placing of coils in slots and shaping; insulating and wedging; connection of coils and attachment of flexible leads; binding of coil overhangs using various methods, e.g. taping, typing

Coil winding testing and soldering.

Multimeters: types – analogue, digital; selection of purpose; circuit connectors; polarity; measurement voltages and currents

Multimeter tests: continuity; resistance

Power Supply: construction; operation; connection of components and circuit; disconnecting of components and circuit; precautions

Types of Insulation Tester: solid state; mechanical driven; purpose; statutory requirements

Test Procedures: components; instruments; test equipment; quality control

Hand Soldering: soldered connections; common materials; soldering process – heating, cooling

Soldering Tools: soldering irons; tips; solutions – some fluxes are long-term corrosive

Soldering: criteria – cleanliness, construction, soldering, drainage; preparation of components – solvents, scouring; maintenance of soldering; process; inspection and testing techniques – solvents; replating; scouring; rejection quality assurance

Extended Soldering Practice: soldering techniques, repairs

Specialisation: Illuminated signs

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

Use and care of lifting equipment.

Regulations: hoisting appliances - general requirements for safe operations, record of examination, examination and testing cranes, cranes, crane drivers and crane signals, record books; fork lift trucks - certificate to operate, training requirements, equipment requirements; manual handling of materials; electrical conductors

Estimation of mass: calculation of solids and hollow rectangular and round sections; mass tables; centre of gravity

Lifting loads and protection: safe working load and load limits; ropes – fibre constructions, properties of various fibres, usage, safety requirements, steel wire rope construction, lay, performing and post - performing, general use of wire rope, safety inspection; chains – types and grade, correct use of chains and hammer locks, care and maintenance of chains, inspection procedures; synthetic fibre slings – types, flat (web) round, maximum operating temperature, limitations, foreign matter, loss of strength static electricity, use, care and safety; calculation of SWL - wire rope slings, single and multiple sling assemblies, chain slings, single and multiple assemblies; lashing, controlling loads, sling attachment; sling accessories – care and maintenance, shackles, eye bolts, clamps, hooks, rings and links, spreader beams, inspection; safe lifting practice – drums, plate, machine components

Cranes and powered lifting equipment: crane types – gantry, cantilever, luffing, overhead travelling, mono-rail, mobile; working with mobile cranes – types and operation; operation of cranes – fixed and track mounted, operators responsibility, crane inspection, general safety; chain blocks and chain pulls – operation and safety procedures, inspection, correct use, application and limitations, maintenance; creeper winches – operation and safety procedures, applications and limitations, correct use, maintenance requirements; types of jacks -–screw, rack, hydraulic and porta packs, correct use, safety requirements; accessories – rigging screws, turn buckles, swivels, ridge sockets; bands and hitches

Crane signals: hand code; whistle code; two way radio

Fork lifts: safe operations; forks; pedestrian controlled pallet trucks; packing and stacking

Lifting special materials: slinging packing, vacuum and magnetic lifting devices

Packing and cribbing: positioning; construction

Specialisation: Operational support

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

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

Basic welding and cutting.

Brazing: process description; consumables; flame setting; joints; typical uses; safety; application; horizontal welding

Thermal cutting: principles of operation; process description; manual cutting; machine straight line cutting; gases: oxygen, acetylene, LPG; nozzles; cutting aids; machine cutting; cutting fault; safety; application, flame cut shapes and bevels

Manual metal arc welding: process description; equipment; consumables; typical uses; safety; application, fillet weld in the flat position

Hazardous locations; confined spaces; containers used for flammable materials; safety procedures and responsibilities

Specialisation: Renewable energy

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 renewable energy.

Non-technical issues: economic, social environmental and political issues; impact on renewable energy technology

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

Energy resources and technologies: solar, wind, hydro; terminology; measurable quantities, units and symbols; technologies and their applications

Biomass resources: terminology; common biofuels (types, energy contents, production, applications); resource assessment

Energy efficient building design: terminology; climate; thermal conductivity, thermal mass and insulation; solar heat gain, ventilation and glazing; shading and active solar systems

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

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

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

Specialisation: Fire Alarms

Introduction to Fire Alarm Installations

Introduction to fire alarm systems; purpose of fire alarm systems; preservation of life in addition to protection of buildings and equipment; operational principles of fire alarm systems; fire detection, role of panels and warning devices.

Control and indicating equipment; purpose of fire alarm panels; role of fire alarm panels including signal processing, warning device activation, fire brigade notification and control of other automated building systems such as smoke management; operational principles of fire alarm panels; performance requirements of the BCA and AS1670; types of fire alarm panels; types of fire alarm panels include conventional (collective) and addressable (analogue).

Warning devices; purpose of warning devices; role of warning devices including strobes and alarm sounders in notifying people of a fire hazard; types of visual warning devices; types of visual warning devices include strobes; operational principles of visual warning devices; performance aspects of differing types of visual warning devices including strobes; types of audible warning devices; types of audible warning devices include alarm sounders, tone generators (speakers) and bells; operational principles of audible warning devices; performance aspects of differing types of audible warning devices including alarm sounders, tone generators (speakers) and bells.

Smoke and heat detectors; purpose of heat and smoke detectors; role of heat and smoke detectors including detection of smouldering or flaming fires; types of smoke detectors; types of smoke detectors may include ionisation, photoelectric, optical beam, and aspirating detectors; operational principles of smoke detectors; performance aspects of differing types of smoke detectors including ionisation, photoelectric, optical beam or aspirating detectors; types of heat detectors: types of heat detectors may include point type heat detectors and linear (including optical fibre) heat detectors; operational principles of heat detectors; performance aspects of point type heat detectors and linear (including optical fibre) heat detectors.

Codes and standards; Australian Standards; relevant Australian Standards include AS1603, AS1668, AS1670, AS1851, AS3000 and AS4428; State Government Building Regulations; relevant Regulations include those referencing the Building Code of Australia; industry Codes of Practice; relevant Regulations include FPAA001; Code of Practice for the installation and maintenance of fire protection equipment; cabling requirements; relevant requirements include AS1670 and the Australian Communications Authority's (ACA) Cabling Provider Rules.

Fire Alarm Routine Testing

Fire alarm test equipment; heat testing equipment; smoke testing equipment; sound testing equipment.

Fire alarm testing; heat detector testing**;** smoke detector testing; system testing

Architectural drawings; fire alarm system symbols (Australia standards); floor plans drawing upgrades;

Site procedures and reporting; OH&S; test warning; reporting – routine & fault; documentation – routine & fault

Building Systems and Materials

Building structures; domestic: footing types, floor construction, internal and external walls, roofs; commercial: floor, walls and roof construction

Building materials; timber; concrete; brick/masonry; plasterboard; tiles; steel; paints

Architectural drawings; site plans; floor plans.

Manual handling techniques; safe manual handling for lifting, pushing, pulling and holding; state/territory regulations for safe manual handling

Category: Electronics (C)

Specialisation: Antennas

Television signal sources.

Theory of electro magnetic waves, wavelength, reflection, refraction, diffraction, polarisation

Use of radio spectrum from 10Khz to 12 Ghz

Propagation of EM waves for: medium frequencies; ground wave, attenuation, day night effects; high frequencies; effect of ionosphere, skip distance, fading day-night and seasonal effects; very high and ultra-high frequencies

Line of sight transmission, multiple path reception, troposphere, ducting and scatter

Theory of antennae, radiation and reception; EM wave transmission including the induction and radiated fields

Feed impedance, polar diagram, current and voltage distribution, polarisation of the half wave dipole and the quarter wave ground plane

Characteristics of specific TV receiving antennae (response, directivity, impedance, front to back ratio)

Characteristics of satellite dishes for TV reception (size, frequency, feed point, tracking)

Characteristics of cables for TV distribution (impedance, attenuation, return loss, screening efficiency)

Antennae gain and directivity

Multiple frequency antennae – TV channels 2, 7, 9, 10

Site surveys

Use of Manufactures' data to select suitable signal sources (antenna, satellite dish, cable)

Use of field strength meters

Optimum antennae or other signal source placement

Methods used to minimise interference

Characteristics of transmission lines – impedance, attenuation, velocity factor for co-axial cable

Transmission line matching, standing waves

Antennae to transmission line impedance, matching networks

Types of interference to RF signals including multiple path reception, power line interference

Adjacent channel interference

Reduction and rejection of interference

TV signal source components.

Typical TV distribution systems and standards (AS300, AS1367)

Signal distribution system fault diagnosis

Basic dB’s

Amplifiers and power supplies

Basic amplifier theory – signal to noise ratio, gain

Calculations of cable and insertion losses

Directional couplers – purpose and operation

Splitters

Diplexers/multiplexer

Combiners

Encoder/decoders

Baluns

System losses

Types of cable and characteristics (attenuation, impedance, insertion loss)

RG6, 11 and 59

Types of connectors: F type; Belling lee; BNC; N type

Crimp connectors and tools

TV signal source and distribution component installation.

Work organisation: job planning; component selection; vehicle preparation; tool kits

Buildings: structures and layouts – hi-rise, domestic; building plans and schematics; power and communications cable layouts; product-building match; safety-around buildings; site security systems

Tools and equipment: work platforms; ladders

Cable laying: cable runs: cavity, surface, ceiling; conduit; positioning of cables – bend radius; where and how to tie cables (laying cables); cable support; cable layout plans and diagrams

Hardware: fixings and mountings - installation etc; standards - (knowledge of only) AS1367 and AS3000; hanging and fixing guide wires, masts

Specialisation: Automotive accessories

Automobile alarm systems.

Safety video: emergency

Soldering: types of solder; soldering tools

Measurement: voltage; current; resistance

Relays: types; applications

Mechanical detectors: switches; vibration

Reed switches: operation; installation

Electro-mechanical detectors: ultra sonic; proximity

Automobile sound systems.

Function and specifications of the following components in an automotive sound system: radio; integrated cassette player radio; integrated CD player radio; after market CD player or changer; graphic equaliser; after market amplifier; loudspeakers; sub-bass woofer; crossovers

The decibel: decibel reference to SPL; typical levels; legal dB limit for automotive sound equipment; effects of excessive SPL's on hearing; threshold of pain

Automotive sound system specifications: RMS and PMPO; power handling; distortion; frequency response; sensitivity; signal to noise ratio; compatibility

Power supply requirements: typical current consumption; power amplifier efficiency; load impedance vs power output; power output and supply current; interconnection cables; fuses

Interpretation of technical specifications: selection of compatible equipment; expected performance

Installation: positioning of items; mounting requirements; loudspeaker baffles and enclosures; loudspeaker phasing; earthing; cabling

Location of faults to: audio unit; cable; connections

Cellular phone and citizens band radio installation.

Equipment location: console or dash mount units – driver/passenger safety, ease of operation, hands free equipment; remote mounted units – vehicle safety standard, station wagon, car, utility, multi-purpose van, truck; Antenna – location vs performance, height restrictions, driver vehicle safety

Equipment installation: vehicle protection using mats and drop sheets; phone cradle fixing using screws, pop rivets or adhesives; microphone and speaker fixing using screws, pop rivets or adhesives; CB radio dash fixing; CB radio console fixing; CB radio cabin fixing; remote unit mounting plate fixing; corrosion and water entry prevention; service access; panel mounted antenna fixing; bracket mounted antenna fixing; on-glass mounted antenna fixing; interpreting manufactures instructions

Cable installation: safety precautions; vehicle power circuits; fusible links and vehicle fuses; power connection using crimp, soldering and splicing methods; chassis connections; cable crossing using loom tape or cable ties; cable routing; prevention of cable damage; pull-wire and cable snake techniques; auxiliary call alert wiring; coaxial cable handling; terminating coaxial cable connectors using soldering and crimp methods; interpreting manufactures instructions

unit testing and fault-finding: interrupt manufactures instructions; cellular phone programming; power cable testing with multimeter; antenna cable testing with multimeter; basic voltage standing wave radio (VSWR) measurement; place an outgoing call and check performance; place an incoming call and check performance; operate vehicle electrical equipment and check that installation work has not affected their correct operation; operate vehicle electrical equipment and check that their operation does not introduce noise into radio/phone installation; noise suppression

Customer education: demonstrate equipment operation; show location of all units; show location of relevant switches, connectors and fuses; provide customer with relevant handbooks and warranty details

Specialisation: Business equipment

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

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

Electromechanics of business machines.

Operating principles of motors: general, stepper, pulse

Relays

Solenoids

Clutches: magnetic, spring, tight and loose slip, friction, one way spring, torque – limited clutch

Tacho sensors

Chains and gearing

Pulleys and belt drives

Vacuum feeds

Feed rollers: pin drive, half roller

Separation pads

Equipment maintenance, anti static brushes, conductive/non conductive greases, correct use of oil

Specialisation: Component/equipment assembly

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

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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 through hole soldering skills.

Identification of surface mount components: resistors, capacitors, metal electrode face (MELF); inductors; relays; switches; LEDS; connectors; small outline transistors (SOTS); small outline integrated circuits (SOICS); plastic leaded chip carriers (PLCCS); quad flat packs (QFPS); ball grid arrays (BGAS)

Operation and routine maintenance of soldering equipment: vacuum; de-soldering tools; soldering tweezers; solder pots; preheat plates; hot air/gas; pens; manual pick and place machines; PLCC and QFP removal tools; viewing and inspection devices

ANSI/J-STD-001A standard (PTH): PTH soldering (electronic assemblies); PTH work environment; PCB and component cleaning, soldering temperatures; lead forming; component placement; gold removal; acceptable/rejectable solder joints; post solder cleaning; three levels of the standards

Post solder inspection of PTH technology: visual, cleaning requirements; visual aids, lighting requirements

Flux, cleaning agents and solder paste: flux (resin/rosin, low residue, no clean); flux percentage in solder, wire and solder paste, cleaning agents (chemical, aqueous, aqueous additives); solder paste (hand dispensing; shelf life, manufacturers designators, dispensing methods, testing)

Advanced soldering skills.

ANSI/J-STD-001A standard (SMT): SMT devices; PCB and component cleaning; soldering temperatures; lead forming; component placement; gold removal; acceptable/rejectable solder joints; post solder cleaning; three levels of the standards

SMT Soldering - component removal; PCB cleaning; PCB inspection; component preparation; lead cleaning; lead forming; component placement; solder application; post solder cleaning

Post Solder Inspection of SMDs: visual; cleaning requirements; visual aids; lighting requirements; electronic testing

BGAS removal and replacement: preheat requirements; top heat; removal; ball replacement; PCB cleaning and inspection; BGA replacement; BGA solder reflow; PCB cleaning

Post solder inspection of BGAs: visual; cleaning requirements; visual aids; lighting requirements; electronic testing

Repair of printed wiring boards.

PWB conductor repair

Substrate repair: substrate blister and delamination

PWB warpage

PWB conductor pattern repair: pad repair; pad replacement; track repair; track alteration; track replacement; conformal coatings - types ; removal and replacement

Specialisation: 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

Category: Refrigeration and air conditioning (E)

Specialisation: Appliances refrigeration

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

Appliance Refrigerants.

Properties for refrigerants in current use

Causes of contamination in the systems

Procedures for working with refrigerants; reclaiming/recovering refrigerants; pressure testing systems; dealing with contamination in refrigeration systems; evacuating systems; detecting refrigerant leaks; charging refrigerant

Properties of refrigeration oils in current use

Refrigeration system components.

Compressor types: reciprocating, rotary, centrifugal, scroll

Condenser types: air cooled – static and forced

Evaporator types: bare pipe, plate and forced draft

Flow control types: capillary, restrictors, hot gas and reverse cycle valves

Category: Data communications (F)

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 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

UTE NES203 (A to Z qualifier) A
Assemble electrical/electronic apparatus

Descriptor: Assemble electrical/electronic distribution or control panels; switchboards; electrical, electropneumatic and electrohydraulic control panels; communications distribution and switching frames; control panels and the like.

Alignment: This unit aligns to and is based on the National Electrotechnology Benchmark Standard EBS202 – Assemble distribution and control panels.

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 NES203B B	Assemble electrical/electronic apparatus *(Electrical)*

Elements		Performance criteria	
203.1	Plan and prepare for the assembly of distribution and control panels	203.1.1	Assembly of distribution and control panels is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		203.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		203.1.3	Assembly of distribution and control panels are checked against job *requirements*
		203.1.4	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		203.1.5	*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
		203.1.6	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*

Elements		**Performance criteria**	
203.2	Assemble distribution and control panels	203.2.1	*OH&S policies and procedures* for assembling distribution and control panels are followed
		203.2.2	Distribution and control panels are assembled in accordance with *requirements*, without damage or distortion to the surrounding environment or services
		203.2.3	Components assembled in distribution and control panels are *terminated* and connected in accordance with *requirements*
		203.2.4	Unplanned events or conditions are responded to in accordance with *established procedures*
		203.2.5	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		203.2.6	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
203.3	Inspect and notify completion of work	203.3.1	Final inspections are undertaken to ensure the assembled distribution and control panels conforms to *requirements*
		203.3.2	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:

- (B) Electrical

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

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’.

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

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

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

Switchboard, design and construction.

Fabrication: sheet metal; bus bar; switchgear; metering

Wiring: DOL starter; star delta starter; reversing starter; control circuits

Testing: insulation; starter circuits; control circuits; fault-finding

UTE NES204 A
Vegetation control

Descriptor: Control vegetation providing vegetation management around electrical, power and communication conductors and cables on poles and according to the requirements of Federal, State/Territory and Local Government legislation, regulations and codes of practice.

Elements		Performance criteria	
204.1	Plan and prepare for the control of vegetation	204.1.1	Ensure OH&S policies and procedures are followed and the work is appropriately sequenced in accordance with *requirements*
		204.1.2	Appropriate personnel and others involved with the worksite are consulted to ensure the work is co-ordinated effectively
		204.1.3	Vegetation management techniques are selected and checked against job *requirements*
		204.1.4	Materials necessary to complete the work are obtained in accordance with established procedures and checked against job *requirements*
		204.1.5	Tools and equipment needed to carry out the work are obtained in accordance with established procedures and checked for correct operation and safety
		204.1.6	Preparatory work is checked to ensure compliance with *requirements* and to ensure work can be conducted without damage to services and with minimal environmental impact
204.2	Control vegetation	204.2.1	OH&S policies and procedures for the control of vegetation are followed
		204.2.2	Vegetation control is carried out in accordance with *requirements*, without damage to services and with minimal environmental impact
		204.2.3	Unplanned events or conditions are responded to in accordance with established procedures
		204.2.4	Approval is obtained in accordance with established procedures from appropriate personnel before any contingencies are implemented

Elements		Performance criteria	
		204.2.5	On-going checks of the quality and environmental impact of the work are undertaken in accordance with established procedures
204.3	Inspect and notify completion of work	204.3.1	Final inspections are undertaken to ensure the control of vegetation conforms to requirements
		204.3.2	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.

Occupational Health and Safety: Acts and Regulations; Codes of Practice; industrial licencing requirements; personal safety: personal protective equipment; hearing conservation; manual handling; workplace hazards identification; risk assessment and risk minimisation; emergency first aid/resuscitation; emergency rescue

Powerline safety: voltage and services identification; power line clearance/distance requirements: personal, equipment, trees; sag and sway calculation; climactic conditions; safety observer; small fire control, evacuation procedures; notification requirements to de-energise electrical conductors; traffic control; state traffic regulatory requirements

Equipment and mobile plant: legislative, licencing and safety requirements for equipment; equipment clean down procedures (weed infestation minimisation); elevating work platforms (EWPs) including maintenance and safety device checks, drive systems, levelling and supporting the EWP for operations, operating procedures, shutting down and securing the EWP for travel, accident reporting procedures, procedures for emergency electrical contacts, engine and hydraulic failures; chainsaws including regulations and specifications, safety equipment, components identification, chainsaw maintenance and operation; wood chippers including pre-start checks, work site set up, operation, periodic maintenance routines; winches and associated cabling; enterprise vehicles

Site identification and assessment: Federal/State/Local Government legislative requirements; map reading; geographic Information System/Geographic Positioning Systems (GIS/GPS); land categories, consultation requirements, risk minimisation, work planning; tree and plant assessment for amenity, bio-diversity, cultural, habitat values; tree and plant identification, plant classification systems including common and botanical nomenclature; basic tree and plant anatomy, growth requirements, heights and patterns; weed and woody weed identification and control methods

Vegetation management techniques: trees including ropes, knots, climbing principles and techniques, ground support, emergency rescue; fall site topography and conditions; drop zone clearance; tree dimension calculation; signage/barrier installation; clear felling in electrical environments; tree rigging and restraint techniques; accessing trees; falling trees under restraint; falling cuts with chainsaws; cut up and remove debris; natural target pruning; pruning principles and practices; pruning tools and equipment; pruning and shaping in accordance with industry codes of practice; pruning trees; use of ropes for branch removal; herbicide selection and application techniques; occupational health and safety laws, pest control regulations, local government requirements; consultation and signage requirements; material safety data sheets and chemical label interpretation; selection and use of personal protective equipment; chemical herbicide selection; calculation of herbicide quantities, mixing and handling; equipment calibration; herbicide application techniques: spray, cut and paint, stem injection; spillage clean-up and disposal techniques; herbicide transportation and storage; stump removal, hand grubbing and mechanical techniques

Communicate plans, intentions and safety criteria to personnel and others.

Enterprise specific requirements with respect to: technical manuals and instructions; Regulations, Codes of Practice, State/Federal Legislation; quality control and environmental management; documentation and record systems including the use of information technologies; consultation requirements; OH&S risk assessment and OH&S instructions; work team participation

UTE NES205 (A to Z qualifier) B
Conduct powerline switching

Descriptor: Undertake isolation and energising of high or low voltage powerlines for power transmission and distribution through approved switching procedures.

Alignment: This unit aligns to and is based on the National Electrotechnology Benchmark Standard EBS 650 – Conduct powerline switching.

Specific unit outcomes

This is presented as a composite unit that has three 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 NES205K A	Conduct powerline switching *(Low voltage switching)*
UTE NES205L A	Conduct powerline switching *(High voltage switching)*
UTE NES205M A	Conduct powerline switching *(System switching)*

Elements		Performance criteria	
205.1	Plan and prepare to undertake powerline switching procedures	205.1.1	Powerline switching procedures are planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		205.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		205.1.3	Powerline switching procedures are checked against *requirements*
		205.1.4	*Tools, equipment, testing devices* and permits needed to carry out the work are obtained in accordance with *established procedures* and checked for correct operation and safety

Elements		Performance criteria	
205.2	Conduct powerline switching	205.2.1	*OH&S policies and procedures* are followed
		205.2.2	Powerline switching procedures are performed in accordance with *requirements*
		205.2.3	*Circuits* are checked as being isolated where necessary using specified testing procedures
		205.2.4	Unplanned events or conditions are responded to in accordance with *established procedures*
		205.2.5	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		205.2.6	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
205.3	Inspect and notify completion of work	205.3.1	Final checks are undertaken to ensure that the switching procedures conforms to *requirements* and permits are surrendered
		205.3.2	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:

(K) Low voltage switching

(L) High voltage switching

(M) System switching

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 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

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'.

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: Low voltage switching (K)

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

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)

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

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

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

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

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

Low voltage switching.

Applications for switching and system diagrams: interpretation; analysis

Switching: operation procedures; earthing procedures

Electrical apparatus: types; characteristics; capabilities

Permits: electrical access permits; contractors authorities

Specialist tools and testing equipment: characteristics; capabilities; uses

Category: High voltage switching (L)

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

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

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

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

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

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

High voltage switching and isolation.

Introduction to high voltage systems

Switching objectives and philosophy

Stages of switching

Research (plan for switching)

Programming (plan for switching)

Preparation (for switching)

Isolation (of high voltage supply)

Restoration (of high voltage supply)

High voltage switching procedures

Preparation and writing of switching programs

Category: System switching (M)

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

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

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

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

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

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

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

Low voltage switching.

Applications for switching and system diagrams: interpretation; analysis

Switching: operation procedures; earthing procedures

Electrical apparatus: types; characteristics; capabilities

Permits: electrical access permits; contractors authorities

Specialist tools and testing equipment: characteristics; capabilities; uses

High voltage switching - techniques.

High voltage switching procedures

Restriction pertaining to HV switching equipment

Isolation of HV transmission and distribution systems

Providing dead and installing main and working earths theory and practical

Use and operation of the following equipment used in association with HV overhead and substation switching: test instruments; sticks; interrupters; arc stranglers

Procedure for the following HV overhead switching or indicating devices: fuses; disconnect fuses; load switching; live line indicators; capacitors; reclosers; sectionalisers; air breaks; disconnects; live line clamps; phasing sticks; phasing tester

Protection systems and substation equipment: relays (overcurrent, reclosing, earth fault); transformer protection (Bucholtz relay, OLTC, regulators); zone leakage; directional overcurrent; distance impedance; annunicators; control panels; underfrequency protection; telephone dialling units; power factor correction; methods; general substation procedures; switchyard devices; circuit breakers; regulators; target reading

Equipment used in association with HV: underground switching; arc stranglers; switch operation; load break elbows; switching cubicles; canister fuses; bayonet fuses; F and G switching cubicles; voltage indicators; phasing testers

HV transmission and distribution system symbols and feeder plans

The preparation of switching sheets: system switching; local switching programs and emergency switching programs, using approved switching terminology

Mobile radio procedures

Double isolation procedures

System switching.

System and feeder characteristics; system protection systems; effects on system stability of system faults and corrective actions

UTE NES206 (A to Z qualifier) B
Maintain & repair apparatus & circuits

Descriptor: Undertake routine maintenance on *apparatus* and associated *basic circuits*, includes wiring, piping, tubing and components.

Alignment: This unit aligns to and is based on the National Electrotechnology Benchmark Standard EBS 406 - Maintain and repair apparatus and associated circuits.

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 NES206A A	Maintain & repair apparatus & circuits *(Computer systems)*
UTE NES206B A	Maintain & repair apparatus & circuits *(Electrical)*
UTE NES206C B	Maintain & repair apparatus & circuits *(Electronics)*
UTE NES206D A	Maintain & repair apparatus & circuits *(Instrumentation)*
UTE NES206E A	Maintain & repair apparatus & circuits *(Refrigeration & a/conditioning)*
UTE NES206F A	Maintain & repair apparatus & circuits *(Data communications)*

Elements		Performance criteria	
206.1	Plan and prepare for maintenance	206.1.1	Maintenance is planned and prepared to ensure *OH&S policies and procedures* are followed, the work is appropriately sequenced in accordance with *requirements*
		206.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		206.1.3	*Apparatus* maintenance schedules and specifications are checked against *requirements*
		206.1.4	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*

Elements		Performance criteria	
		206.1.5	*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
		206.1.6	Preparatory work is checked to ensure no unnecessary damage has occurred and complies with *requirements*
206.2	Maintain *apparatus* and associated circuits	206.2.1	*OH&S policies and procedures* are followed
		206.2.2	Normal function of *apparatus* and associated *circuits* is ascertained in accordance with *requirements*
		206.2.3	*Circuits* are checked as being isolated where necessary using specified testing procedures
		206.2.4	*Apparatus* is maintained in accordance with *requirements*, without damage or distortion to the surrounding environment or services
		206.2.5	"Like for like" replacement of *wiring systems*, *apparatus (fixed wired)* or *apparatus* is undertaken in accordance with *established procedures*, where necessary
		206.2.6	Unplanned events or conditions are responded to in accordance with *established procedures*
		206.2.7	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		206.2.8	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
206.3	Inspect and notify completion of work	206.3.1	Final inspections are undertaken to ensure the maintenance of *apparatus* conforms to *requirements*
		206.3.2	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 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/pulsar 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; faultfinding 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

Electronic fault-finding.

Customer relations; testing to ascertain actual fault; select appropriate repair agency; packaging of damaged equipment; observe equipment for signs of visual damage; check power supplies; observe circuit board for obvious signs of damage; split half method; test equipment; functional testing after repair; invoicing; warranty item

Graphical user interface.

The graphical user interface environment: mouse; icons; windows; menus; drop-down menus; pointer icons; dialogue boxes; command buttons; check boxes; option switches; list boxes; test boxes; scrolling; background and foreground

Mouse operations: selecting icons; selecting menu choices; selecting a group of items; selecting a block of text; opening windows; starting programs; dragging

Using a graphical disk management program to manage files and directories: creating and removing directories; creating, copying, deleting, moving and renaming files

Re-sizing windows: starting programs; making programs inactive; reactivating programs

Running multiple applications

Using keystroke alternatives to mouse operations

Accessing and using manuals, third party references and on-line help

Command line interface.

Operations: copying; moving; deleting and renaming files; initialising disks; using paths; running applications; identifying, accessing and using information from on-line help or a manual

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

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

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: 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

Photocopier operating principles.

Photocopiers: general operating processes, block diagram, operation of the major functional blocks, use of service manual

Copy processes: analogue photocopier (image scanning process, development process, transfer process, cleaning process, fusing process, process control/compensation techniques) digital photocopier (image scanning process, image capture process, image storage techniques, image manipulation process); comparison of digital and analogue photocopiers

Paper feed and transportation: paper types, paper handling, methods of paper feed, paper transportation

Maintenance procedures: photocopier adjustment for correct operation, replacement of consumable items, cleaning procedures

Colour photocopying principles.

Principles of colour and colour separation: effects of light on the eye, colour principles, colour separation, colour mixing processes, colour wheel

Colour separation in colour photocopying: three scan process, four scan process, under colour removal

Principles of colour photocopying: reflected light paths, block diagrams of, photocopiers, principles of operation

Scanning processes of colour photocopiers: CCD, pre amps, auto gain, image, processing unit, laser unit, exposure processes

Printing processes of colour photocopiers: laser diode unit, polygon mirrors, laser synchronising and detector, cylindrical lens

Routine maintenance and servicing: optics, paper feeds, developer unit, drum unit, belts and rollers, fusing unit

Business machine transducers.

Introduction to transducers: definition and basics, linear position and velocity, angular position measurement, angular velocity measurement, temperature sensors, humidity sensors, current sensors, piezo sensors

Temperature sensors: introduction, thermocouples, resistance temperature detectors (RTD), thermistors, bimetal temperature sensors, applications

Optoelectronic devices: introduction, photoresistors, photodiodes, phototransistors, LASCR, photovoltaic devices, optocouplers, laser, applications

Facsimile machines.

Fundamental concepts: CCITT standards, analogue and digital transmissions, transmission process, phases of facsimile calls

Scanning operations: single photosensor, CCD operations, area image sensors, lighting systems, optical systems

Signal processing: picture reduction, modems

Printing processes: thermal, plain paper, carbon transfer ink jet

Dialling parameters: pulse (decadic) dialling, DTMF, manual dial, blind dial, line and dial detect, redial and listen to dial

Coding systems: data compression, modified Hauffman (MH) systems, modified read (MR) systems, modified read (MMR) systems, “K” factor, error correction modes (ECM)

Operational principles: transmission, reception, copying

Installation, operation, maintenance and servicing procedures: disassembly and assembly, consumable replacement, cleaning, fault identification, machine faults, line faults

Facsimile services: faxstream, duet

Business machine accessories.

Input: paper trays, high capacity bins, document feeders, duplex unit, manual bypass, coin boxes, card readers, raster image processing unit

Output: sorters, staplers, collators, folders, stackers

Colour cartridges

Basic telephony/switching systems overview.

Sound: characteristics; wave forms; distortion and resonant frequency; voice and audio frequency; pressure; level

Transmission: principles; speed; mediums; limits; telephone functions

Telephone transmitter: function; types; microphones

Telephone receiver: functions; types; operation

Circuit operation of a telephone: facilities; basic operation

Customer switching systems (CSS) services: extension; extension to extension; extension to PSTN; PSTN to extension; operator; phones; modems; switch boards; connection to telephone exchange; public line coming in; enquiry calls; paging; call back; conferencing; hold music; night switching; bip tones

Development of customer switching systems: generations of CSS

Installation procedures: regulations; ACA

Hazards associated with printed circuit board: physical – card damage, vibration; chemical – cleanliness, heman acids, foot, dust, water; electrical – electrical static discharge; other – environmental (UV radiation); safety procedures; storage and packaging of components; electrostatic equipment – leads, earthing mats; protective clothing - gloves

Personal computer servicing.

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

Computer PC hardware: motherboard/s; power supplies; keyboards; monitors and adaptors; disk drives; printers; sundry devices

Operating systems: types of operating systems; file and data structures; file naming conventions; directory structures and access; operating system bootstrapping process; operating system commands; basic concepts of batch (start-up) files; usage; configuration files

Personal computer servicing.

Editors: concepts of editors; create/modify delete file

Hardware/software system configuration: operating system configuration commands and files; start-up/bootstrap files; disk formatting and partition concepts; memory set-up and memory management; I/O port configurations

Installing options: optional cards; optional software drives and installation; optional devices; upgrading the standard PC

Troubleshooting techniques: ‘first level’ servicing (modular approach); cost-effectiveness of repairs; ‘chip level’ servicing; test equipment; typical diagnostics

Installation application packages: types; installation procedures; copyright protectors; backup procedures; upgrading packages

Preventative maintenance and environment: daily operating routines and shutdown; ‘cleanliness’; packing equipment for transport; static problems

Computer peripherals.

Introduction to peripherals: definition; types/models/classes; terminology; interfacing techniques

Visual display units: types; applications; basic block diagram; detailed block diagram; colour standards

Printers: types; uses; printing quality; basic block diagram; detailed block diagram; connectivity; configuration

Other peripherals: types; applications; configuration

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

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

Feedback, filters and oscillators.

Positive and negative feedback

Effects of negative feedback on voltage amplifier

Ideal filters: high pass, low pass, band pass, band stop, example of practical filters in audio and HF systems

Analogue and digital oscillators: Barkhausen criteria; phase shift oscillator, three stage; Colpitts oscillator – BJT or JFET; oscillator characteristics – applications of phase shift and Colpitts oscillators

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

Control programming style.

Control applications of software; software terminology; relevant programming languages currently available; flowcharts; pseudocode; nassi sniedeman charts; developing algorithms; programming style; programming structure; documentation; installing a language compiler; using a text editor; compiling source code; generating executable files

Scalar and structured data types; constants and variables; reading from keyboard and writing to screen; arithmetic, relational and logical operations; making decisions using if/then, if/then/else, nested if/then and case; looping operations using while/do, repeat/until and for/do; subprograms; functions; procedures

Installation of computer interface circuit boards; programming to access external devices via I/O boards

Control interfacing.

Introduction to the integrated control system: basic make-up of an integrated control system; hierarchy of an integrated control system; the five levels in a typical integrated control system

Field signals: standard control signals transmitters (four wire, two wire and isolators)

Serial data communications: basic principles; simplex/duplex; asynchronous and synchronous; basic standards (RS232, RS423, RS422 and RS485)

Local area networks (level 1 only): OS1 model; topology – ring, star and bus

Protocols: basic principles; map, top, modbus, profibus etc

Industrial automation software: basic principles (drivers etc); examples (wizcon, citect, dmacs, factory link, process windows, control view, genesis etc)

Practical exercises

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

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

Specialisation: Data capture

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

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

Feedback, filters and oscillators.

Positive and negative feedback

Effects of negative feedback on voltage amplifier

Ideal filters: high pass, low pass, band pass, band stop, example of practical filters in audio and HF systems

Analogue and digital oscillators: Barkhausen criteria; phase shift oscillator, three stage; Colpitts oscillator – BJT or JFET; oscillator characteristics – applications of phase shift and Colpitts oscillators

Automatic data capture systems.

Introduction to automatic data capture (ADC): definition of ADC; reasons for using ADC; labelling types including – barcodes, RF tags, magnetic strips, touch memory, finger prints, visual and voice recognition and smart cards

Barcoding standards and symbologies: including – UPC, EAN, ITF, CODABAR, code 39 code 128, 2D barcodes

Equipment: general input equipment; including pens, wands, CCD scanners and laser scanners; printers and print quality standards; include thermal/laser, dedicated Vrs pre-print codes; ancillary equipment; keyboard wedge, TTL/wand emulation and OCIA software; RF systems; equipment required, applications of RF, cost issues, RF interfacing issue

Interfacing problems: identifying customer needs requirements for system; hardware/hardware – hardware/software, software/software type interfacing, problems with case studies, updating hardware/software issues

Systems examples: point-of-sale, asset management, warehousing, manufacturing, traceability and security systems

Designing a system: input design; interface design; debugging

Filters and resonance.

Resonance in circuits: impedance vs frequency for series resonant circuit; ‘bandwidth’; energy exchange L and C

Parallel resonance: currents in parallel circuit; current, above and below resonance; line current vs frequency; impedance, above, below and at resonance; phasor diagrams for R–L–C circuits; phase angles; power factor correction

Phasor diagrams for L–R, C–R, and R–L–C circuits: impedance of series R–L–C circuits above, below and at the resonant frequency; circuit currents;

component voltages; Q factor; introduction, definition; relationship between Q 'bandwidth' and the resonant frequency

Capacitive – resistive filters: output voltage vs frequency for a capacitive resistive filter; principles of inductive – resistive filters, for sinewave input signals; graphical representation

Low pass filters: principles of capacitive – resistive filters; principles of inductive – resistive filters; graphical representations

Band stop filters: principles of series resonant circuits as band stop filters for sinewave signals; principles of parallel resonant circuits as band stop filters, for sinewave signals; graphical representations

Band pass filters: principles of series resonant circuits as band pass filters; graphical representation; parallel resonant circuits as band pass filters; graphical representations; circuits using more than one resonant circuit

Other devices used in filter circuits: quartz crystals; ceramic filters; mechanical filters; comb filters; SAW devices; cavity resonators

Control interfacing.

Introduction to the integrated control system: basic make-up of an integrated control system; hierarchy of an integrated control system; the five levels in a typical integrated control system

Field signals: standard control signals transmitters (four wire, two wire and isolators)

Serial data communications: basic principles; simplex/duplex; asynchronous and synchronous; basic standards (RS232, RS423, RS422 and RS485)

Local area networks (level 1 only): OS1 model; topology – ring, star and bus

Protocols: basic principles; map, top, modbus, profibus etc

Industrial automation software: basic principles (drivers etc); examples (wizcon, citect, dmacs, factory link, process windows, control view, genesis etc)

Practical exercises

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

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 signals in common use

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

Comparison of 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

Computer monitors.

Standards: compatibility; VGA; SVGA

Video adaptors and video drivers: requirements; principles of operation; compatibility of SVGA to VGA; graphics accelerators

Multi sync monitors: synch detection; display mode

CRTs: principles of operation; thermionic emission; electron gun; basic raster scanning; synchronisation; typical electrode voltages; safety; in-line delta; high contrast/brightness; flat screen

Flat panel displays: super twisted nematic (STN); neutralised super twisted nematic (NTN); film compensated super twisted nematic (FTN); passive matrix; active matrix; new technologies

Shielding: safety; radiation; magnetic

Input signal levels: voltage levels

Digital controls and control circuitry: picture size; picture centering; picture symmetry

Basic telephony/switching systems overview.

Sound: characteristics; wave forms; distortion and resonant frequency; voice and audio frequency; pressure; level

Transmission: principles; speed; mediums; limits; telephone functions

Telephone transmitter: function; types; microphones

Telephone receiver: functions; types; operation

Circuit operation of a telephone: facilities; basic operation

Customer switching systems (CSS) services: extension; extension to extension; extension to PSTN; PSTN to extension; operator; phones; modems; switch boards; connection to telephone exchange; public line coming in; enquiry calls; paging; call back; conferencing; hold music; night switching; bip tones

Development of customer switching systems: generations of CSS

Installation procedures: regulations; ACA

Hazards associated with printed circuit board: physical – card damage, vibration; chemical – cleanliness, heman acids, foot, dust, water; electrical – electrical static discharge; other – environmental (UV radiation); safety procedures; storage and packaging of components; electrostatic equipment – leads, earthing mats; protective clothing, - gloves

Control programming style.

Control applications of software; software terminology; relevant programming languages currently available; flowcharts; pseudocode; nassi sniedeman charts; developing algorithms; programming style; programming structure; documentation; installing a language compiler; using a text editor; compiling source code; generating executable files

Scalar and structured data types; constants and variables; reading from keyboard and writing to screen; arithmetic, relational and logical operations; making decisions using if/then, if/then/else, nested if/then and case; looping operations using while/do, repeat/until and for/do; subprograms; functions; procedures

Installation of computer interface circuit boards; programming to access external devices via I/O boards

Microprocessor programming.

Addressing modes: block diagram of a computer system; internal architecture of a microprocessor (uP); overview of instruction set; revision of addressing modes studied so far - immediate, direct, indirect, register and indexed addressing modes; moving blocks of data

Branch instructions: use of flags in decision making; conditional and non-conditional jumps, with relative and direct addressing modes; relationship of clock cycles required for an instruction to the period of the system clock; writing timing loop programs in machine code flow charts

Flag setting: use of masking with logical instructions to allow bit testing using flags; flag setting and testing instructions; bit testing a data byte; use of rotate and shift instructions, relationship to carry flag; compare instructions, use of carry and zero flags to test equality/non-equality of two data bytes; development of flow diagrams and algorithms

Subroutines: need for and advantages in using subroutines within a program; stack and stack pointer instructions; need for saving registers when using subroutines; conditional subroutine entry and exit instructions

Interrupts: need for interrupts; input polling vs use of interrupts; maskable and non-maskable interrupts; interrupt modes; interrupt priorities; writing interrupt service routines

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 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

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 (3rd 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

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

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, 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

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 (3rd 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

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

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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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Methods of power control and phase angle control

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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

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

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Advanced circuit design techniques: documenting circuit design; modifying circuits

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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

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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; VDRs; 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

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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

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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 (3rd 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

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

Electrical drawings and their interpretation.

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Fault-finding techniques

Advanced circuit design techniques: documenting circuit design; modifying circuits

Application of programmable controllers in circuit design

Drawing interpretation and sketching.

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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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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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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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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

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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, 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

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

Documentation: reporting tests; minimum requirements

Electrical drawings and their interpretation.

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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

Transformers.

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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

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

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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, repeatability

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: 3rd angle orthogonal projections; isometric; interpretation of drawing symbols; practical exercises

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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

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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

Specialisation: Appliances

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

Appliance timers and controllers.

Application and operation: timer types (mechanical, electrical, electronic, microprocessor); controllers (thermostats, safety cut outs, solenoids, drain valves, water level control); relevant standards

Fault-finding: typical faults from symptoms; manufacturers' circuits diagrams; maintenance manuals; testing procedures; electrical safety

Heating appliances.

Codes, acts and regulations; gas and electrical isolation procedure; leak testing; electrical safety tests; rating plate; potential hazards (combustible materials, flueing and ventilation); safety devices

Construction and operation: gas components (igniters, regulators, burners, thermostats, automatic controls/timers, safety devices); electrical components (heating elements, thermostats, automatic controls/timers, safety devices); space heaters; hot water systems (gas, electric, solar)

Fault-finding: manufacturers service manuals; fault locations

Cooking appliances.

Codes, regulations and acts: electrical; water; gas; building; health

Construction and operation: gas stoves, ovens and ranges (ignition system, regulator, burner assembly, temperature controllers, safety controls, overall unit operation); electrical stoves, ovens and ranges (hot plates, elements, temperature controllers, accessories, overall unit operation

Installation and commissioning

Service and fault-finding

Washing appliances.

Washing machines: washing actions; transmissions; couplings; motors; pumps; water inlet solenoids; water level controls; sud saver; draining actions; heaters and temperature control; cycle controls; installation procedures

Dryers: types (tumble/airing); motors; drives; heating elements and temperature control; cycle controls; installation procedures

Dish washers: water control devices; pumps (wash and drain); washing action; elements; temperature control; safety devices; overall unit operation

Service and fault-finding: manufacturers' service instructions; circuit diagrams; operating sequences; typical symptoms

Small kitchen appliances.

Construction and operation: garbage disposal units; food mixer/processors; small heating appliances; small heating appliances; small motor driven appliances; range hoods (knowledge of types, purpose and function, interpretation of manufacturers' specifications

Service and fault-finding

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 recovery 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)

Domestic refrigerators and freezers.

Operation and function of refrigerators/freezers and components: static plate condensers; static fin and tube; forced and induced air condensers; capillary tube; plate evaporators; bare pipe evaporators; forced and induced air evaporators; accumulators; heat exchangers; hermetic compressors; thermostats; defrost systems; fans; charging adapters (b-p valves, etc)

Electrical and refrigeration faults

Replacement of door liners, gaskets and fittings

Gas appliances.

Safe working practice: detecting and handling unburnt gases; procedures in a carbon monoxide gas environment; safety equipment; appliance isolation

Components and operation: safety controls; ignition devices; appliance regulators; thermostats; controllers; burners; flues; fans; adjustments for optimum performance

Test equipment: manometer; leak testers; gas and electrical safety tests; tests and/or adjustments

Gas identification: types of gases and their application; methods of identification

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: Machines

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

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

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

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

Rotating machines - maintenance and repairs.

Machine faults and testing procedures: faults (run hot, sparks at brushes, runs fast, slow, voltage variation in generators, nameplate data vs actual operating values); testing (insulation, continuity, current-tong test, volt drop, ‘growler’, heat run, dynamometer, polarity, inductive kick, vibration and noise, load testing of generators); inspecting (commutation and slip ring condition, winding condition)

Dismantling/assembling and repair procedures: marking of electrical connections; recording positions of gears/pulleys/couplings; removal; bearing removal/replacement; ball/roller bearing; plain bearing white metal/bronze; importance of cleanliness; method of lubrication; grease and oil selection; assembly; test run; ventilation, cooling, environment protection

Machining: commutator skimming; undercutting; slip ring repair

Brushes: characteristics; types; selection

Removal and installation: marking of winding connections; importance of alignment; alignment procedures, dowel pins, shims; rubber couplings; chain couplings; direct couplings

Stator winding - three phase.

Winding procedures (universal fields): data collection and recording; winding stripping procedures; measurement of wire size; identification of insulation material types, class, temperature rating and applications; stator insulation methods; coil former sizing from stator iron and/or old coil measurements

Testing procedures (universal fields): continuity of coils; insulation resistance to earth; polarity of coils

Checking for mechanical faults: broken/damaged components; missing components; damaged or bent shafts; causes of noisy rotation; worn bearings, shafts and/or housings; bearing fits and tolerances

Dismantling procedures: recording nameplate data; marking electrical connections and components; marking mechanical components; disassembly

Rewinding procedures: identification of various windings; coil former sizing from stator iron measurements; identification of various coil shapes; former manufacture; coil winding; placement of coils in stator and shaping

Testing procedures: continuity of windings; short circuit between turns (growler); insulation resistance to earth; insulation resistance between phases; polarity (compass); assembly and test run, recording current per phase and speed on data card; reversing direction of rotation; record keeping

Stator winding - single phase.

Checking for mechanical faults: broken or damaged components; missing components; damaged or bent shaft; worn bearings and/or housings; noisy rotation; operation of centrifugal switch

Rewinding procedures: data collection and recording; winding techniques; placing of coils in slots and shaping; insulating and wedging; connection of coils and attachment of flexible leads; binding of coil overhangs using various methods, e.g.. taping and tying

Split phase motor starting devices: three types, e.g.. centrifugal switch, current relay, solid state switch; principles of operation of each type; connection of each type in a motor circuit and test running

Capacitors in single phase motors: types of capacitors; testing capacitors for electrical faults; determination of capacitance values using voltage and current readings

Single phase capacitor motors: motor types, advantages and applications; drawing circuit diagrams of each type; connection and running of each type

Small armature winding.

Winding procedures (small armatures): definition of winding terms; location of lead position; determining winding progression; data collection and recording; data diagram development; winding stripping procedures; commutator preparation and testing; insulation of armature; winding armature of coils; wedging and tying of coils; connection of coils to commutator; armature banding procedures; turning and undercutting a commutator

Balancing armatures: methods of balancing; static balancing an armature

Testing procedures: growler testing; voltage drop testing; insulation resistance testing; test running and records; reversal; of direction of rotation

Varnishes: types, applications, properties and methods

Single phase wiring modifications.

Single phase dual voltage motors: types of windings; connection diagrams

Effects of voltage changes on motors: power output, torque, motor current, temperature rise and speed; calculation of new torque for a supply voltage change; demonstration of the effect of voltage changes on motor torque

Rewinding for a change in supply voltage

Rewinding for a change in supply frequency

Rewinding for a combined change in supply voltage and frequency

Two speed motors (single winding): the factors which govern motor speed; the method of obtaining a 2:1 speed ratio

Two speed motors (multi-winding): connection diagram of a three winding two speed motor showing internal and external switching connections

Three phase winding modifications.

Chord factor

Odd coil grouping

Changing a two layer to a basket winding

Dual speed single winding motors

Dual voltage three phase star motors

Reconnecting a three phase winding for a new voltage

Rewinding for a new voltage

Rewinding for a new frequency (calculations only)

Rewinding for a combined new voltage and frequency

Rewinding for a change in poles

Stators – winding development.

Calculating data for a bare split phase stator; rewinding the split phase stator; calculating data for a bare three phase stator; rewinding in three phase stator; pulse amplitude modulation windings – slot diagrams showing magnetic polarities for each speed; precautions necessary when data taking

Rotor windings.

Three phase rotor windings; rotor winding calculations and diagrams for a two tier wire wound rotor; rewinding a wire wound rotor; rotor winding calculations and diagrams for two tier wire wound rotor with a “dog leg” coil; rewinding a wire wound rotor with a ‘dog leg’ coil using ‘pull through’ technique; squirrel cage rotor faults; testing and repairing squirrel cage rotors with copper bars; testing and repairing stator irons

Specialisation: Maritime maintenance

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

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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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Purpose and use of block, circuit and wiring diagrams

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Transformers.

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Rotating machines - maintenance and repairs.

Machine faults and testing procedures: faults (run hot, sparks at brushes, runs fast, slow, voltage variation in generators, nameplate data vs actual operating values); testing (insulation, continuity, current-tong test, volt drop, ‘growler’, heat run, dynamometer, polarity, inductive kick, vibration and noise, load testing of generators); inspecting (commutation and slip ring condition, winding condition)

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Machining: commutator skimming; undercutting; slip ring repair

Brushes: characteristics; types; selection

Removal and installation: marking of winding connections; importance of alignment; alignment procedures, dowel pins, shims; rubber couplings; chain couplings; direct couplings

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

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

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

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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: construction; 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: Switchgear

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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

Switchboards.

Regulations

Control circuits: types; applications

Connections: types; applications

Screened cables: types; applications

Current transformers: purpose; applications; connections

Potential transformers: purpose; application; connections

DC Power circuits: purpose; features

Earthing: purpose; types; connections

Interlocks: purpose; types

Metering circuits: purpose; types

Motor start circuits: special requirements

PLC circuits: purpose; function; application

Switchboard equipment: purpose; types; function

Switchboard materials: purpose; types; application

Electrical tests: general switchboard; control circuits

Switchboard, design and construction.

Fabrication: sheet metal; bus bar; switchgear; metering

Wiring: DOL starter; star delta starter; reversing starter; control circuits

Testing: insulation; starter circuits; control circuits; fault-finding

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

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

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

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/pulsar 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; faultfinding 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

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

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

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

Electronic fault-finding.

Customer relations; testing to ascertain actual fault; select appropriate repair agency; packaging of damaged equipment; observe equipment for signs of visual damage; check power supplies; observe circuit board for obvious signs of damage; split half method; test equipment; functional testing after repair; invoicing; warranty item

Specialisation: Communication - broadcast

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; compounding; aliasing

Spread spectrum techniques

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; colinear 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

Television basics.

Broadcast TV System: block diagram; channel allocation (RF bandwidth, carrier frequencies); Australian Standards

Transmitter: block diagram of a television transmitter

Camera: scanning principles; synchronisation; video signal

Receiver: simplified block diagram of typical television receiver

TV picture tube: principles of operation

VHF and UHF signal propagation and distribution: signal levels; test equipment; test patterns

Safety: high voltages; manual handling

Television reception systems.

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

TV antennas: types; TV antenna/satellite dish terminology; multiple antennas

Transmission lines: types; characteristic impedance; manufacturers data; test equipment

Antenna distribution systems: identical and adjacent channel interference; antenna distribution components; test equipment

Antenna fault-finding: multiple outlet systems; satellite systems

Basic receivers.

Receiver block diagrams: image reception problems with single conversion; principle of dual conversion technique; block diagram of Double Sided Band Full Carrier (DSBFC) dual conversion receiver; FM dual conversion receiver; Single Sided Band Suppressed Carrier (SSBSC) receiver

Radio frequency (RF) amplifiers: purpose of RF amplifiers; Bipolar Junction Transistors (BJT's) as RF amplifiers; Field Effect Transistors (FET's) as RF amplifiers; input and output coupling

Mixer stages: mixer stage requirements; mixing techniques; noise figure and conversion gain; local oscillator injection; calculation of first order mixer output frequencies

Intermediate frequency amplifiers: choice of intermediate frequency; input and output coupling; filters; limiter requirements with FM; limiter operation concepts; limiter performance

Demodulation: AM demodulation; FM demodulation

Automatic gain control (AGC) systems: need for AGC; AGC in FM receivers; AGC for DSBSC receivers

Phase locked loops (PLLs): PLL basics; loop frequency response and bandwidth; frequency synthesis basic

Basic transmitters.

DSBFC transmitter operation: low and high level modulation functional blocks; oscillator requirements; buffer stages and tuned amplifiers; frequency multipliers; radio frequency power amplifiers; low level modulation operation; high level modulation operation

DSBFC transmitter tuning and adjustment: oscillator tuning and frequency adjustments; tuning buffer stages and RF amplifiers; tuning frequency multipliers; tuning radio frequency power amplifiers; adjusting modulation level

DSBFC transmitter testing: radio frequency power output; carrier frequency; spurious radiation; modulation depth; modulation frequency response; modulation linearity (carrier shift)

SSBSC transmitter operation: functional block diagram; carrier oscillators; balanced modulators; sideband filters; heterodyne mixers; linear power amplifiers; automatic level control; audio processors

SSBSC transmitter tuning and adjustment: adjusting radio frequency power output; adjusting carrier frequency; adjusting carrier balance; reducing spurious emissions by tuning/adjustment; adjusting audio compression/processing

SSBSC transmitter tests: radio frequency power output; carrier frequency; spurious emissions – carrier leak – opposite sideband third order intermodulation; products; modulation frequency response; audio compression

Microwave devices and components.

Safety: safety symbols and signs; high voltages; ionising radiation hazards; non-ionising radiation hazards; personnel safety in the vicinity of radiation hazards, high voltage hazards, high voltage arcing; insulation

Propagation of electromagnetic waves: through the atmosphere; transmission lines; waveguides; characteristic impedance Zo; impedance matching; standing waves; microwave frequency bands

Microwave device parameters: wavelength; phase; VSWR; impedance matching; circuit parameters; amplifiers; transmit; receive; oscillators; noise figure; noise temperature

Microwave devices and components: microwave operational constraints; operating parameters (power, bandwidth, gain, noise figure, efficiency, life, voltage, stability, cooling, size, signal flow, linearity, testing); active devices (diodes – Gunn, tunnel, IMPATT, PIN, Step-recovery); transistors (bipolar, GaAs FET, HEMT, MMIC); valves (magnetrons, klystrons, reflex klystrons, travelling wave tubes, masers, lasers, beam focussing and accelerator coils); amplifiers (cross field, solid state, parametric); oscillators; modulators; mixers and detectors; microwave switches; passive components (chip components, printed components, ferrites); attenuators; isolators; circulators; cavity resonators

Microwave measurements: active devices; signal sources; amplifiers; detectors; passive devices; attenuators; isolators; circulators; test equipment; equipment; S parameter analysers; frequency generators - fixed and sweeping; spectrum analysers; dummy loads - air and water cooled; power meters and associated sensors; VSWR meters; calibrated RF cables; RF voltmeters/millivoltmeters and associated sensors; calibration; errors of measurement and their effects; charts and graphs

EMI/EMC: generation; suppression ; reduction

Digital television principles.

Digitising the picture and sound: sampling rate; sampling structure; bit rate; video encoding (Serial Digital Interface - SDI video, embedded audio, embedded data); AES audio

Video data compression: Spatial Data Compression; Discrete Cosine Transform (DCT); Quantising the DCT Block; Coding DCT Coefficients

Discrete Cosine Transform: (DCT) Coder: temporal data compression; codec; forward prediction; bi-directional prediction; Group of Pictures (GOP) Construction; Differential Coding; Video packetised Elementary Stream (PES)

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

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; compounding; 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; colinear 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

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)

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

Modulation.

Multiplexing: time division multiplexing (TDM); frequency division multiplexing (FDM)

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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

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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)

Specialisation: Data communications

Organisation of resources.

Supply and storage of equipment and material; third 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 third 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 - 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 atonomy; sensitivity of human ear; in signal; 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: Entertainment - audio - digital

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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

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Television basics.

Broadcast TV System: block diagram; channel allocation (RF bandwidth, carrier frequencies); Australian Standards

Transmitter: block diagram of a television transmitter

Camera: scanning principles; synchronisation; video signal

Receiver: simplified block diagram of typical television receiver

TV picture tube: principles of operation

VHF and UHF signal propagation and distribution: signal levels; test equipment; test patterns

Safety: high voltages; manual handling

Television reception systems.

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

TV antennas: types; TV antenna/satellite dish terminology; multiple antennas

Transmission lines: types; characteristic impedance; manufacturers data; test equipment

Antenna distribution systems: identical and adjacent channel interference; antenna distribution components; test equipment

Antenna fault-finding: multiple outlet systems; satellite systems

Digital television principles.

Digitising the picture and sound: sampling rate; sampling structure; bit rate; video encoding (Serial Digital Interface - SDI video, embedded audio, embedded data); AES audio

Video data compression: Spatial Data Compression; Discrete Cosine Transform (DCT); Quantising the DCT Block; Coding DCT Coefficients

Discrete Cosine Transform: (DCT) Coder: temporal data compression; codec; forward prediction; bi-directional prediction; Group of Pictures (GOP) Construction; Differential Coding; Video packetised Elementary Stream (PES)

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 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

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 (3rd 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

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

Operational amplifiers.

The differential amplifier: operating conditions; circuit configurations and applications

Op amp configurations: characteristics; inverting and non-inverting amplifiers; the inverting summer; differential amplifier circuits

OP amp limitations: manufacturers' specifications; practical limitations

Comparators: principles of operation; applications of comparators

Op amp applications: clipping circuits; precision rectifiers; oscillators; integrator/differentiator circuits; function generators; active filter circuits

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/pulsar 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, 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

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, repeatability

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

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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.

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)

Air conditioning.

Air conditioning: definitions; classification and application; comfort zone; basic system layout; air conditioning processes; basics of ventilation; SAA codes

Psychrometerics: terminology/definitions; sling psychrometer; psychrometric chart

Heat load estimation: elements of heat load; industry check figures; calculations

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 phase 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

Refrigeration system operation.

Pressure enthalpy chart zones represented on chart: sub-cooled; latent; superheated

Interpretation of chart lines

Plotting systems cycle

Calculation of values from chart information: refrigeration effect; flow rate; specific volume; system capacity; discharge temperature; total heat rejection; heat of compression

Refrigerant oil properties types of lubrication systems: splash; forced

Methods of system capacity control: oil pressure; refrigerant bypass; air flow; water flow

Compressor calculations: piston displacement; compressor displacement; compression ratio; compressor efficiency

Heat exchange design

Heat exchange calculation

Water treatment code requirement

Types of motor drives: belt drive; direct drive

Calculation of speed vs pulley size

Alignment requirements: belt drive; direct coupling

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

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

Domestic refrigerators and freezers.

Operation and function of refrigerators/freezers and components: static plate condensers; static fin and tube; forced and induced air condensers; capillary tube; plate evaporators; bare pipe evaporators; forced and induced air evaporators; accumulators; heat exchangers; hermetic compressors; thermostats; defrost systems; fans; charging adapters (b-p valves, etc)

Electrical and refrigeration faults

Replacement of door liners, gaskets and fittings

Residential air conditioning.

System operation: construction, operation and application of (room air conditioners, split systems, evaporative, ducted, cassette); reverse; refrigeration system; control system

Air distribution: fans; ducts; filters; registers; noise; vibration

Heat load calculations: design conditions; residence survey; heat load sources; load calculations; equipment sizing; air distribution selection

Installation and commissioning

Service and fault-finding

Retrofitting refrigeration systems.

Refrigerant phaseout: montreal protocol; ANZECC "Revised Strategy for Ozone Protection in Australia 1994"; Kyoto Summit; Ozone layer; global warning; codes of practice; state codes and regulations

System analysis: equipment identification; refrigerant usage audit; system options; refrigerant management program

Refrigerant selection: ANSI/ASHRAE standard 34; AIRAH Refrigerant selection guide; transition and drop-in refrigerant; refrigerant selection considerations; system performance testing; refrigerant recovery, recycling and reclaim; lubrication selection considerations

Retrofit procedure: flushing procedures; retrofit procedure for CFC to HCFC refrigerants; retrofit procedure CFC or HCFC to HFC refrigerants

Performing a retrofit: refrigerant recovery; flushing the system; oil and drier replacement; evacuation; refrigerant charging; refrigerant control adjustment; pressure control adjustment; system labelling

Ventilation.

Ventilation systems

Fan classifications and applications

Conducting an air balance

Filtration applications and service requirements of ventilation – air conditioning systems

Noise and vibration sources in a ventilation – air conditioning system

Site work/architectural drawings

Auxiliary equipment

Layout and zoning of duct work system

Occupational health aspects

Air conditioning systems.

Air conditioning systems components: types; applications safety, environmental and legislative issues; terminology; design features; component characteristics; ancillary equipment; symbols

Air conditioning systems: types; design features and heat loads; system characteristics; system layout and constructional drawing interpretation

Air conditioning systems servicing: routine scheduled; fault tracing; rectification

Coolrooms/freezer rooms.

Food spoilage: effects of storage conditions; controlled atmosphere; relative humidity; evaporator temperature difference

Walk-in coolrooms and freezer rooms: construction; insulation; vapour barrier; frost heave; interior fittings

Layouts and installation: location of equipment; power supply and electrical services; arrangement of piping

Components and features: refrigerant controls; evaporators; solenoid valves; crankcase pressure regulators; defrosting method and mullions; drain facilities and heaters; pressured relief valves; door hardware; lighting and germicidal lamps

System and defrost controls: operating conditions; thermostat and pressure controls; defrost timers and controllers; overloads and safety control; electrical control circuits

Commissioning procedures

Specialisation: Commercial air conditioning

Maintain and service air handling plant.

Filter cleaning methods: cleaning water nozzels, 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 nozzels, 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; paintin 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 leveling 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

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, details and standard drawings

Locating the position of electrical services from architectural drawings

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 (3rd 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

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

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 NES207 (A to Z qualifier) A
Co-ordinate maintenance of apparatus & systems' circuits

Descriptor: Co-ordinate maintenance of apparatus and associated circuits, piping and components and provided technical support to maintenance personnel.

Alignment: This unit aligns to and is based on the National Electrotechnology Benchmark Standard EBS 407 - Co-ordinate maintenance of apparatus and associated systems' circuits.

Specific unit outcomes

This is presented as a composite unit that has five specific 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 NES207A A	Co-ordinate maintenance of apparatus & systems' circuits *(Computer systems)*
UTE NES207B A	Co-ordinate maintenance of apparatus & systems' circuits *(Electrical)*
UTE NES207C A	Co-ordinate maintenance of apparatus & systems' circuits *(Electronics)*
UTE NES207D A	Co-ordinate maintenance of apparatus & systems' circuits *(Instrumentation)*
UTE NES207E A	Co-ordinate maintenance of apparatus & systems' circuits *(Refrigeration & a/conditioning)*

Elements		Performance criteria	
207.1	Plan and prepare for maintenance	207.1.1	Maintenance is planned and prepared to ensure *OH&S policies and procedures* are followed and the work is appropriately sequenced in accordance with *requirements*
		207.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site

Elements		Performance criteria	
		207.1.3	Maintenance schedules are obtained to enable appropriate allocation of work
		207.1.4	Materials necessary to complete the work are made available in accordance with *established procedures* and checked against job *requirements*
		207.1.5	*Tools*, *equipment* and *testing devices* needed to carry out the work are made available in order that they are checked for correct operation and safety
207.2	Co-ordinate and support maintenance activities	207.2.1	*OH&S policies and procedures* are followed.
		207.2.2	Technical support is provided to maintenance personnel where necessary
		207.2.3	Unplanned events or conditions are responded to in accordance with *established procedures*
		207.2.4	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		207.2.5	On-going checks of the quality of work are undertaken in accordance with *established procedures*
207.3	Inspect and notify completion of work	207.3.1	Final inspections are undertaken to ensure the maintenance of *apparatus* and associated systems' *circuits* conforms to *requirements*
		207.3.2	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

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

This unit should be addressed only after competency in unit UTE NES206 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’.

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 implementing and monitoring.

Legislation and Australian Standards: AS1470 – 1986; OHSC:7025 (1994); generic competencies A, B and C; relevant acts (electrical); general duty of care

Policy and program development: assigning accountability; focus on improvement

Consultative processes: OH&S committee; meetings and workshops; information gathering

Training and development: provision and type; dissemination of information; cultural considerations; literacy considerations

Hazard identification and assessment: safety audits; workplace inspections; injury and illness records, statistics; complaints and observations; contributing factors to a hazard (exposure, severity, human differences)

Risk assessment and management: hierarchy of control (elimination, substitution, design, mitigation)

Management and improvement: promoting OH&S activities; integration management structures; evaluation of control strategies; evaluation of educational and training programs

Engineering mathematics A.

Arithmetic: rational and irrational numbers, surds, SI units, conversion using unity, brackets, laws of indices (base 10), scientific and engineering notation; estimations, errors and approximations, significant figures

Algebra: substitution; +, -, x on simple polynomials, simple indices; expanding brackets; factorising quadratics, common factors, difference of two squares; simplifying algebraic fractions; transposition of engineering formulae; solving one variable equation; simple algebraic division

Geometry: pythagoras theorem; angles – degrees, radians, parallel lines cut by a transverse; triangles – sum of angles, properties of equilateral and isoceles triangles; congruent triangles; similar triangles – ratio of corresponding sides; sin, cos, tan – ratios of a right angled triangle; sine and cosine rules; circles – circumference, arcs, chords, tangents, circle theorems; area and perimeter mensuration on above figures

Co-ordinate geometry: 2D plane – x-y axes, s-t axes; graph of linear function – $y = ax + b$, functional notation – $y = f(x)$; straight line given slope and one point or given two points; linear equations – solving algebraically and geometrically; line segment – length and mid point

Electrical control ‘C’ programming.

‘C’ language: uses; advantages and disadvantages

‘C’ development package: editor commands; the edit-compile-run cycle; compiler and linker options; header files

Language syntax: data types; arithmetic and logical operations; program structure

Control structure: sequential; repetition; selection

Functions: macros; global and local variables; intrinsic functions used in control; writing functions, linking in external functions to control hardware; numerical and character arrays; sequential file reading and writing

Interfacing applications using C.

Background: brief historical development of C, unix; K and R vs ANSII; program development environment

Program structure and compilation: top-down modular design methodology; program structure, functions, external functions; global, local, static, register and scope; linking with libraries; program compilation; memory models; using project 'make' facilities

Data types and operators: variables, constants, simple data types; statements, identifiers; arithmetic operators; pointers and their use; cast operator

Loop control: relational, equality and logical operators; compound operators; if-else, switch; while, do-while, for, break and continue

Complex data types and structures: pointers; arrays and strings; structures and unions; passing as parameters to functions

C and assembler: in-line assembly; bit manipulation in C; 10 port addressing

C++: objects, data abstraction, OOP; classes; parameters passed by reference

PC system interfacing.

Microprocessor system components: review of the operation of a microprocessor based computer system including the following system components ROM, RAM, timer, DMA, interrupt controller and IO interface; system reset/boot procedure

IO interfacing: detailed timing considerations of address, data and control bus; prototype development card interface (memory and IO address decoding map, bus signals); detailed timing considerations for memory and IO read/write cycle; electrical considerations (voltage, current etc.) of system address data and control bus and interfacing to the external world; wait state generation for slow peripherals or memory

Peripheral support chips: parallel ports, e.g. intel 8255; parallel printer timing considerations; serial USART, e.g. national semi-conductors 8250; serial printer or dumb terminal timing considerations; matrix keypad and seven segment display interfaces; special controller chips, CRTC, FDC, HDC, HDLC, etc; interfacing A/D and D/A, programming considerations

Documentation debugging and development equipment: application of CAD for documentation; system specification and documentation; debugging and tracing program execution in software; debugging and tracing in firm ware; producing romable code for embedded systems; in-circuit emulators

Specialisation: Control

Control concepts.

Advantages of control

Measurement terminology

Dimensional calculations

Basic transducer principles and physical variables

Control terminology

Type controllers

Process characteristics

Controller principles

Control systems

Industrial computer interfacing.

Bus structures

Parallel I/O – memory mapped, polled I/O, interrupt driven I/O

Dedicated support devices: programmable peripheral interfaces; programmable timer counters; programmable interrupt controllers

Analogue to digital converters, digital to analogue converters

Serial and parallel ports

Keyboard and video displays

Advanced PLCs.

Medium to high level PLC hardware and software: hardware configuration; addressing; memory map; programming instruction syntax; file manipulation; documentation; saving/restoring programs

Number systems and codes: common number formats (binary, octal, integer, hexadecimal); conversions between formats; codes (BCD, grey, ASCII)

Diagnostics: flags/status words (file); fault locations; scan considerations (fixed, variable, immediate update)

Data manipulation (word): binary word structure; single and double works; word devices; arithmetic instructions; word logical instructions; conversions (BCD to binary, binary to BCD); indirect addressing (image register to word, word to IR, word to word, word to table, table to table); word shift registers (LIFO, FIFO); masking; bit manipulation (bit set, bit clear, bit test); entering data constants; multiplexing

Analogue I/O: common signal types; module resolution; scaling; unscaling; signal offset

Sequencers/drum controllers

SCADA systems.

System requirements

Use, features and facilities of different SCADA packages

Hardware requirements

PLC interface requirements

Networking requirements of the system

Mimics and animated graphics: graphics designs; balance of layout

Trending: analysis of process to select data; sampling of the process in terms of temperatures, time, weight; viewing data and graphical representation of selected information; trend graphs and data matching

Alarm logging: analysing select data, applying limits and specification applied to processes; corrective action of alarm status

Recipes and scheduling: methods of producing libraries for different process conditions, required for varied production runs; analysis of different production runs; alarm limits/material specifications; scheduling, setting limits and evoking program changes

Data collection and databasing: producing a database of variables; conversion of raw data into appropriate databasing software package

Reports: types and layout of reports; analysis of data

Programming language: automation of tasks within the software package

Implementation and applications: networking; types of networks; co-ordination and access of networking by linking to mainframe or factory network

Modems.

Interface: RS232, RS422; hayes compatibility; internal; external; control of data flow RTS/CTS (X-on, X-off); connect PC to PC; connect PC to Network; connect network to network

Software: kermit; procomm; proprietary

Modulation: PSK, FSK, QAM; DPSK, DAMQAM, QAM trellis coding

Protocols and standards: full-duplex, half-duplex; Xmodem; Ymodem; UUCP; V.22, V.32, V.42, X.25; connecting to ISDN

Data error detection/correction and compression: noise and distortion; error detection; error correction; data compression; security

Specialisation: Networks

Digital applications.

Boolean Algebra: generation of Boolean expressions and truth table for verbal logic descriptions and logic circuit schematics; simplification of Boolean expressions using Boolean algebra; complementation of a Boolean expression – De Morgan’s laws

Karnaugh maps: construction of K maps for given functions of up to 4 variables; use of k mpas to derive the minimal and into or (S.O.P) form implementation for a given expression; conversion of and or (S.O.P) form into all NAND gate implementation; nature of “don’t cares” and how they can be used to advantage by a designer

Propagation delays: definition - t_{plh} and t_{phl}; affect on operation of discrete devices – simple combinational circuits and ripple counters; set-up and hold times - definition and consequences of

Oscillators: schmitt-trigger action - V_{T+}, and V_{T-}, hysteresis; waveform smoothing; schmitt trigger oscillator - factors determining frequency; two gate R-C oscillator; two gate crystal oscillator; an integrated, crystal controlled, oscillator/frequency-divider chip - e.g. 4060

Monostables: basic operation - trigger conditions and pulse-width determination; response of non-re-triggerable vs re-triggerable one shots; duty cycle limitation; simple applications of one shots e.g. pulse stretching and delaying, switch debouncing/key pressed strobe and missing pulse detector

Asynchronous counters: characteristics of common ie "ripple" counters e.g. 7490 family; changing the counter modulus - frequency division and output duty cycle; cascading asynchronous counters to extend modulus; disadvantages - glitches and clocking frequency limitations

Synchronous counters: basic internal structure of a presettable synchronous I.C. counter; distinction between synchronous and asynchronous control inputs and their relative affects - e.g. load enable and clear inputs; use of counter (clock) enable inputs and terminal count outputs; analysis of a synchronous I.C. counter circuit (maximum of 2 counters) to determine count-cycle - modulus, frequency and form of output waveform

Memory: classification – RAM and ROM (historic), volatile and non-volatile memory; memory terminology - array structure, memory size data word, address; data - address and control buses; read and write modes of operation - basis steps in; memory timing:- access time and write (cycle) time; RAM devices - SRAM and DRAM - speed, density refresh and addressing differences; ROM devices - nature of masked ROM, PROM, EPROM, E^2ROM and NVRAM

Digital circuit applications: memory decoding - expansion of word size and address space; development of a memory map from a given memory decoding system (no images); control waveform generator using a MUX and counter; use of a ROM as a code converter - look-up table and character generator (ASCII code to dot pattern); use of a BDC to 7 segment decoder/latch to drive either a common anode or common cathode led display; display multiplexing - time sharing a single decoder between two display chips

Micro computer systems.

Software development for a micro-processor based system: using an assembler; using a debugging tool; producing documentation that includes algorithms and list file

Block diagram functions: programmable peripheral interface (PPI); programmable interval timer; universal asynchronous receiver transmitter (UART); programmable interrupt controller (PIC) – including the processing of single and multiple interrupts received; programmable memory access controller (DMAC); bus controller; floppy disk controller (FDC); cathode ray tube controller (CRTC) – including producing characters for output to the display device, display adaptor card using the CRTC

Function of pins of common micro processor peripheral ICs: programmable peripheral interface (PPI); programmable interval timer (PIT); universal asynchronous receiver transmitter (UART); programmable interrupt controller (PIC); programmable memory access controller (DMAC); bus controller; floppy disk controller (FDC); cathode ray tube controller (CRTC)

Software for initialisation: PPI to transfer data in modes 0, 1, 2 ; PIT in modes 0, 1, 2, 3; PIC to one of its 6 modes of operation; UART to transfer data; DMAC for single transfer and block transfer modes

Use of the operational mode: programmable peripheral interface (PPI); programmable interval timer (PIT); universal asynchronous receiver transmitter (UART); programmable interrupt controller (PIC); programmable memory access controller (DMAC); exercising the floppy disk drive; change the operational characteristics of the CRTC

Interfacing of IC peripherals: PPI – the use of the handshaking line with data transfer techniques used on 8 bit and 16 bit data buses; PCI – cascading the PIC; bus controller – to a micro processor

Modems.

Interface: RS232, RS422; hayes compatibility; internal; external; control of data flow RTS/CTS (X-on, X-off); connect PC to PC; connect PC to Network; connect network to network

Software: kermit; procomm; proprietary

Modulation: PSK, FSK, QAM; DPSK, DAMQAM, QAM trellis coding

Protocols and standards: full-duplex, half-duplex; Xmodem; Ymodem; UUCP; V.22, V.32, V.42, X.25; connecting to ISDN

Data error detection/correction and compression: noise and distortion; error detection; error correction; data compression; security

Data communications.

Data communications: brief history of communications; description of how information is transferred; types of codes used to transmit information; data terminal equipment and types; data communication equipment; DTE-DCE interface; data transmission – communications mode; baseband and broadband; transmission mode; error control – checking, parity, CRC

Messages and transmission channels: information as a quantity; information content of symbols; use of redundancy in communications; media used in information transmission; twisted pair – coaxial cable, waveguide, fibre optic, HF radio, satellite and cellular radio systems

Protocols: description of a protocol; simple protocols – teletypewriter, parity, X modem; half and full duplex

Modems and interface: definition – types of modems; modulation – speed, multiplexing; interface and signalling standards RS232C, V24 interface, current loop, RS422, RS423, RS449, RS485, V35, X21 and G703; limitations of interface standards – distance, speed, ground IEEE standards

Fibre optic communications: fundamentals of fibre optic systems; fibre composition; multimode – single mode propagation; types of index; bandwidth; sources – detectors of light; types of connectors; splicing fibre optic cable

Category: Electrical (B)

Common

Occupational health and safety implementing and monitoring.

Legislation and Australian Standards: AS1470 – 1986; OHSC:7025 (1994); generic competencies A, B and C; relevant acts (electrical); general duty of care

Policy and program development: assigning accountability; focus on improvement

Consultative processes: OH&S committee; meetings and workshops; information gathering

Training and development: provision and type; dissemination of information; cultural considerations; literacy considerations

Hazard identification and assessment: safety audits; workplace inspections; injury and illness records, statistics; complaints and observations; contributing factors to a hazard (exposure, severity, human differences)

Risk assessment and management: hierarchy of control (elimination, substitution, design, mitigation)

Management and improvement: promoting OH&S activities; integration management structures; evaluation of control strategies; evaluation of educational and training programs

Industrial computer systems.

Computer systems overview

PC hardware orientation

DOS commands

DOS set-up commands

Windows operations

Word processors

Spreadsheets

Databases as used for control applications

CAD/vector graphics

Control applications

Specialisation: Control

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

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

Control concepts.

Advantages of control

Measurement terminology

Dimensional calculations

Basic transducer principles and physical variables

Control terminology

Type controllers

Process characteristics

Controller principles

Control systems

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/pulsar 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

Power control devices.

Need for power control typical applications

Power control methods: switched control; rheostatic control; voltage control; simmerstatic control; thyristor control

Advantages and benefits of thyristor power control: efficiency; reliability; precision; overall cost

Silicon controlled rectifiers: construction and symbol; basic operating principles; characteristics; voltage ratings – PRV, forward blocking voltage, dv/dt rating; current ratings – average forward current, latching and holding currents, di/dt rating; triggering requirements – gate pulse characteristics; commutation; cooling and protection; testing for serviceability; applications

Gate turn off (GTO) thyristors: construction and symbol; basic operating principles; characteristics; voltage ratings – PRV, forward blocking voltage, dv/dt rating; current ratings – average forward current, latching and holding currents, di/dt rating; triggering requirements – gate pulse characteristics; commutation – gate turn off requirements; applications

BJT, IGBTs: construction and symbols; basic operating principles; characteristics; cut off; saturation and amplification

Triacs: construction and symbol; basic operating principles; characteristics; voltage ratings – blocking voltage, dv/dt rating; current ratings – rms current, latching and holding currents, di/dt rating; triggering requirements – modes of triggering and sensitivity; commutation; cooling and protection; testing for serviceability; applications

Unijunction transistors (UJT): construction and symbol; operating principles; intrinsic stand-off ratio and peak point voltage; revision of R.C constants; UJT relaxation oscillator circuit; UJT oscillator circuit operation – frequency, output pulse characteristic, waveforms

Programmable unijunction transistors (PUT):   construction and symbol; operating principles; peak point voltage; programmable stand-off ratio; PUT relaxation oscillator circuit; PUT oscillator circuit operation – frequency, output pulse characteristic, waveforms

Diacs: construction and symbol; operating principles; breakover voltage – symmetrical and asymmetric diacs; diac trigger circuit; diac trigger circuit operation – frequency, output pulse characteristic, waveforms

Phase shift control: definition; triggering and conduction angles; relationship between output voltage and conduction angle; problems associated with phase shift control

Single phase half wave controlled rectifier: rectifier operation; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; load voltage determination – calculation; applications and limitations

Single phase full wave controlled rectifier: half controlled bridge – circuit configuration, including trigger circuits; circuit operation and waveforms – resistive loads only; load voltage determination – calculation; applications and limitations; comparison with single phase half wave controlled rectifier

Single phase A.C. voltage control: half and full control circuits; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; use of triacs or inverse parallel SCR's; 'snap on' effect of phase control circuits – reduction of the snap on effect; load voltage determination – form circuit characteristic; applications and limitations

Single phase zero voltage switching (ZVS):   operating principles; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; relationship between load power and conduction time; solid state relays types and ratings; applications and limitations

Fault-finding procedures: typical faults – power and trigger circuits; characteristics displayed by common faults; comparison of test date with expected data (voltage/current waveforms); location and replacement of faulty components

Advanced circuit development.

Advanced circuit design techniques

Documenting circuit design

Modifying circuits

An introduction and overview of CAD

Application of programmable controllers in circuit design

Sensors for machinery and product monitoring.

Operation and application of transducers: linear position and displacement; angular position; proximity and limits; vibration and acceleration; speed of rotation; strain

The application of mechanical measuring devices to monitor: industrial plant and manufacturing - processes; production line and material handling systems; the condition of plant and equipment

The statutory requirements: noise and vibration; monitoring techniques

Thyristor converters.

Single and three phase controlled rectifiers: purpose of function of a controlled rectifier; circuit configurations and applications - single and three phase half wave, single and three phase half controlled bridge, single and three phase fully controlled bridge; rectifier performance and operation on resistive and inductive loads; output voltage and waveform, determination of output voltage by both calculation and use of circuit characteristic; communication problems associated with inductive loads; comparison of single and three phase controlled rectifiers

Single phase AC controllers: purpose of function of an AC controller; circuit configurations and applications - single phase half controller, single phase full controller (triac control), single phase full controller (inverse parallel SCR's); circuit performance and operation on resistive and inductive loads; output voltage and waveform, determination of output voltage using circuit characteristic; range of control with inductive loads; triggering problems associated with inductive loads

Three phase AC controllers: circuit configurations and applications – three phase three wire controllers, three phase four wire controllers (circuit only); circuit performance and operation on resistive and inductive loads; output voltage and waveform, determination of output voltage using circuit characteristic; range of control with inductive loads; triggering problems associated with inductive loads

Thyristor controlled DC to DC converters: purpose and function of a DC to DC converter; voltage control methods – pulse width modulation, pulse rate modulation, modulating both pulse width and rate; output voltage and current levels and waveforms for both resistive and inductive loads; calculation of output voltage

Thyristor protection: protection techniques – snubber networks (dv/dt protection), series inductors (di/dt protection), Amp trap (HRC) fuses, gate pulse suppression; need for heat sinking of power thyristor devices; heat sink features and types; installation methods for all types of thyristor packages; basic thermal model, only to demonstrate the effect of different heat sink types and profiles and installation methods on thyristor junction temperature

Series and parallel thyristor connection: need for series and/or parallel connection of thyristors; series, or high voltage operation – problems associated with series connection, transient voltage equalisation, steady state voltage equalisation, simultaneous triggering, heat sink mounting

Parallel, or high current operation: problems associated with parallel connection – current equalisation, junction temperature equalisation, simultaneous triggering, heat sink mounting

Specialisation: Energy supply

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

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

Control concepts.

Advantages of control

Measurement terminology

Dimensional calculations

Basic transducer principles and physical variables

Control terminology

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Digital electronics.

Analogue and digital signal definition

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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

Power control devices.

Need for power control typical applications

Power control methods: switched control; rheostatic control; voltage control; simmerstatic control; thyristor control

Advantages and benefits of thyristor power control: efficiency; reliability; precision; overall cost

Silicon controlled rectifiers: construction and symbol; basic operating principles; characteristics; voltage ratings – PRV, forward blocking voltage, dv/dt rating; current ratings – average forward current, latching and holding currents, di/dt rating; triggering requirements – gate pulse characteristics; commutation; cooling and protection; testing for serviceability; applications

Gate turn off (GTO) thyristors: construction and symbol; basic operating principles; characteristics; voltage ratings – PRV, forward blocking voltage, dv/dt rating; current ratings – average forward current, latching and holding currents, di/dt rating; triggering requirements – gate pulse characteristics; commutation – gate turn off requirements; applications

BJT, IGBTs: construction and symbols; basic operating principles; characteristics; cut off; saturation and amplification

Triacs: construction and symbol; basic operating principles; characteristics; voltage ratings – blocking voltage, dv/dt rating; current ratings – rms current, latching and holding currents, di/dt rating; triggering requirements – modes of triggering and sensitivity; commutation; cooling and protection; testing for serviceability; applications

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Programmable unijunction transistors (PUT): construction and symbol; operating principles; peak point voltage; programmable stand-off ratio; PUT relaxation oscillator circuit; PUT oscillator circuit operation – frequency, output pulse characteristic, waveforms

Diacs: construction and symbol; operating principles; breakover voltage – symmetrical and asymmetric diacs; diac trigger circuit; diac trigger circuit operation – frequency, output pulse characteristic, waveforms

Phase shift control: definition; triggering and conduction angles; relationship between output voltage and conduction angle; problems associated with phase shift control

Single phase half wave controlled rectifier: rectifier operation; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; load voltage determination – calculation; applications and limitations

Single phase full wave controlled rectifier: half controlled bridge – circuit configuration, including trigger circuits; circuit operation and waveforms – resistive loads only; load voltage determination – calculation; applications and limitations; comparison with single phase half wave controlled rectifier

Single phase A.C. voltage control: half and full control circuits; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; use of triacs or inverse parallel SCR's; 'snap on' effect of phase control circuits – reduction of the snap on effect; load voltage determination – form circuit characteristic; applications and limitations

Single phase zero voltage switching (ZVS): operating principles; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; relationship between load power and conduction time; solid state relays types and ratings; applications and limitations

Fault-finding procedures: typical faults – power and trigger circuits; characteristics displayed by common faults; comparison of test date with expected data (voltage/current waveforms); location and replacement of faulty components

Distribution transformers.

Transformer principles: basic construction; operation

Voltage regulation: percentage impedance; testing

Tap changing switches: types; maintenance; solid state equipment

Losses, efficiency

Cooling methods: types of cooling; testing and maintenance of coolant

Auxiliary equipment: breathers; gauges; vents; electrical/mechanical safety devices

Testing: fault-finding; standard test procedures; methods of connection; vector grouping; tertiary windings

Parallel operation: transformer load sharing; vector group

Harmonics in transformers: causes; solutions

System operating characteristics.

Power distribution system electrical characteristics: inductance, capacitance and resistance

Voltage problems in a power distribution system: low-voltage; unbalanced voltages; voltage rises

Voltage regulation: autotransformers with on-load tap changer; transformers with on-load tap changer ; static capacitors; load control

Control of on-load tap changer: regulation relays; control circuits; line drop compensation

Power distribution system faults: type/classification of fault; typical causes/effects of faults; three-phase symmetrical fault levels; fault level limitation

Voltage surges in a power distribution system: lighting; switching; typical levels; impedance, typical values; significance of the system impedance

Protection and relaying.

System faults: type and classification of faults; three phase symmetrical fault levels

Protection fundamentals: purpose; features of a scheme

Instrument transformers for protection: current transformers; voltage transformers

Feeder protection: fuse; overcurrent and earth fault; sensitive earth fault; unit schemes; distance; trip/close sequences for feeders; recloser/sectionaliser systems

Transformer protection: overheating; overcurrent; restricted earth fault; differential; oil and gas devices

Busbar protection: types of fault; requirements of busbar protection; system; frame-earth

Surge protection: voltage surges; surge diverters; arcing horns

Specialisation: Hazardous areas

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

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

Control concepts.

Advantages of control

Measurement terminology

Dimensional calculations

Basic transducer principles and physical variables

Control terminology

Type controllers

Process characteristics

Controller principles

Control systems

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/pulsar 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

Power control devices.

Need for power control typical applications

Power control methods: switched control; rheostatic control; voltage control; simmerstatic control; thyristor control

Advantages and benefits of thyristor power control: efficiency; reliability; precision; overall cost

Silicon controlled rectifiers: construction and symbol; basic operating principles; characteristics; voltage ratings – PRV, forward blocking voltage, dv/dt rating; current ratings – average forward current, latching and holding currents, di/dt rating; triggering requirements – gate pulse characteristics; commutation; cooling and protection; testing for serviceability; applications

Gate turn off (GTO) thyristors: construction and symbol; basic operating principles; characteristics; voltage ratings – PRV, forward blocking voltage, dv/dt rating; current ratings – average forward current, latching and holding currents, di/dt rating; triggering requirements – gate pulse characteristics; commutation – gate turn off requirements; applications

BJT, IGBTs: construction and symbols; basic operating principles; characteristics; cut off; saturation and amplification

Triacs: construction and symbol; basic operating principles; characteristics; voltage ratings – blocking voltage, dv/dt rating; current ratings – rms current, latching and holding currents, di/dt rating; triggering requirements – modes of triggering and sensitivity; commutation; cooling and protection; testing for serviceability; applications

Unijunction transistors (UJT): construction and symbol; operating principles; intrinsic stand-off ratio and peak point voltage; revision of R.C constants; UJT relaxation oscillator circuit; UJT oscillator circuit operation – frequency, output pulse characteristic, waveforms

Programmable unijunction transistors (PUT): construction and symbol; operating principles; peak point voltage; programmable stand-off ratio; PUT relaxation oscillator circuit; PUT oscillator circuit operation – frequency, output pulse characteristic, waveforms

Diacs: construction and symbol; operating principles; breakover voltage – symmetrical and asymmetric diacs; diac trigger circuit; diac trigger circuit operation – frequency, output pulse characteristic, waveforms

Phase shift control: definition; triggering and conduction angles; relationship between output voltage and conduction angle; problems associated with phase shift control

Single phase half wave controlled rectifier: rectifier operation; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; load voltage determination – calculation; applications and limitations

Single phase full wave controlled rectifier: half controlled bridge – circuit configuration, including trigger circuits; circuit operation and waveforms – resistive loads only; load voltage determination – calculation; applications and limitations; comparison with single phase half wave controlled rectifier

Single phase A.C. voltage control: half and full control circuits; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; use of triacs or inverse parallel SCR's; 'snap on' effect of phase control circuits – reduction of the snap on effect; load voltage determination – form circuit characteristic; applications and limitations

Single phase zero voltage switching (ZVS): operating principles; circuit configuration – including trigger circuits; circuit operation and waveforms –

resistive loads only; relationship between load power and conduction time; solid state relays types and ratings; applications and limitations

Fault-finding procedures: typical faults – power and trigger circuits; characteristics displayed by common faults; comparison of test date with expected data (voltage/current waveforms); location and replacement of faulty components

Specialisation: Instrument and servicing

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

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

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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

Control concepts.

Advantages of control

Measurement terminology

Dimensional calculations

Basic transducer principles and physical variables

Control terminology

Type controllers

Process characteristics

Controller principles

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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/pulsar 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

Sensors for machinery and product monitoring.

Operation and application of transducers: linear position and displacement; angular position; proximity and limits; vibration and acceleration; speed of rotation; strain

The application of mechanical measuring devices to monitor: industrial plant and manufacturing - processes; production line and material handling systems; the condition of plant and equipment

The statutory requirements: noise and vibration; monitoring techniques

Power control devices.

Need for power control typical applications

Power control methods: switched control; rheostatic control; voltage control; simmerstatic control; thyristor control

Advantages and benefits of thyristor power control: efficiency; reliability; precision; overall cost

Silicon controlled rectifiers: construction and symbol; basic operating principles; characteristics; voltage ratings – PRV, forward blocking voltage, dv/dt rating; current ratings – average forward current, latching and holding currents, di/dt rating; triggering requirements – gate pulse characteristics; commutation; cooling and protection; testing for serviceability; applications

Gate turn off (GTO) thyristors: construction and symbol; basic operating principles; characteristics; voltage ratings – PRV, forward blocking voltage, dv/dt rating; current ratings – average forward current, latching and holding currents, di/dt rating; triggering requirements – gate pulse characteristics; commutation – gate turn off requirements; applications

BJT, IGBTs: construction and symbols; basic operating principles; characteristics; cut off; saturation and amplification

Triacs: construction and symbol; basic operating principles; characteristics; voltage ratings – blocking voltage, dv/dt rating; current ratings – rms current, latching and holding currents, di/dt rating; triggering requirements – modes of triggering and sensitivity; commutation; cooling and protection; testing for serviceability; applications

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Diacs: construction and symbol; operating principles; breakover voltage – symmetrical and asymmetric diacs; diac trigger circuit; diac trigger circuit operation – frequency, output pulse characteristic, waveforms

Phase shift control: definition; triggering and conduction angles; relationship between output voltage and conduction angle; problems associated with phase shift control

Single phase half wave controlled rectifier: rectifier operation; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; load voltage determination – calculation; applications and limitations

Single phase full wave controlled rectifier: half controlled bridge – circuit configuration, including trigger circuits; circuit operation and waveforms – resistive loads only; load voltage determination – calculation; applications and limitations; comparison with single phase half wave controlled rectifier

Single phase A.C. voltage control: half and full control circuits; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; use of triacs or inverse parallel SCR's; 'snap on' effect of phase control circuits – reduction of the snap on effect; load voltage determination – form circuit characteristic; applications and limitations

Single phase zero voltage switching (ZVS): operating principles; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; relationship between load power and conduction time; solid state relays types and ratings; applications and limitations

Fault-finding procedures: typical faults – power and trigger circuits; characteristics displayed by common faults; comparison of test date with expected data (voltage/current waveforms); location and replacement of faulty components

Electrical installation requirements.

Cable selection for mains and submains using AS3000.1 for installation conditions where de-rating factors are required to apply

Voltage drop calculations using circuit impedance for various load power factors

Effects of harmonics on cable selection: methods of harmonic control

Determination of permissible short circuit currents and temperature limits

Cable selection for final subcircuits where de-rating factors need to be apply

Control and protection requirement, switchboard design including arrangement of equipment, CT metering, links, circuit protection and fault current protection

Determination of cable selection, control and protection using AS3000, AS3008.1, AS3001 and AS3004 for theatres, halls, controlled atmosphere rooms, caravans, caravan parks and boating marina installations

Specialisation: Mining

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

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

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Control concepts.

Advantages of control

Measurement terminology

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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

Power control devices.

Need for power control typical applications

Power control methods: switched control; rheostatic control; voltage control; simmerstatic control; thyristor control

Advantages and benefits of thyristor power control: efficiency; reliability; precision; overall cost

Silicon controlled rectifiers: construction and symbol; basic operating principles; characteristics; voltage ratings – PRV, forward blocking voltage, dv/dt rating; current ratings – average forward current, latching and holding currents, di/dt rating; triggering requirements – gate pulse characteristics; commutation; cooling and protection; testing for serviceability; applications

Gate turn off (GTO) thyristors: construction and symbol; basic operating principles; characteristics; voltage ratings – PRV, forward blocking voltage, dv/dt rating; current ratings – average forward current, latching and holding currents, di/dt rating; triggering requirements – gate pulse characteristics; commutation – gate turn off requirements; applications

BJT, IGBTs: construction and symbols; basic operating principles; characteristics; cut off; saturation and amplification

Triacs: construction and symbol; basic operating principles; characteristics; voltage ratings – blocking voltage, dv/dt rating; current ratings – rms current, latching and holding currents, di/dt rating; triggering requirements – modes of triggering and sensitivity; commutation; cooling and protection; testing for serviceability; applications

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Phase shift control: definition; triggering and conduction angles; relationship between output voltage and conduction angle; problems associated with phase shift control

Single phase half wave controlled rectifier: rectifier operation; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; load voltage determination – calculation; applications and limitations

Single phase full wave controlled rectifier: half controlled bridge – circuit configuration, including trigger circuits; circuit operation and waveforms – resistive loads only; load voltage determination – calculation; applications and limitations; comparison with single phase half wave controlled rectifier

Single phase A.C. voltage control: half and full control circuits; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; use of triacs or inverse parallel SCR's; 'snap on' effect of phase control circuits – reduction of the snap on effect; load voltage determination – form circuit characteristic; applications and limitations

Single phase zero voltage switching (ZVS): operating principles; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; relationship between load power and conduction time; solid state relays types and ratings; applications and limitations

Fault-finding procedures: typical faults – power and trigger circuits; characteristics displayed by common faults; comparison of test date with expected data (voltage/current waveforms); location and replacement of faulty components

Advanced circuit development.

Advanced circuit design techniques

Documenting circuit design

Modifying circuits

An introduction and overview of CAD

Application of programmable controllers in circuit design

Sensors for machinery and product monitoring.

Operation and application of transducers: linear position and displacement; angular position; proximity and limits; vibration and acceleration; speed of rotation; strain

The application of mechanical measuring devices to monitor: industrial plant and manufacturing - processes; production line and material handling systems; the condition of plant and equipment

The statutory requirements: noise and vibration; monitoring techniques

Thyristor converters.

Single and three phase controlled rectifiers: purpose of function of a controlled rectifier; circuit configurations and applications - single and three phase half wave, single and three phase half controlled bridge, single and three phase fully controlled bridge; rectifier performance and operation on resistive and inductive loads; output voltage and waveform, determination of output voltage by both calculation and use of circuit characteristic; communication problems associated with inductive loads; comparison of single and three phase controlled rectifiers

Single phase AC controllers: purpose of function of an AC controller; circuit configurations and applications - single phase half controller, single phase full controller (trial control), single phase full controller (inverse parallel SCR's); circuit performance and operation on resistive and inductive loads; output voltage and waveform, determination of output voltage using circuit characteristic; range of control with inductive loads; triggering problems associated with inductive loads

Three phase AC controllers: circuit configurations and applications – three phase three wire controllers, three phase four wire controllers (circuit only); circuit performance and operation on resistive and inductive loads; output voltage and waveform, determination of output voltage using circuit characteristic; range of control with inductive loads; triggering problems associated with inductive loads

Thyristor controlled DC to DC converters.: purpose and function of a DC to DC converter; voltage control methods – pulse width modulation, pulse rate modulation, modulating both pulse width and rate; output voltage and current levels and waveforms for both resistive and inductive loads; calculation of output voltage

Thyristor protection: protection techniques – snubber networks (dv/dt protection), series inductors (di/dt protection), Amp trap (HRC) fuses, gat pulse suppression; need for heat sinking of power thyristor devices; heat sink features and types; installation methods for all types of thyristor packages; basic thermal model, only to demonstrate the effect of different heat sink types and profiles and installation methods on thyristor junction temperature

Series and parallel thyristor connection: need for series and/or parallel connection of thyristors; series, or high voltage operation – problems associated with series connection, transient voltage equalisation, steady state voltage equalisation, simultaneous triggering, heat sink mounting

Parallel, or high current operation: problems associated with parallel connection – current equalisation, junction temperature equalisation, simultaneous triggering, heat sink mounting

Specialisation: Process

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

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

Power control devices.

Need for power control typical applications

Power control methods: switched control; rheostatic control; voltage control; simmerstatic control; thyristor control

Advantages and benefits of thyristor power control: efficiency; reliability; precision; overall cost

Silicon controlled rectifiers: construction and symbol; basic operating principles; characteristics; voltage ratings – PRV, forward blocking voltage, dv/dt rating; current ratings – average forward current, latching and holding currents, di/dt rating; triggering requirements – gate pulse characteristics; commutation; cooling and protection; testing for serviceability; applications

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Single phase zero voltage switching (ZVS): operating principles; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; relationship between load power and conduction time; solid state relays types and ratings; applications and limitations

Fault-finding procedures: typical faults – power and trigger circuits; characteristics displayed by common faults; comparison of test date with expected data (voltage/current waveforms); location and replacement of faulty components

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

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

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

Specialisation: AC machines

Sensors for machinery and product monitoring.

Operation and application of transducers: linear position and displacement; angular position; proximity and limits; vibration and acceleration; speed of rotation; strain

The application of mechanical measuring devices to monitor: industrial plant and manufacturing - processes; production line and material handling systems; the condition of plant and equipment

The statutory requirements: noise and vibration; monitoring techniques

A.C. stators - formed coil rewind.

Stripping stator core of old windings, data collection, preparation for rewind

Fitting of new coils to the stator core, wedging, bracing, connecting

Impregnating materials, procedures, tests, precautions

Static electrical testing: procedures, precautions

Electrical machine bearings.

Types of bearings used in electric motors: ball and roller bearings - deep groove, maximum capacity, angular contact, self aligning, special thrust

Ball and roller bearings-roller: cylindrical, tapered, spherical, special thrust

Plain bearings: full sleeve, split sleeve, thrust – fixed and tilting pad, carbon and sintered

Bearing clearances

Fitting bearings to shafts: hot oil bath, oven heating, induction heating, cooling, hydraulic, mechanical, adaptor sleeves

Fitting of bearings into housings: pressing, heating

Removal of bearings from shafts (mechanical, hydraulic, heating) and housings (pressing, heating)

Handling and storage of bearings

Methods of lubrication: grease, oil bath, oil circulating system, throw away system, oil mist

Seals: oil grooves, labyrinth, oil seals, v rings, mechanical

Calculation of bearing life

Dimensions of housing and shafts

Bearing damage and remedial action: brinelling, false brinelling, foreign material, corrosion, overload, electric current

Electric rotating machines - condition monitoring.

Routine maintenance and condition monitoring of: bearings, windings, cooling circuits, commutators, sliprings, couplings, pulleys, rotating components

Couplings and pulleys.

Types of couplings, applications

Fitting couplings to shafts, alignment

Types of belts, applications

Fitting of pulleys to shafts, alignment

Wave wound rotors – rewind.

Winding removal: details, measurements, calculations

Preparation of core for rewinding

Types of insulation

Half coils: forming, preparing the ends, insulating

Fitting coils to rotor core: wedge, connect, band

Impregnation methods

Static electrical testing: procedures, precautions

Sliprings and commutators.

Problems relating to sliprings and commutators

Brush selection

Brush gear servicing

Slipring servicing

Commutator servicing

Submersible motors.

Cable selection for underwater use

Stator rewinding

unit assembling and sealing

Testing of the complete units

unit repair

Specialisation: AC/DC machines

Sensors for machinery and product monitoring.

Operation and application of transducers: linear position and displacement; angular position; proximity and limits; vibration and acceleration; speed of rotation; strain

The application of mechanical measuring devices to monitor: industrial plant and manufacturing - processes; production line and material handling systems; the condition of plant and equipment

The statutory requirements: noise and vibration; monitoring techniques

A.C. stators - formed coil rewind.

Stripping stator core of old windings, data collection, preparation for rewind

Fitting of new coils to the stator core, wedging, bracing, connecting

Impregnating materials, procedures, tests, precautions

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Ball and roller bearings roller: cylindrical, tapered, spherical, special thrust

Plain bearings: full sleeve, split sleeve, thrust – fixed and tilting pad, carbon and sintered

Bearing clearances

Fitting bearings to shafts: hot oil bath, oven heating, induction heating, cooling, hydraulic, mechanical, adaptor sleeves

Fitting of bearings into housings: pressing, heating

Removal of bearings from shafts (mechanical, hydraulic, heating) and housings (pressing, heating)

Handling and storage of bearings

Methods of lubrication: grease, oil bath, oil circulating system, throw away system, oil mist

Seals: oil grooves, labyrinth, oil seals, v rings, mechanical

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Couplings and pulleys.

Types of couplings, applications

Fitting couplings to shafts, alignment

Types of belts, applications

Fitting of pulleys to shafts, alignment

DC armatures - coil forming and winding.

Armature stripping: tasks, procedures, precautions

Insulation: types, properties, applications, ratings

Forming coils and equalisers, preparing the ends, insulating

Fitting coils to armature core, wedge, connecting leads to commutator and band

Impregnation: precautions, materials, test procedures

Static electrical testing procedures

Sliprings and commutators.

Problems relating to sliprings and commutators

Brush selection

Brush gear servicing

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Category: Electronics (C)

Common

Occupational health and safety implementing and monitoring.

Legislation and Australian Standards: AS1470 – 1986; OHSC:7025 (1994); generic competencies A, B and C; relevant acts (electrical); general duty of care

Policy and program development: assigning accountability; focus on improvement

Consultative processes: OH&S committee; meetings and workshops; information gathering

Training and development: provision and type; dissemination of information; cultural considerations; literacy considerations

Hazard identification and assessment: safety audits; workplace inspections; injury and illness records, statistics; complaints and observations; contributing factors to a hazard (exposure, severity, human differences)

Risk assessment and management: hierarchy of control (elimination, substitution, design, mitigation)

Management and improvement: promoting OH&S activities; integration management structures; evaluation of control strategies; evaluation of educational and training programs

Industrial computer systems.

Computer systems overview

PC hardware orientation

DOS commands

DOS set-up commands

Windows operations

Word processors

Spreadsheets

Databases as used for control applications

CAD/vector graphics

Control applications

Specialisation: Communications - broadcast

Modulation techniques.

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; compounding; aliasing

Spread spectrum techniques

Frequency selective amplifiers.

Band pass and band stop circuits; tuned amplifiers - using single L.C. load, calculation of gain; amplifiers using frequency selective feedback, active filters; gain stability; higher order filter circuits; multi stage tuned amplifiers; other filter networks - ceramic resonator, surface acoustic wave (SAW) filter, crystal, mechanical, other types; digital filters

Analogue electronics.

Inverting, non-inverting, voltage follower, transresistance and transconductance operational amplifier circuits

Limitations on power supply, input and voltage and output current

DC non-idealities – input bias current, input offset current, input, offset voltage

Slew rate

Noise calculation and measurement in operational amplifiers

Frequency compensation: gain and phase margin; single-pole, double pole and feedforward compensation

Analysis of single stage small signal BJT/FET amplifiers in the alternative modes of operation (e.g.. C.B; C.E; C.C) in order to determine the D.C. bias conditions and a.c

Determination of the low and high frequency composite gain and phase response of an amplifier

Multistage amplifiers - coupling techniques and effect on system parameters

Advanced oscillators.

L.O. oscillators using discrete components, colpitts, clapp, hartley, butler, miller (single, multi and overtone operation); variable frequency oscillators; voltage controlled oscillators; synthesised tuning PLL; phase shift; wien bridge; non-sinusoidal - a stable and bistable circuits, 555 integrated circuit, discrete component, crystal, ceramic; buffer amplifiers

Receiver and transmitter circuits.

Receiver block diagrams: principles of dual conversion; DSBFC dual conversion receiver

RF amplifiers: intermodulation; cross modulation; RF amplifier performance

Intermediate frequency (IF) amplifiers: IF amplifier alignment; neutralisation; IF amplifier performance

Demodulation: SSBSC

AGC systems: SSBSC receivers

Phase locked loops (PLL): PLL noise; frequency synthesis using PLLs

Receiver performance criteria: sensitivity test (FM quieting, S/N ratio, SINAD measurements), spurious signal responses; receiver noise figure

NBFM transmitters: operation; tuning and adjustment; testing

Digital transmitters

Personal radio communications.

Spectrum usage; two-way radio; CB radio – 27 MHz, AM, SSB, UHF; repeaters; remote area communications – radio, radphone, selcall, satellite; common faults; installation; servicing; repair; regulations

Cellular broadcast systems.

Brief history of cellular mobile radio - car phone, AMPS, GSM

Need for GSM standard

Cellular radio frequency reuse: ideal hexagonal layout; frequency allocation for omni aerials

Tilting of aerials to allow spill over

Omni and sectorised aerials: base station location; frequency allocation (3 sector aerial)

Block diagram of cellular mobile radio system: functions and placement within the system of - MS - mobile station, BTS - base transceiver station, BSC -base station controller, BSS -base station system, MSC (or MSSC) - mobile services switching centre, HLR - home location register, VLR - visitor location register, AUC - authentication centre, PLMN - public land mobile network, PIN - personal identification number, PUK - personal unblocking key, IMSI - international mobile subscriber identity, TMSI - temporary mobile subscriber identity, SIM - subscriber identity module, TDMA - time division multiple access, EIR - equipment identity register, IMEI - international mobile station equipment identity, OMC - operations and maintenance centre, TRX – transceiver, MSISDN - mobile subscriber ISDN number

HLR, VLR: general concepts, worked example of use

Polling: demonstration of recorded announcements

Roaming: within home location, but to other carriers; within country (same carrier); overseas

Call placement to MS from PLMN

Call placement to PLMN from MS

Electromagnetic Radiation: safe levels; safe work practices

TDMA and FDMA concepts

Frequency plan of Cabling Provider rules GSM network: TX/RX offset; total Spectrum allocation and TX/RX channel bandwidth; number of TRX channels per carrier; modulation method used; guard bands

Handovers (general concepts via AMPS network)

Mobile assisted handovers (c.f. AMPS)

GSM radio interface frame: total time per frame; general content; use of guard times; total bit rate and effective data rates; frequency hopping

Interleaving (brief concept)

Forward error correction (brief concept)

Encryption (brief concept)

Linear predictive coding (brief concept)

Line-of-sight: radio propagation concepts revised; multiple paths (rayleigh fading)

Demonstrate effect of signal loss with Faraday cage or attenuator

Measure output power in GSM MS (digital phone)

Demonstrate power level changes in MS

SIM card features

Basic phone operation: SIM card changing; PIN, PUK password changing; memory dialling (storing); toll restriction

Low earth orbit satellite concepts

Cellular satellite frequency bands: mobilesat (OPTUS); iridium (Motorola); inmarsat

DCS 1800 and CT2 (brief mention)

Comparison of AMPS to GSM: frequency spectrum; total number of channels; modulation; bandwidth per user channel; interference alignment cell size radius

Specialisation: Communications - broadcast station operations

Modulation techniques and circuits.

Multiplexing: time division multiplexing (TDM); frequency division multiplexing (FDM)

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NBFM Transmitters: operation; tuning and adjustment; testing

Digital transmitters

Broadcast transmitters.

RF propagation: frequency spectrum; em waves; wave attenuation and absorption; ground and space wave propagation.

Satellite communications

Channel separation

Broadcast antennae: AM and FM; range; feeders; matching; change-over switch

Broadcast transmitters: radio; TV; controls; power supplies; output stages; remote control; standby

Digital broadcasting

Broadcast signal distribution.

Video distribution amplifier

Audio distribution amplifier

Routing switcher

Video patch panel

Audio jackfield

Repeaters

Audio signal processing.

Dynamic range

Non linear effects; compression; gating

Sound processing amplifier

Equalisers

Audio mixer

Stereo sound

Subjective loudness

Digital audio

Audio signal monitoring.

Listening environment

Loud speaker systems

Power amplifiers

Stereo image

Surround sound

Foldback and interrupted foldback

Audio signal measurements.

The audio signal; mic level; line level; standard level

Balanced and unbalanced circuits

Impedance matching

Decibels; dB; dBm; dBo; dBu

VU meter

Noise

Video signal processing.

Processing amplifier

Frequency response

Non linear effects

Frame synchroniser

Vision mixer

Video effects; keyers

Component video

Digital video

Video monitoring systems.

Picture monitors grade 1 and grade 3

Colour grading and grey scale

Off air reception

Waveform analysis

Viewing conditions

Video signal measurements.

Video signal; standard level; impedance matching

Chrominance and Luminance

Sync and blanking

Burst

Vertical interval

Waveform monitor

Vector monitor

Interval test signals

Noise

Digital broadcasting.

RF digital modulation schemes: n-QAM; QPSK; COFDM; CDMA; CDPD

Baseband signal processing: noise; BER; FER

Digital radio systems

Digital TV systems

Studio control systems.

Radio control systems

Studio talkback

Station talkback

Radio talkback; VHF; UHF

TV control systems

Specialisation: Communications - microwave

Modulation techniques.

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Digital modulation: sampling theorem, bandwidth, filtering requirements; pulse code modulation (PCM); pulse width modulation (PWM); delta modulation; quantising noise; compounding; aliasing

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NBFM transmitters: operation; tuning and adjustment; testing

Digital transmitters

Waveguides and antenna devices.

Safety: RF leakage detection; RF leakage measurement; radio frequency hazards (RADHAZ) markings and precautions

Equipment: microwave test sets (network analysers); PP analysers; RF probes (nada probes); power meters; attenuators; directional couplers; detectors/crystals; build in test equipment (BITE); RF head (injection devices); special purpose RF test sets

Waveguides: frequencies; handling; e and h bends; propagation modes; couplings – RF type; rigid and flexible; rotating joints/bronski couplers (multiple waveguide rotating joints); circulators; dummy loads – air and water cooled; pressurisation and drying (including air, SF6, N2 and other inert gases); teflon; cleaning; RF gaskets and spacers; ferrites – properties and RF applications

Antenna devices: transmit/receive cells; rotary couplings and joints; feed horns; dipoles; reflectors; diplexers; duplexers; end feed slotted array; squint angle correction; squint angle alignment; squint angle compensation

Directional antenna devices: comparators; mechanical scanning (include conical scan on receive only); directional antennae, controllers and feed arrangements; stabilisation – stable elements (mechanical and optical), rate gyros; tracking loops – range and angle; operating modes – designation, search, acquisition and track; search patterns; advanced doppler/pulse doppler; monopulse tracking; RF to optical alignment; FFT and CFAR filters; software control; software elimination of blind/ambiguous ranges and velocities

Microwave devices.

Waveguide propagation

Cavity devices: couplers – T, hybrid-T, directional, diplexers, phase shifters, power splitters, circulators, horns

Stripline structures

Ferrite and dielectric devices

Thermionic microwave devices: klystrons – magnetrons, cross field amplifiers (CFA), travelling wave tubes (TWT)

Solid state microwave devices: diodes – tunnel, pin, gunn, TRAPPATT, BARRATT; stimulated emission devices – MASER; parametric amplifiers - Josephson devices (explain need for circulators with the above).

Matching systems: single stub match using Smith chart - determine physical length of matching network

Specialisation: Communications -satellite

Modulation techniques.

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Digital applications.

Boolean Algebra: generation of Boolean expressions and truth table for verbal logic descriptions and logic circuit schematics; simplification of Boolean expressions using Boolean algebra; complementation of a Boolean expression – De Morgan's laws

Karnaugh maps: construction of K maps for given functions of up to 4 variables; use of K maps to derive the minimal and into or (S.O.P) form implementation for a given expression; conversion of and or (S.O.P) form into all NAND gate implementation; nature of "don't cares" and how they can be used to advantage by a designer

Propagation delays: definition - t_{plh} and t_{phl}; affect on operation of discrete devices – simple combinational circuits and ripple counters; set-up and hold times - definition and consequences of

Oscillators: schmitt-trigger action - V_{T+}, and V_{T-}, hysteresis; waveform smoothing; schmitt trigger oscillator - factors determining frequency; two gate R-C oscillator; two gate crystal oscillator; an integrated, crystal controlled, oscillator/frequency-divider chip - e.g. 4060

Monostables: basic operation - trigger conditions and pulse-width determination; response of non-re-triggerable vs re-triggerable one shots; duty cycle limitation; simple applications of one shots e.g. pulse stretching and delaying, switch debouncing/key pressed strobe and missing pulse detector

Asynchronous counters: characteristics of common i.c "ripple" counters e.g. 7490 family; changing the counter modulus - frequency division and output duty cycle; cascading asynchronous counters to extend modulus; disadvantages - glitches and clocking frequency limitations

Synchronous counters: basic internal structure of a presettable synchronous I.C. counter; distinction between synchronous and asynchronous control inputs and their relative affects - e.g. load enable and clear inputs; use of counter (clock) enable inputs and terminal count outputs; analysis of a synchronous I.C. counter circuit (maximum of 2 counters) to determine count-cycle - modulus, frequency and form of output waveform

Memory: classification – RAM and ROM (historic), volatile and non-volatile memory; memory terminology - array structure, memory size data word, address; data - address and control buses; read and write modes of operation - basis steps in; memory timing:- access time and write (cycle) time; RAM devices - SRAM and DRAM - speed, density refresh and addressing differences; ROM devices - nature of masked ROM, PROM, EPROM, E^2ROM and NVRAM

Digital circuit applications: memory decoding - expansion of word size and address space; development of a memory map from a given memory decoding system (no images); control waveform generator using a MUX and counter; use of a ROM as a code converter - look-up table and character generator (ASCII code to dot pattern); use of a BDC to 7 segment decoder/latch to drive either a common anode or common cathode led display; display multiplexing - time sharing a single decoder between two display chips

Advanced analogue electronics.

Applications of power; amplifiers and definitions

Additional considerations related to large signal operations

Class A, B, AB, C and D power amplifiers

Distortion/feedback

Heat transfer and sinking

Data sheet usage related to typical characteristics of fully integrated power amplifiers

Specification and testing of power amplifiers

VCR advanced.

Chrominance processing principles: down converted colour recording. principles; specifications; colour cross talk and the need for phase rotation; functional block diagram in record mode; functional block diagram in playback mode; practical circuits; alignment of practical circuits

System control principles: system control requirements; serial and parallel data transmission in VCRs; input devices; functional block diagram; operating principles; display and timer operation; practical circuits; methods of testing practical system control circuits; variable speed and trick mode operation; and principles of operation during pause modes; principles of operation during, variable speed playback modes; application of variable speed and trick modes to servo systems

Advanced VCR techniques: practical circuit operation; Hi Fi systems; digital tracking systems; digital picture storage; digital still pictures; bar code systems; multi-standard VCR

VCR fault-finding.

Mechanical faults

Components: identification; location

VCR test equipment: waveform measurement; voltage measurement

Safe working practice

VCR faults: typical faults; analysis of symptoms; repairs; luminance processing faults; chrominance processing faults; system control faults; servo system faults; timer and display faults; power supply faults; sound faults; RF faults

Electronic signals and systems.

Electronic test signals: relation to instrumentation – audio, video, radio, data, process instrumentation, industrial control systems; electromagnetic spectrum - DC references, sine wave, rectangular wave, exponential rise and fall, sawtooth, triangular, staircase, noise sources, modulated sources, swept sources; sine waves - harmonic distortion, multiplication of different frequencies; analysers - non-distortion analysers, spectrum analysers; waveshapes and spectra of common signals

Deducing outputs from inputs: basic signal processing functions and subsystems – analogue, digital; deductions using – amplifiers, attenuators, transducers, buffers, limiters, rectifiers, comparators with hysteresis, comparators without hysteresis, DC shift integrator, differentiator, tuned circuits, filters (LP, HP, BP, BS), adders, mixers, multipliers, modulators, detectors, vcos, phase locked loops; digital functions – bits, bytes, words, codes, gates, flip-flops, clocks, counters, registers, memories, DACs, ADCs, samplers, sample and hold, keyboards, displays, modems, codes

Interpreting and drawing diagrams: functional diagrams; block diagrams; waveform diagrams; spectra diagrams; predicting signal waveforms and spectra; circuit schematics; system written specifications; catalogues; handbooks; application notes

Electronic equipment: measuring instruments – multimeter, oscilloscope, signal generators, spectrum analyser; communications systems - modulation-demodulation, AM, DSCSC, SSB, FM, PM, QAM; transmission - noise interference, signal distortion, reflections/attenuations; shannon model – source, channel, destination, noise, bandwidth, information rates; radio - receivers and transmitters, superhets, AGC, phase locked loops; television – imaging, scanning, resolution, synchronising, luminance, chrominance

Advanced professional audio techniques.

Advanced audio systems interfaces; radio microphones; multi channel FM receiving systems; special sound effects; advanced mixing desks; new technologies; diagnosis and fault-finding techniques

High power speaker arrays and cables.

Cable: types; uses; placement; de-rating

Connectors – types; uses

Speaker arrays: selection; phasing; power; mounting

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Specialisation: Entertainment - TV

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

Display devices.

Picture tubes: types; construction; operational principles; adjustments; drive voltages and waveforms; safety; disposal; EHT voltage measurement; tube rejuvenation and testing

LCD displays: types and operation; construction; scanning techniques; drive voltages and waveforms

Other display devices: plasma; light emitting plastics

Special display types: aspect ratios; HDTV

Projection techniques: front projection; rear projection; 3 tube; single light source; LCD projectors

TV micro controllers.

Micro controller: block diagram; I/O; typical faults; fault-finding

Remote controls: block diagram of transmitter and receiver; service; typical faults; fault-finding

On screen display: circuitry; adjustments; fault-finding

Field storage systems: circuitry; picture-in picture; typical faults

Teletext: operation; circuitry; typical faults

Television servicing practices.

Components and circuits: components and device functions; circuit functions;

interpretation of schematics

Fault-finding: techniques and strategies; analysis of symptoms; locations of faults to component level; repair

Test equipment: TV test signal generators; waveform and voltage measurement; specialised TV test equipment

Safety procedures

Introduction to camcorders.

Overview: camera block diagram; camcorder block diagram (basic); principles of operation

Standards and tape format: VHS; VHS compact; 8 mm; HI 8; digital (basic)

Pick up tubes and charge coupled devices: newvicon (principles of operation); charge coupled devices (principles of operation)

Lenses and light values: basic lens action; automatic focus (systems and devices); light measurement (light and colour temperature); zoom (optical and electronic)

Adjustment of tube type cameras (monochrome): beam current; focus; beam alignment; video adjustments

Colour separation: early systems; dichroic mirrors; single tube colour stripe filter; colour correction filters

Signal processing (single tube colour camera): static shading correction; dynamic shading correction; white balance (manual and automatic); R-Y/B-Y encoding

Signal processing. (CCD colour camera): CCD charge level; high speed shutter; R-Y/B-Y encoding; digital (basic)

Mechanical overview (basic): video head types – VHS, VHS-C; video 8mm; special tools and equipment

Camcorders power supplies and battery chargers: battery charging requirements; battery types

Digital versatile disc (video) principles.

DVD overview: disc drive unit; disc type and capacity; standard functions of a DVD player

Compression systems: principles of MPEG digital video processing; MPEG standards; reasons for data compression; MPEG2 profiles; hybrid encoding with three technologies - spatial axis compression-discrete cosine transform, time base competition, predictive encoding motion competition, image compression by predictive encoding for predicting motion from neighbouring frames; time base competition; sequence; bidirectional prediction; I,P and B picture sequence; Hoffman encoding - 4:2:0 encoding; data compression: CD ROM(MPEG 1 and 4) – DVD video, DVD ROM; DVD video image quality – variable transfer rate – high image recording efficiency; DVD video sound – 5.1 channel surround sound; Dolby AC3 encoding system, linear PCM

Other DVD features: multiple language – feature, dubbing, subtitles; stream and packet transmission - stream -data flow, packet multiplex transmission system; DVD video interactive features - title menu, DVD menu, multi story, multi angle, multiple aspect ratio, seamless playback, parental control

DVD video copyright protection system: reproduction control - regional codes; copy protection

DVD video software production: disc manufacture (overview)

DVD ROM and other standards: block diagram of a DVD player; RF block; data processor; decryption; buffer control; video decoder; letter box conversion; video equaliser and noise reduction; sub picture; PAL encoder; on screen display; audio detector; audio decoder; clock generation system control; interface control; laser operation principles

Service adjustments: set up, connection and operation of a DVD player

MATV – small commercial antenna distribution systems.

MATV distribution systems: wide band distribution amplifiers; single channel distribution amplifiers; directional couplers; trunked tee feed distribution system; signal equalisers; outlet isolation

Channelised distribution systems: single channel amplifiers; high level launch amplifiers; signal equalisers

Signal reticulation: VCR signals; signal combiners

System design: design factors; component specifications

Fault-finding: measurement; typical faults; symptoms

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Safety procedures

VCR basic principles

VCR installation: typical installation methods; cables and connectors; VCR operation; VCR specification

Magnetic recording techniques: magnetic recording principles; specifications, limitations and terminology; audio recording principles; block diagram of simple audio recording process

Helical scanning principles: need for helical scanning; head and tape speeds; two head recording; zero guard band principles; azimuth recording; requirement for head switching; head drum assembly; VHS tape format and specifications

VHS mechanical systems: tools and equipment required for mechanical service; basic mechanical system layout; tape transport system; mechanical maintenance; mechanical adjustments; mechanical component replacement; safety

FM recording principles: review of FM principles; requirements for FM recording; basic block diagram of luminance processing

VHS electronic system overview: block diagram; E-E modes; system and servo control; colour under-recording

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Adjustment of tube type cameras (monochrome): beam current; focus; beam alignment; video adjustments

Colour separation: early systems; dichroic mirrors; single tube colour stripe filter; colour correction filters

Signal processing (single tube colour camera): static shading correction; dynamic shading correction; white balance (manual and automatic); R-Y/B-Y encoding

Signal processing. (CCD colour camera): CCD charge level; high speed shutter; R-Y/B-Y encoding; digital (basic)

Mechanical overview (basic): video head types – VHS, VHS-C; video 8mm; special tools and equipment

Camcorders power supplies and battery chargers: battery charging requirements; battery types

Specialisation: Scanning - radar

Analogue electronics.

Inverting, non-inverting, voltage follower, transresistance and transconductance operational amplifier circuits

Limitations on power supply, input and voltage and output current

DC non-idealities – input bias current, input offset current, input, offset voltage

Slew rate

Noise calculation and measurement in operational amplifiers

Frequency compensation: gain and phase margin; single-pole, double pole and feedforward compensation

Analysis of single stage small signal BJT/FET amplifiers in the alternative modes of operation (e.g.. C.B; C.E; C.C) in order to determine the D.C. bias conditions and a.c

Determination of the low and high frequency composite gain and phase response of an amplifier

Multistage amplifiers - coupling techniques and effect on system parameters

Digital applications.

Boolean Algebra: generation of Boolean expressions and truth table for verbal logic descriptions and logic circuit schematics; simplification of Boolean expressions using Boolean algebra; complementation of a Boolean expression – De Morgan’s laws

Karnaugh maps: construction of K maps for given functions of up to 4 variables; use of K maps to derive the minimal and into or (S.O.P) form implementation for a given expression; conversion of and or (S.O.P) form into all NAND gate implementation; nature of “don’t cares” and how they can be used to advantage by a designer

Propagation delays: definition - t_{plh} and t_{phl}; affect on operation of discrete devices – simple combinational circuits and ripple counters; set-up and hold times - definition and consequences of

Oscillators: schmitt-trigger action - V_{T+}, and V_{T-}, hysteresis; waveform smoothing; schmitt trigger oscillator - factors determining frequency; two gate R-C oscillator; two gate crystal oscillator; an integrated, crystal controlled, oscillator/frequency-divider chip - e.g. 4060

Monostables: basic operation - trigger conditions and pulse-width determination; response of non-re-triggerable vs re-triggerable one shots; duty cycle limitation; simple applications of one shots e.g. pulse stretching and delaying, switch debouncing/key pressed strobe and missing pulse detector

Asynchronous counters: characteristics of common i.c "ripple" counters e.g. 7490 family; changing the counter modulus - frequency division and output duty cycle; cascading asynchronous counters to extend modulus; disadvantages - glitches and clocking frequency limitations

Synchronous counters: basic internal structure of a presettable synchronous I.C. counter; distinction between synchronous and asynchronous control inputs and their relative affects - e.g. load enable and clear inputs; use of counter (clock) enable inputs and terminal count outputs; analysis of a synchronous I.C. counter circuit (maximum of 2 counters) to determine count-cycle - modulus, frequency and form of output waveform

Memory: classification – RAM and ROM (historic), volatile and non-volatile memory; memory terminology - array structure, memory size data word, address; data - address and control buses; read and write modes of operation - basis steps in; memory timing:- access time and write (cycle) time; RAM devices - SRAM and DRAM - speed, density refresh and addressing differences; ROM devices - nature of masked ROM, PROM, EPROM, E^2ROM and NVRAM

Digital circuit applications: memory decoding - expansion of word size and address space; development of a memory map from a given memory decoding system (no images); control waveform generator using a MUX and counter; use of a ROM as a code converter - look-up table and character generator (ASCII code to dot pattern); use of a BDC to 7 segment decoder/latch to drive either a common anode or common cathode led display; display multiplexing - time sharing a single decoder between two display chips

Waveguides and antenna devices.

Safety: RF leakage detection; RF leakage measurement; radio frequency hazards (RADHAZ) markings and precautions

Equipment: microwave test sets (network analysers); PP analysers; RF probes (nada probes); power meters; attenuators; directional couplers; detectors/crystals; build in test equipment (BITE); RF head (injection devices); special purpose RF test sets

Waveguides: frequencies; handling; e and h bends; propagation modes; couplings – RF type; rigid and flexible; rotating joints/bronski couplers (multiple waveguide rotating joints); circulators; dummy loads – air and water cooled; pressurisation and drying (including air, SF6, N2 and other inert gases); teflon; cleaning; RF gaskets and spacers; ferrites – properties and RF applications

Antenna devices: transmit/receive cells; rotary couplings and joints; feed horns; dipoles; reflectors; diplexers; duplexers; end feed slotted array; squint angle correction; squint angle alignment; squint angle compensation

Directional antenna devices: comparators; mechanical scanning (include conical scan on receive only); directional antennae, controllers and feed arrangements; stabilisation – stable elements (mechanical and optical), rate gyros; tracking loops – range and angle; operating modes – designation, search, acquisition and track; search patterns; advanced doppler/pulse doppler; monopulse tracking; RF to optical alignment; FFT and CFAR filters; software control; software elimination of blind/ambiguous ranges and velocities

Advanced test equipment.

Advanced test equipment: types; uses

Advanced CROs: block diagram; operating principles; triggering sources (chan ½ ext, V mode, starts after delay, etc); triggering coupling (AC, DC, video, LF reject, HF reject, etc); triggering modes (auto, triggering, normal, single); dual trace (chop/alternated/add); quad trace; delayed time base (A, Alt, A Int B, B delayed, X-Y)

CRO probes: compensated; voltage divider (1:1. 10:1, 100:1); high-voltage; active/passive; terminated (HF, audio, etc); current

Storage oscilloscopes: analogue; digital

Signal generators: sinewave; pulse (variable mark/space); sweep

Audio and mini volt meters

Noise and distortion meters

Counter timers/frequency meters

Chart recorders

A/D-D/A converters

Logic pulsers

Logic probes

Secondary radar.

Safety; principles of operation; transponders; decoding; air traffic control; modes – 1, 2, 3/A, 4, C; standards; slaved to primary; tactical air navigation

(TACAN); instrument landing systems (ILS); beacons; frequencies; emergency codes

High voltage power supplies.

Safety: safety symbols (high voltages, ionising radiation hazards, non-ionising radiation hazards); signs (high voltages, ionising radiation hazards, non-ionising radiation hazards);· personnel safety in the vicinity of radiation hazards; personnel safety in the vicinity of high voltage sources; high voltage arcing; insulation breakdown; carbon tracking; ionisation; measurement of high and extra high voltages

Test equipment: applications (electrometers, high voltage probes, ionisation testers, insulation testers, discharge probes, DC and AC voltmeters, millivoltmeters, microvoltmeters, DC and AC ampmeters, milliampmeters, microampmeters, scaling networks, corona, spark gaps, creepage; tracking); calibration; errors of measurement and their effects;· charts and graphs used in assessing equipment and materials (dialectric characteristics, insulation characteristics, air ionisation gaps)

High voltage sources and components: voltage doublers,· voltage triplers and higher voltage multipliers;· Van Der Graaff generators;· cockcroft walton generators;· pulse transformers;· pulse forming networks;· modulators;· travelling wave linear accelerator;· cyclic accelerator;· gas tubes;· hydrogen thyratrons;· diodes/solid state thyratrons;· capacitors;· transformers;· bleed resistors

Routine maintenance procedures: schedules;· safety precautions; fault finding

EMI/EMC: causes; effects; standards

Category: Instrumentation (D)

Common

Occupational health and safety implementing and monitoring.

Legislation and Australian Standards: AS1470 – 1986; OHSC:7025 (1994); generic competencies A, B and C; relevant acts (electrical); general duty of care

Policy and program development: assigning accountability; focus on improvement

Consultative processes: OH&S committee; meetings and workshops; information gathering

Training and development: provision and type; dissemination of information; cultural considerations; literacy considerations

Hazard identification and assessment: safety audits; workplace inspections; injury and illness records, statistics; complaints and observations; contributing factors to a hazard (exposure, severity, human differences)

Risk assessment and management: hierarchy of control (elimination, substitution, design, mitigation)

Management and improvement: promoting OH&S activities; integration management structures; evaluation of control strategies; evaluation of educational and training programs

Analogue electronics.

Inverting, non-inverting, voltage follower, transresistance and transconductance operational amplifier circuits

Limitations on power supply, input and voltage and output current

DC non-idealities – input bias current, input offset current, input, offset voltage

Slew rate

Noise calculation and measurement in operational amplifiers

Frequency compensation: gain and phase margin; single-pole, double pole and feedforward compensation

Instrument field practice.

Introduction: the roll of instrumentation in industry; application of instrumentation; managerial justification; trends in control of processes; responsibilities of instrument department

Types of instrument maintenance, (breakdown, preventative and performance)

Personal safety

Hazardous atmospheres

Wiring, (including intrinsic safety)

Enclosures and barriers

Mounting of instruments

Tubing and piping

Calibration and documentation

Industrial computer systems.

Computer systems overview

PC hardware orientation

DOS commands

DOS set-up commands

Windows operations

Word processors

Spreadsheets

Databases as used for control applications

CAD/vector graphics

Control applications

Control concepts.

Advantages of control

Measurement terminology

Dimensional calculations

Basic transducer principles and physical variables

Control terminology

Type controllers

Process characteristics

Controller principles

Control systems

Power control devices.

Need for power control typical applications

Power control methods: switched control; rheostatic control; voltage control; simmerstatic control; thyristor control

Advantages and benefits of thyristor power control: efficiency; reliability; precision; overall cost

Silicon controlled rectifiers: construction and symbol; basic operating principles; characteristics; voltage ratings – PRV, forward blocking voltage, dv/dt rating; current ratings – average forward current, latching and holding currents, di/dt rating; triggering requirements – gate pulse characteristics; commutation; cooling and protection; testing for serviceability; applications

Gate turn off (GTO) thyristors: construction and symbol; basic operating principles; characteristics; voltage ratings – PRV, forward blocking voltage, dv/dt rating; current ratings – average forward current, latching and holding currents, di/dt rating; triggering requirements – gate pulse characteristics; commutation – gate turn off requirements; applications

BJT, IGBTs: construction and symbols; basic operating principles; characteristics; cut off; saturation and amplification

Triacs: construction and symbol; basic operating principles; characteristics; voltage ratings – blocking voltage, dv/dt rating; current ratings – rms current, latching and holding currents, di/dt rating; triggering requirements – modes of triggering and sensitivity; commutation; cooling and protection; testing for serviceability; applications

Unijunction transistors (UJT): construction and symbol; operating principles; intrinsic stand-off ratio and peak point voltage; revision of R.C constants; UJT relaxation oscillator circuit; UJT oscillator circuit operation – frequency, output pulse characteristic, waveforms

Programmable unijunction transistors (PUT): construction and symbol; operating principles; peak point voltage; programmable stand-off ratio; PUT relaxation oscillator circuit; PUT oscillator circuit operation – frequency, output pulse characteristic, waveforms

Diacs: construction and symbol; operating principles; breakover voltage – symmetrical and asymmetric diacs; diac trigger circuit; diac trigger circuit operation – frequency, output pulse characteristic, waveforms

Phase shift control: definition; triggering and conduction angles; relationship between output voltage and conduction angle; problems associated with phase shift control

Single phase half wave controlled rectifier: rectifier operation; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; load voltage determination – calculation; applications and limitations

Single phase full wave controlled rectifier: half controlled bridge – circuit configuration, including trigger circuits; circuit operation and waveforms – resistive loads only; load voltage determination – calculation; applications and limitations; comparison with single phase half wave controlled rectifier

Single phase A.C. voltage control: half and full control circuits; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; use of triacs or inverse parallel SCR's; 'snap on' effect of phase control circuits – reduction of the snap on effect; load voltage determination – form circuit characteristic; applications and limitations

Single phase zero voltage switching (ZVS): operating principles; circuit configuration – including trigger circuits; circuit operation and waveforms – resistive loads only; relationship between load power and conduction time; solid state relays types and ratings; applications and limitations

Fault-finding procedures: typical faults – power and trigger circuits; characteristics displayed by common faults; comparison of test date with expected data (voltage/current waveforms); location and replacement of faulty components

Control interfacing.

Introduction to the integrated control system: basic make-up of an integrated control system; hierarchy of an integrated control system; the five levels in a typical integrated control system

Field signals: standard control signals; transmitters (four wire, two wire and isolators)

Serial data communications: basic principles; simplex/duplex; asynchronous and synchronous; basic standards (RS232, RS423, RS422 and RS485)

Local area networks (level 1 only): OS1 model; topology – ring, star and bus

Protocols: basic principles; map, top, modbus, profibus etc

Industrial automation software: basic principles (drivers etc); examples (wizcon, citect, dmacs, factory link, process window, control view, genesis etc)

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

Specialisation: Control

Advanced PLCs.

Medium to high level PLC hardware and software: hardware configuration; addressing; memory map; programming instruction syntax; file manipulation; documentation; saving/restoring programs

Number systems and codes: common number formats (binary, octal, integer, hexadecimal); conversions between formats; codes (BCD, grey, ASCII)

Diagnostics: flags/status words (file); fault locations; scan considerations (fixed, variable, immediate update)

Data manipulation (word): binary word structure; single and double works; word devices; arithmetic instructions; word logical instructions; conversions (BCD to binary, binary to BCD); indirect addressing (image register to word, word to IR, word to word, word to table, table to table); word shift registers (LIFO, FIFO); masking; bit manipulation (bit set, bit clear, bit test); entering data constants; multiplexing

Analogue I/O: common signal types; module resolution; scaling; unscaling; signal offset

Sequencers/drum controllers

Specialisation: Measurement

Advanced PLCs.

Medium to high level PLC hardware and software: hardware configuration; addressing; memory map; programming instruction syntax; file manipulation; documentation; saving/restoring programs

Number systems and codes: common number formats (binary, octal, integer, hexadecimal); conversions between formats; codes (BCD, grey, ASCII)

Diagnostics: flags/status words (file); fault locations; scan considerations (fixed, variable, immediate update)

Data manipulation (word): binary word structure; single and double works; word devices; arithmetic instructions; word logical instructions; conversions (BCD to binary, binary to BCD); indirect addressing (image register to word, word to IR, word to word, word to table, table to table); word shift registers (LIFO, FIFO); masking; bit manipulation (bit set, bit clear, bit test); entering data constants; multiplexing

Analogue I/O: common signal types; module resolution; scaling; unscaling; signal offset

Sequencers/drum controllers

Category: Refrigeration and air conditioning (E)

Common

Occupational health and safety implementing and monitoring.

Legislation and Australian Standards: AS1470 – 1986; OHSC:7025 (1994); generic competencies A, B and C; relevant acts (electrical); general duty of care

Policy and program development: assigning accountability; focus on improvement

Consultative processes: OH&S committee; meetings and workshops; information gathering

Training and development: provision and type; dissemination of information; cultural considerations; literacy considerations

Hazard identification and assessment: safety audits; workplace inspections; injury and illness records, statistics; complaints and observations; contributing factors to a hazard (exposure, severity, human differences)

Risk assessment and management: hierarchy of control (elimination, substitution, design, mitigation)

Management and improvement: promoting OH&S activities; integration management structures; evaluation of control strategies; evaluation of educational and training programs

Preventive maintenance.

Maintenance systems: maintenance terminology; preventive maintenance; predictive maintenance; corrective maintenance

Plant, machinery and equipment audit: identify critical equipment/components; assess plant performance and history; identify labour and material requirements

Creation of a preventive maintenance program: writing preventive maintenance tasks; scheduling preventive maintenance tasks; recording of information

Review of preventive maintenance program: collection of data; comparison of present information with prior history

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HVAC control systems.

Control fundamentals: control terminology; HVAC system characteristics; control system characteristics; control system components

Types of control equipment: pneumatic (terminology, symbols, pneumatic control systems, air supply equipment, thermostats, controllers, actuators, relays – switches); electrical (classification of circuits, two position control, floating control, sensors, controllers, flow control devices); electronic (operating principles, sensors, controllers, control systems)

DDC systems: terminology; controllers; controller software; basic controller programming, applications

Control systems applications: air handling system controls - ventilation, heating, humidification, cooling, dehumidification, heating; building airflow system control; airflow control - singles and multi–zones; chiller boiler and distribution system control - chilled water, boiler, distribution systems

Supervisory control systems: systems function; configurations; introduction building management

Specialisation: Control systems

HVAC air systems.

Air distribution principles: static and velocity pressures; measurements; terminology; laminar and turbulent fluid flows; system performance profiles

Air system design: method - velocity reduction, equal friction, static regain, computer aided; selection of duct fitting and diffusion fittings

Fans: types; fan laws; fan curves; installation criteria; applied system curves

Ventilation, dust extraction: system configuration; Australian standards; AS – 1668 Part 1 and 2; componentry; system selection; building regulations

Air systems: dual and single duct constant volume; variable volume; induction units; multi-zone

Applied psychrometrics.

Fundamentals and terms: sensible lie at factor - conditioned space, grand total; quantity of air; effective surface temperature; bypass factor

Coil characteristics: processes - sensible cooling, cooling, dehumidification, sensible heating

Spray processes: saturation efficiency; processes - adiabatic/evaporative cooling, cooling and humidification, sensible cooling, cooling and/or humidification

System analysis: partial load; reheat control; bypass control; volume control

Management of indoor air quality.

Indoor air quality factors: interactive nature of pollutants; comfort criteria; source of odours; pathway form source to occupants; occupant activities; impact on productivity

Cause of IAQ problems: moisture; mould and mildew; bacterial growths; asbestos and other particulate; volatile chemicals produced in the building; chemical products

HVAC systems: types of HVAC systems; system components; duct cleaning; system commissioning; operation of system; damper adjustment

Measurements: common parameters to measure; measurement devices available; instrument calibration; analysing and interpreting results; laboratory tests; standards

Resolving IAQ problems: conducting IAQ investigations; the walk-through; building history; HVAC system information; occupant interviews; troubleshooting

IAQ management: building IAQ profile; location of potential IAQ problems; procedures to control IAQ; communication; response to complaints; equipment preventive maintenance; chemical inventory

Energy management systems for commercial refrigeration.

Functions of a commercial refrigeration E.M.S.: control function; inputs; outputs; communications; graphing; supervising; data logging; scheduling; alarms; power consumption

E.M.S. control components: pressure sensors; temperature sensors; timeclocks; humidity sensors; liquid level sensors; leak detector sensor

Operating parameters of components and sensors for: pressure; temperature; time; humidity; liquid level; leak detection

Installation requirements and considerations for: controller(s); refrigerant leak detectors; systems pressure transducers, temperature sensors

System design and applications: control components selection

Programming of a control system: display terminal and keypad functions; calibration of sensors; changing original settings; application specific programming

Refrigeration/HVAC direct digital controls.

Computer based control fundamentals: definitions; principles

Controller configuration: equipment controllers; zone level controllers; system level controllers

Controller software: operating software; application software

Controller programming: system diagrams; control diagrams; configuration; programming; initialisation; EMS, BMS

Sensors and actuators

Applications: refrigeration systems; HVAC systems; logic analysis; energy management; energy conservation; asset management; life cycle

Refrigeration/HVAC electronic controls.

Control fundamentals: electronic control terminology; definitions

Electronic control basics: voltage supplies; analogue control; controller basics; inputs and outputs

Controllers: variable such as temperature; step; enthalpy; compensation; time proportional

Sensors: temperature; humidity; enthalpy; pressure; velocity

Actuators: water valves; dampers; relays

Control systems: refrigeration systems; ventilation systems; multi-zone A/C systems; variable air volume A/C systems; face and by-pass system; economiser system; chilled water systems; hot water systems

Refrigeration/HVAC pneumatic controls.

Control fundamentals: electronic control terminology; definitions

Control basics: air supply; pilot bleed system; signal amplifier; sensing elements; relays and switches

Air supply system: air drying methods; pressure regulating valves; pressure reducing valves

System controllers: thermostats; sensors; actuators; dampers

System control configurations: sequence control; limit control; changeover control; compensated control; recycling control; pneumatic – electric control

Control systems: refrigeration systems; ventilation systems; multi-zone A/C systems; variable air volume A/C systems; face and by-pass system; Economiser system; chilled water systems; hot water systems

Specialisation: HVAC systems

Industrial air conditioning codes and regulations

Fire and smoke control: AS1668.1; pressurisation

Mechanical ventilation for acceptable indoor air quality: AS1668.2; AS3666

Noise measurement and control: AS1055; AS1359.51

Building code of Australia: section E2, smoke control; section F4, light and ventilation; section G2, heating appliances, fireplaces; chimneys and flues

Regulations under state government acts: workplace health and safety act – provisions relating to workplace health and safety, general duties of employers, manufacturers etc., provisions concerning projects, provisions relating work place amenities, state environment protection acts, air and water pollution control regulations, local government by-laws; noise control; water consumption, disposal

Emergency services requirements

HVAC air systems.

Air distribution principles: static and velocity pressures; measurements; terminology; laminar and turbulent fluid flows; system performance profiles

Air system design: method velocity reduction, equal friction, static regain, computer aided; selection of duct fitting and diffusion fittings

Fans: types; fan laws; fan curves; installation criteria; applied system curves

Ventilation, dust extraction: system configuration; Australian standards; AS – 1668 Part 1 and 2; componentry; system selection; building regulations

Air systems: dual and single duct constant volume; variable volume; induction units; multi-zone

Refrigeration system analysis.

Pressure enthalpy definitions: sensible heat; saturated liquid; latent heat; pressure/temperature relationship; saturated vapour; quantity of heat; power; enthalpy; entropy; isothermal expansion and compression; adiabatic process

Refrigeration Cycle: expansion process; vaporising process; compression process; condensing process; compression ratio

Enthalpy processes: coefficient of performance; effect of suction temperature on cycle efficiency; effect of condensing temperature on cycle efficiency

Actual refrigerating cycles: effects of superheating suction vapour; super heating without useful cooling; superheating that produces useful cooling; superheating in suction piping outside the refrigerated space; superheating the vapour inside the refrigerated space; effects of subcooling the liquid; liquid-suction heat exchangers; effects of pressure losses resulting from friction

Cooling plant maintenance procedures.

Cooling towers/evaporative condensers/humidifiers: types, applications; cleaning; decontamination

Condensate trays and drains: fall; cleaning

Water treatment: water tests. procedures; pH; micro-biological; suspended solids; corrosion; bleed; filtration; chemical treatment; cathodic protection

Air filters: types, applications; pressure drop; face velocity; cleaning, changing; fit

Maintenance programs: purpose; methods of establishing specific requirements; planning; manual and computer programs; log books

Personal safety, legal and regulatory requirements: risks to service personnel and public; safe practices; personal protective equipment; duty of care; regulation under workplace health and safety act; NH and MRC recommendations; AS3666

Applied psychrometrics.

Fundamentals and terms: sensible lie at factor - conditioned space, grand total; quantity of air; effective surface temperature; bypass factor

Coil characteristics: processes - sensible cooling, cooling, dehumidification, sensible heating

Spray processes: saturation efficiency; processes - adiabatic/evaporative cooling, cooling and humidification, sensible cooling, cooling and/or humidification

System analysis: partial load; reheat control; bypass control; volume control

Specialisation: Refrigeration systems

Industrial air conditioning codes and regulations.

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Emergency services requirements

Refrigeration system analysis.

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Refrigeration and food storage technology.

Food spoilage and possible causes: physical damage; animal activity; chemical breakdown; enzyme activity; micro-organisms; effects of temperature change; effects of humidity change; effects of freezing on fresh produce; effects of slow freezing time; effects of refreezing

Food preservation: removing or taking out a reactant; removing or inactivating the catalyst; reducing temperature; changing the reaction system

Micro-organisms: conditions for growth; potentially hazardous foods; cross contamination

Identification of food spoilage: recognition and suggest possible cause; physical damage;

Animal activity; chemical breakdown; enzyme activity; micro-organisms

Types of heat processing techniques: heat processing using steam and water; blanching; pasteurisation; sterilisation; evaporation; heat processing using hot air; dehydration; baking and roasting

Types of chilling processing techniques: chilling and controlled atmosphere storage; freezing; freeze drying and freeze concentration

Heat load estimating (commercial refrigeration).

Heat transfer: factors effecting heat transfer; insulation material characteristics; vapour barriers(seals); ambient conditions; composite walls - heat flows; types of common insulation; thermal conductivity; film factors

Air change load: room volumes; room usage - average, medium, heavy; heat removed from cooling air to; refrigerated conditions; air curtains; temperature differences; door opening sizes

Product load: sensible heat; latent heat; heat of respiration; storage temperatures; unit running times; humidity; air flows; stacking of products

Miscellaneous loads: electrical; human; defrost; machinery

Total freezer/cool room loads: wall load; air change load; product load; miscellaneous; total load, safety factor and unit running times

Computer programs

Cabinet construction and design: deep freeze case; meat case; dairy case; fruit and vegetable case; drink cabinets

Commercial refrigeration system design.

Calculation of capacity in heat exchangers: Q=UATd; Q=mc⊗t; Q=m⊗h

Evaporators: commercial types and applications; coil bypass factor; effects of evaporator TD on space humidity; effects of air circulation on product conditions; selection criteria and selection tables

Condensers: commercial types and applications; effects of ambient conditions; condenser control; heat reject factor; condenser TD; selection criteria and selection tables

Compressors: types and applications; capacity – displacement, volume rate flow, mass flow rate, theoretical capacity, total volumetric efficiency, effect of operating conditions, including suction pressure drop and superheating, actual capacity; power – theoretical requirement, effect of operating conditions, actual requirements, post defrost loads, pull down torque requirements, high, medium and low back pressure compressors; selection tables; motor selection

Liquid expansion devices: types, operation and applications; effects from subcooling; distributor types, operation and applications

Selection tables

System load balance point: graphical representation

Line sizing and design: velocity tables; pressure drop in lines and fittings; oil migration stabilisation; refrigerant velocity; effect of varying system capacity; oil traps; risers; double risers; liquid migration; design for parallel components and multiplex systems

Commercial refrigeration system types: medium and low temperature applications; operating conditions; system operating and service requirements; refrigerant types; components; multiple evaporator systems; multiple temperature systems; multiple compressor (rack) systems; two stage compressors; multiplex systems; defrost requirements and methods; electric defrost systems; hot gas defrost systems; cool gas defrost systems

Manufacturer's data: rating tables; selection tables; catalogues

Operating characteristics: effects of temperature glide with blended; refrigerants; Ph charts; refrigerating effect; heat of compression; heat rejected on high side of the system; required mass flow rate of refrigerant; volume flow rate at various points in system; theoretical compressor power; required condenser capacity

Review automatic controls: refrigerant regulating valves; solenoid valves; expansion valves; pressure regulating valves; cycling controls; pressure-stats; thermostats; defrost controls; monitoring and alarm controls; energy management systems; refrigeration automation systems; control strategies; control modes

UTE NES208 (Z to A qualifier) B
Disconnect & reconnect fixed wired electrical equipment 1,000 Vac/1,500 Vdc

Descriptor: Disconnect and reconnect *fixed wired electrical equipment* which is incidental and related to a principle work function.

Alignment: This unit is based on the National Electrotechnology Benchmark Standard EBS 701 Apply occupational health and safety requirements associated with restricted electrical work and EBS 702 – Disconnect and reconnect fixed wired electrical equipment which is connected to a supply up to 650 volts.

Specific unit outcomes

This is presented as a composite unit that has five specific units as outcomes. There are five distinct *endorsable* outcomes in which competence can be achieved. This is done because of the high degree of commonality in knowledge, process or function. Reporting the unit with the inclusion of an *endorsement* allows for the formal identification of 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 outcomes are:

UTE NES 208N B	Disconnect and reconnect *fixed wired electrical equipment* 1,000 Vac/1,500 Vdc *(Pre-assembled Neon Signs)*
UTE NES 208P B	Disconnect and reconnect *fixed wired electrical equipment* 1,000 Vac/1,500 Vdc *(Composite equipment)*
UTE NES 208Q B	Disconnect and reconnect *fixed wired electrical equipment* 1,000 Vac/1,500 Vdc *(Control Devices)*
UTE NES 208R B	Disconnect and reconnect *fixed wired electrical equipment* 1,000 Vac/1,500 Vdc *(Electrical Heaters)*
UTE NES 208S B	Disconnect and reconnect *fixed wired electrical equipment* 1,000 Vac/1,500 Vdc *(Motors)*

Elements		Performance criteria	
208.1	Prepare to disconnect *electrical equipment*	208.1.1	Disconnection is planned to ensure *OH&S policies and procedures* are followed
		208.1.2	*Appropriate personnel* are consulted to ensure work is co-ordinated effectively with others involved in the work site
		208.1.3	*Electrical characteristics* of *electrical equipment* and electrical supply are determined and recorded in accordance with *established procedures*
		208.1.4	The point of isolation of *electrical equipment* to be disconnected is determined

Elements		Performance criteria	
		208.1.5	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
208.2	Disconnect *electrical equipment*	208.2.1.	*OH&S policies and procedures* are followed
		208.2.2	*Electrical equipment* is isolated in accordance with AS/NZS 4836:2001 and established procedures. (see range statement)
		208.2.3	Conductor connection sequence is recorded and labelled in accordance with *established procedures*
		208.2.4	*Electrical equipment* is disconnected from fixed wiring without damage to other components
		208.2.5	Disconnected conductors/cables are terminated in accordance with *requirements* to ensure they are safe and present no potential hazard
208.3	Prepare to reconnect *electrical equipment*	208.3.1	Reconnection is planned to ensure *OH&S policies and procedures* are followed
		208.3.2	*Appropriate personnel* are consulted to ensure work is co-ordinated effectively with others involved in the work site
		208.3.3	The point of isolation of the circuit to which the *electrical equipment* is to be connected is determined
		208.3.4	Replacement *electrical equipment* is selected on the basis of rating and characteristics being the same as that of the original *electrical equipment*
		208.3.5	*Appropriate personnel* are consulted in the event that appropriate replacement *electrical equipment* is not available
		208.3.6	Original and/or replacement *electrical equipment* is tested to ensure it is safe to connect to the electrical supply and use

Elements		Performance criteria	
		208.3.7	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
208.4	Reconnect *electrical equipment*	208.4.1	*OH&S policies and procedures* are followed
		208.4.2	Measure are taken to ensure circuit to which *electrical equipment* is to be connected remains isolated in accordance with AS/NZS 4836:2001.
		208.4.3	The continuity of protective earthing conductor is tested to determine whether it is sufficiently low.
		208.4.4	The resistance between the protective earthing conductor and the neutral conductor is tested to determine whether it is sufficiently.
		208.4.5	The insulation resistance of active conductors is tested to confirm that it is greater than 1M Ω.
		208.4.6	An appropriate qualified person is engaged to rectify any non-compliance condition revealed by the testing under item 208.4.3 to 208.4.5.
		208.4.7	Continuity between exposed conductive parts of the *electrical equipment* and the main earth or metal switchboard enclosure is confirmed.
		208.4.8	*Electrical equipment* is connected to comply with *requirements*.
		208.4.9	Connections to the *electrical equipment* are checked to confirm they are correct.
208.5	Test the reconnected *electrical equipment* for safe operation	208.5.1	*OH&S policies and procedures, and established procedures* for the reinstatement of isolated circuits and *electrical equipment* are followed
		208.5.2	Arrangements are made with *appropriate personnel* to test the operation of the *electrical equipment*
		208.5.3	Operational non-conformances are identified and reported in accordance with *established procedures*

Elements		Performance criteria	
208.6	Provide status report(s)	208.6.1	Status 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.

Additional definitions

Electrical characteristics – refers to voltage, current rating, power rating, direction of rotation, phase sequence/polarity, name plates information and duty.

Electrical equipment – refers to the following items:

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

(P) **Composite equipment** –refers to an item of composite equipment incorporating one or more current-using devices and/or controls. Some examples are a self-contained refrigeration unit, a machine tool, a self-contained telephone booth, medical equipment.

(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 independent single or three phase motors or those incorporated as part of plant or machinery. For example, motors driving such things as pumps, conveyors, and other similar parts of plant and machinery.

Endorsement –

Endorsement is the formal method of verifying the item(s) of *electrical equipment* so defined, competency has been demonstrated on. Competency can be achieved on any one, more than one or all of the items of *electrical equipment*. Formal endorsement for each is to be provided separately as prescribed in the Evidence Guide.

(N) Pre-assembled neon signs

(P) Composite equipment

(Q) Control devices

(R) Electrical heaters

(S) Motors

Fixed wiring – a system in which cables are fixed or supported in position in accordance with the requirements determined by Australian/New Zealand

Standards for wiring. This also includes catenary, open and underground wiring systems.

Accessory - any device such as a switch, fuse, plug, socket-outlet, lampholder, fitting, adaptor or ceiling rose which is associated with wiring, luminaries, switchboards or appliances.

Scope of work

This unit describes competency within the scope of:

- the relevant item of *electrical equipment* so defined.
- isolating *electrical equipment* for safe disconnection/reconnection.
- disconnecting/reconnecting *electrical equipment.*
- replacement of *electrical equipment* like for like.
- *electrical equipment* connected to fixed wired supply up to 1,000 volts a.c. or 1,500 d.c.

Conditions and limitations specified

This unit is not intended to cover the knowledge and skills necessary for work:

- competencies associated with high current faults.
- complex electrical work.
- associated with fixed wiring other than to disconnect and reconnect respective *electrical equipment* listed in the Range Statement.
- In hazardous areas or on *electrical equipment* that is part of an explosion protection technique.
- work on luminaires.

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.

Safe Working

Safe procedures for working within in the scope of this unit shall be in accordance with AS/NZS 4836:2001 “Safe working on low-voltage electrical installations or equivalent.”

Evidence guide

Critical aspects of evidence

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 across a representative range of specified electrical equipment in the scope of work and for which endorsement of competency for the specified electrical equipment is being sought; autonomously and to requirements. To requirements means meeting all relevant safe working practices, manufacturers specifications, codes of practice, statutory and regulatory requirements, Standards both Australian and International and OH&S Standards.

- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace for the endorsement sought and scope of work in the Range Statement.
- demonstrating an understanding of the underpinning knowledge and skills identified for the scope of work undertaken in the section of this unit titled Underpinning knowledge.

Competency shall be demonstrated in relation to the endorsement for which competency is sought. The following critical aspects of competency shall be demonstrated:

- Preparation to disconnect electrical equipment;
- Disconnecting of electrical equipment;
- Preparation to reconnect electrical equipment;
- Reconnection of electrical equipment; and
- Testing of the reconnected electrical equipment for safe operation.

Reporting requirement – endorsement(s)

The formal transcript – Statement of Attainment for each type of *electrical equipment* in which competency is attributed with respective endorsement is to be provided.

Maintaining competence

Where the competencies described in this unit are not frequently practiced consideration should be given to periodic assessment of the competencies and retraining.

Context of assessment

In judging work performance it is essential that evidence regarding the following aspects of competency is considered.

- Performance is autonomous and to requirements and occurs **on at least 2 occasions for each of the following elements:**
- Prepare to disconnect electrical equipment
- Disconnect electrical equipment
- Prepare to reconnect electrical equipment
- Test the reconnected electrical equipment for safe operation
- Provide status reports
- and the following aspects be demonstrated:
- OH&S practice

- Determining electrical characteristics of equipment
- Identifying point of installation
- Isolating equipment
- Disconnection techniques
- Selecting replacement equipment
- Reconnection techniques
- Testing to ensure safety, including earth continuity and insulation integrity

- Applying techniques, procedures, information and resources relevant to performance.

Judgement should be made on evidence gathered from a number of events and over a period showing the development of competent work performance.

Interdependent assessment of units

Competency development and assessment in this unit should be determined only after competency has been demonstrated in:

- a field of work to which the electrical work covered by this unit, is incidental; and
- the field referred to above includes a broad application of skills and knowledge related to occupational health and safety and, in the selection, knowledge and use of general hand and power tools.

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 would ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments within the scope for which competency is being sought.

This section includes that set of knowledge and skills additional to that specified in each pre-requisite unit see point 3 above 'Interdependent assessment of units'.

Safe electrical work practices and procedures according to standards such as AS/NZ 4836:2001 or equivalent

Safe use of tools and plant

Safe use of ladders and elevated work platforms

Safe use of protective clothing

Hazards in the (electrical) work environment: shock hazards; fire hazards; chemical hazards

Hazardous areas

Special situations

Procedures for dealing with fires associated with electrical equipment

Procedures for dealing with PCBs

Electric shock victim rescue methods and procedures: basic first aid treatment for shock, burns and bleeding; Expired air resuscitation (EAR) (purpose of each procedure and application); external cardiac-compression (ECC) (purpose of each procedure and application); cardio-pulmonary resuscitation (CPR) (combined application of EAR and ECC) (purpose of each procedure and application)

Basic electrical circuit(s): source; control; protection; load

Circuit diagrams: symbols; conventions; interpretations; free sketches

Circuit connections and functions: open circuit; closed circuit; short circuit

Basic electrical measurement: use of multimeters; use of ammeter; use of voltage measuring and indicating devices; testing of measuring instruments; care of measuring instruments; voltage, current and resistance measurement; estimating values of voltage, current and resistance; using ohms law

Fundamental electrical concepts: effects of current; practical resistors; sources of emf; simple practical circuit; series, parallel and series-parallel circuits; electrical measurement; capacitors; inductors; magnetism

Insulation resistance measurement and requirements

Earthing principles and systems

Methods for testing insulation resistance; continuity of prospective earthing conductor; continuity between exposed conductive parts and the earthing system

Acceptable test results for compliance with safety requirements; test results, which are not compliant and require an appropriate qualified person to further investigation

Cable types and conductor termination methods and techniques: conductors solid, stranded and flexible; colour codes

Single and three phase systems and loads: number of active and live conductors required; line and phase voltage; typical loads

General appliances: appliance identification; appliance ratings

Single phase induction motors: motor identification; motor ratings; direction of rotation

Three phase induction motors: motor identification; motor ratings; direction of rotation

Single and three phase heaters: types of heaters; heater identification; heater ratings

Electrical distribution arrangement: power systems; within a premises; purpose of switchboards/distribution boards (residual current devices and ELCBs)

Circuit isolation and protection devices

Isolation procedures: work clearance; testing for voltage; lock-off and tagging; techniques, regulation, codes of practice and procedures

Disconnection procedures, practices and requirements

Replacement equipment

Ensuring equipment is safe to connect to supply

Reconnection procedures, practices and requirements

Return equipment to service

UTE NES209 B
Attach flexible cords & plugs to electrical equipment to 250 volt supply

Descriptor: Attach flexible cords and plugs to *electrical equipment* connected to supplie**s** up to 250 volt incidental to a principle function in the workplace.

Alignment: This unit is based on the National Electrotechnology Benchmark Standard EBS 705 Attach flexible cords and plugs to equipment connected to a single phase 250 volt supply.

Elements		Performance criteria	
209.1	Plan and prepare to attach flexible cord(s) and plug(s)	209.1.1	Work is planned and prepared to ensure *OH&S policies and procedures* are followed, and the work is appropriately sequenced in accordance with *requirements*
		209.1.2	*Condition and ratings* under which the flexible cord and plug is to operate is determined from *requirements* and in consultation with *appropriate personnel* followed by written instruction
		209.1.3	Flexible cord and plugs are selected to comply with standards and *requirements* for the *condition* and *rating* to be determined
		209.1.4	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		209.1.5	T*ools, equipment and testing devices* needed to carry out the work are obtained in accordance with *established procedures* and checked for correct operation and safety
		209.1.6	Flexible cord is prepared without damage to insulation and conductors and in accordance with *requirements*
209.2	Attach flexible cord(s) and plug(s)	209.2.1	*OH&S policies and procedures* are followed
		209.2.2	Single insulated metal framed equipment is earthed in accordance with *requirements*
		209.2.3	The integrity of double insulated equipment is maintained in accordance with *requirements*

Elements		Performance criteria	
		209.2.4	Conductors are connected to terminals in accordance with *requirements* to ensure the required polarity is effected
209.3	Test equipment for operation and safety	209.3.1	Appropriate tests of the cord(s) and plug(s) connected to the *electrical equipment* are conducted in accordance with *requirements* and to *established procedures* to ensure safe installation and operation
209.4	Provide status report(s)	209.4.1	Status 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.

Additional definitions

Conditions – environmental and other influences that could have a detrimental affect on electrical equipment, for instance high ambient temperatures, corrosives atmospheres, vibration, and the like.

Ratings – The current carrying capacity and operating voltage limitations of the cord and/or plug

Flexible cord – as defined by Standards.

Configured (plug) – Pin arrangement and shape of an electrical plug and socket.

Scope of work

This unit describes competency within the scope of:

- the relevant item of *electrical equipment* so defined
- removing cords and plugs connected to *electrical equipment* from the supply
- selecting cords and appropriately *configured plugs* suitable for the *condition* under which they are to operate
- selecting cords and plugs rated for the equipment they are to supply
- fitting and connecting cords and plugs to *electrical equipment* intended to operate from single phase supplies up to 250V a.c.
- testing cord and plug assemblies for integrity, electrical continuity and correct polarity

the relevant work being carried out in *non-hazardous areas* and on *electrical equipment* that is not part of an explosion protection technique.

Conditions specified

This unit is not intended to cover:

- competencies associated with high current faults.
- complex electrical work.
- nor competencies associated with fixed wiring
- work on luminaires.

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 across a *representative range* of specified *electrical equipment* in the scope of work and for which *endorsement* of competency for the specified *electrical equipment* is being sought; autonomously and to requirements. To requirements means meeting all relevant safe working practices, manufacturers specifications, codes of practice, statutory and regulatory requirements, Standards both Australian and International and OH&S Standards.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace for the *endorsement* sought and scope of work in the Range Statement.
- demonstrating an understanding of the underpinning knowledge and skills identified for the scope of work 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 specified *electrical equipment* for the *endorsement* and scope of work for which competency is being sought; autonomously and to requirements. Equivalent evidence from other sources, e.g., formal assessment, is also acceptable. Although it is preferred that assessing competency be carried out in the workplace it can be undertaken in a simulated work environment approved for that purpose by the industry.

Interdependent assessment of units

Competency in this unit should be determined only after competency has been achieved in:

- a relevant field to which the electrical work is incidental, this is expected to include a broad application of skills and knowledge related to occupational health and in the selection, knowledge and use of general hand tools and power tools.
- additional competencies will be required where conditions in the workplace are such that specific precaution and techniques must be used to ensure safety. For example, situations where high fault currents are possible; hazardous areas where explosion-protection techniques must be used; damp situations and the like.

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 would ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments within the scope for which competency is being sought.

This section includes that set of knowledge and skills additional to that specified in each pre-requisite unit, see point 3 above ‘Interdependent assessment of units’.

Unsafe (electrical) work practices

Safe use of tools and plant

Safe use of ladders and elevated work platforms

Safe use of protective clothing

Hazards in the (electrical) work environment: shock hazards; fire hazards; chemical hazards

Procedures for dealing with fires associated with electrical equipment

Procedures for dealing with PCBs

Electric shock victim rescue methods and procedures: basic first aid treatment for shock, burns and bleeding; Expired air resuscitation (EAR) (purpose of each procedure and application); external cardiac-compression (ECC) (purpose of each procedure and application); cardio-pulmonary resuscitation (CPR) (combined application of EAR and ECC) (purpose of each procedure and application)

Fundamental electrical concepts: current; voltage; resistance

Insulation resistance measurement and requirements

Cable types and conductor termination methods and techniques: colour codes; cable ratings

250V Flexible cords for use with single phase appliances/apparatus: types and loading; service duty

250V Plugs for use with single phase applications/apparatus: types and loading; IP rating

Continuity testing

Connection requirements and techniques

Isolation procedures: work clearance; testing for voltage; lock-off and tagging; techniques, regulation, codes of practice and procedures

Safety testing

Conditions

Ratings

UTE NES210 B
Attach flexible cables & plugs to electrical equipment to 1,000 Vac/1,500 Vdc

Descriptor: Attach flexible cables and plugs to *electrical equipment* connected to a supply up to 1,000 volts a.c. or 1,500 volts d.c. incidental to a principle function in the workplace.

Alignment: This unit is based on the National Electrotechnology Benchmark Standard EBS 706 Attached flexible cable and plug to equipment connected to supply up to 650 volts.

Elements		**Performance criteria**	
210.1	Plan and prepare to attach flexible cable(s) and plug(s)	210.1.1	Work is planned and prepared to ensure *OH&S policies and procedures* are followed, and the work is appropriately sequenced in accordance with *requirements*
		210.1.2	*Condition and ratings* under which the flexible cable(s) and plug(s) is to operate is determined from *requirements* and in consultation with *appropriate personnel* followed by written instruction
		210.1.3	Flexible cable(s) and plug(s) are selected to comply with standards and *requirements* for the *condition* and *rating* to be determined
		210.1.4	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		210.1.5	T*ools, equipment and testing devices* needed to carry out the work are obtained in accordance with *established procedures* and checked for correct operation and safety
		210.1.6	Flexible cable(s) is prepared without damage to insulation and conductors and in accordance with *requirements*
210.2	Attach flexible cable(s) and plug(s)	210.2.1	*OH&S policies* and *procedures* are followed
		210.2.2	Single insulated metal framed equipment is earthed in accordance with *requirements*
		210.2.3	The integrity of double insulated equipment is maintained in accordance with *requirements*

Elements		Performance criteria	
		210.2.4	Conductors are connected to terminals in accordance with *requirements* to ensure the required polarity is effected
210.3	Test equipment for operation and safety	210.3.1	Appropriate tests of the cables(s) and plug(s) connected to the *electrical equipment* are conducted in accordance with *requirements* and to *established procedures* to ensure safe installation and operation
210.4	Provide status report(s)	210.4.1	Status 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.

Additional definitions

Conditions – environmental and other influences that could have a detrimental affect on electrical equipment, for instance high ambient temperatures, corrosives atmospheres, vibration, and the like.

Ratings – The current carrying capacity and operating voltage limitations of the cord and/or plug

Flexible cable – as defined by Standards.

Configured (plug) – Pin arrangement and shape of an electrical plug and socket.

Scope of work

This unit describes competency within the scope of:

- the relevant item of *electrical equipment* so defined
- removing cables and plugs connected to *electrical equipment* from the supply
- selecting cables and appropriately *configured plugs* suitable for the *condition* under which they are to operate
- selecting cables and plugs rated for the equipment they are to supply
- fitting and connecting cables and plugs to *electrical equipment* intended to operate from single phase supplies up to 1,000volts a.c or 1,500volts d.c.
- testing cables and plug assemblies for integrity, electrical continuity and correct polarity

the relevant work being carried out in *non-hazardous areas* and on *electrical equipment* that is not part of an explosion protection technique.

Conditions specified

This unit is not intended to cover:

- competencies associated with high current faults
- complex electrical work
- nor competencies associated with fixed wiring
- work on luminaires
- modular wiring systems

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 across a *representative range* of specified *electrical equipment* in the scope of work and for which *endorsement* of competency for the specified *electrical equipment* is being sought; autonomously and to requirements. To requirements means meeting all relevant safe working practices, manufacturers specifications, codes of practice, statutory and regulatory requirements, Standards both Australian and International and OH&S Standards.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace for the *endorsement* sought and scope of work in the Range Statement.
- demonstrating an understanding of the underpinning knowledge and skills identified for the scope of work 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 specified *electrical equipment* for the *endorsement* and scope of work for which competency is being sought; autonomously and to requirements. Equivalent evidence from other sources, e.g., formal assessment, is also acceptable. Although it is preferred that assessing competency be carried out in the workplace it can be undertaken in a simulated work environment approved for that purpose by the industry.

Interdependent assessment of units

Competency in this unit should be determined only after competency has been achieved in:

- a relevant field to which the electrical work is incidental, this is expected to include a broad application of skills and knowledge related to occupational health and in the selection, knowledge and use of general hand tools and power tools.
- additional competencies will be required where conditions in the workplace are such that specific precaution and techniques must be used to ensure safety. For example, situations where high fault currents are possible; hazardous areas where explosion-protection techniques must be used; damp situations and the like.

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 would ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments within the scope for which competency is being sought.

This section includes that set of knowledge and skills additional to that specified in each pre-requisite unit, see point 3 above 'Interdependent assessment of units'.

Unsafe (electrical) work practices

Safe use of tools and plant

Safe use of ladders and elevated work platforms

Safe use of protective clothing

Hazards in the (electrical) work environment: shock hazards; fire hazards; chemical hazards

Procedures for dealing with fires associated with electrical equipment

Procedures for dealing with PCBs

Electric shock victim rescue methods and procedures: basic first aid treatment for shock, burns and bleeding; Expired air resuscitation (EAR) (purpose of each procedure and application); external cardiac-compression (ECC) (purpose of each procedure and application); cardio-pulmonary resuscitation (CPR) (combined application of EAR and ECC) (purpose of each procedure and application)

Fundamental electrical concepts: current; voltage; resistance

Circuit isolation and protection devices

Isolation procedures: work clearance; testing for voltage; lock-off and tagging; techniques, regulation, codes of practice and procedures

Up to 1,000Volts A.C./1,500Volts D.C. appliance/electrical equipment applications: basic principles of appliance/electrical equipment (non mathematical); appliance/electrical equipment identification; appliance/electrical equipment ratings; basic principles of operation of control equipment and protection devices; fault conditions and symptoms; test equipment; safe testing procedure, including continuity; fault types in appliances/electrical equipment; fault-finding procedures (prescriptive)

Circuit connections and functions: open circuit; closed circuit; short circuit

Basic voltage, current and resistance measurement and calculation

Insulation resistance measurement and requirements

Cable types and conductor termination methods and techniques: colour codes; cable ratings

Up to 1,000Volts A.C. 1,500Volts D.C. flexible cords/cables for use with single phase appliances/apparatus: types and loading; service duty

Up to 1,000Volts A.C. 1,500Volts D.C. plugs for use with single phase applications/apparatus: types and loading; IP rating

Continuity testing

Connection requirements and techniques

Safety testing

Continuity

Ratings

UTE NES211 A
Disconnect & reconnect explosion-protected electrical equip. connected fixed wired 1,000Vac/1,500Vdc

Descriptor: Isolate, disconnect and reconnect flame proof, increased safety and intrinsic safety *electrical equipment* to supply up to 1,000 volts A.C. or 1,500 volts D.C. under restrictions of *designated electrical equipment* and *conditions specified.*

Alignment: This unit is based on the National Electrotechnology Benchmark Standard EBS 707 Disconnect and reconnect explosion protected equipment connected to supplies.

Elements		Performance criteria	
211.1	Prepare for disconnection or reconnection	211.1.1	*Electrical equipment* to be disconnected or reconnected is identified and purpose of the work to be carried out is verified with the *authorised personnel*
		211.1.2	*OH&S policies and procedures* and other statutory *requirements* and *established procedures* are followed
		211.1.3	*Work clearances* are obtained, isolation procedures followed and *electrical equipment* removed to a safe area
211.2	Disconnect *electrical equipment*	211.2.1	Electrical characteristics and explosion protection specifications are identified
		211.2.2	*Electrical equipment* is dismantled to the extent necessary for disconnection and without unnecessary damage
		211.2.3	*Electrical equipment* components are stored appropriately to protect them against damage
		211.2.4	*Cables* are identified and marked and connection sequence recorded
		211.2.5	*Cables* are disconnected without unnecessary damage to terminals or components
		211.2.6	*Electrical equipment* is inspected for damage to the explosion protection components and conclusions verified with *authorised personnel*
		211.2.7	Any repairs required to explosion protection are carried out in accordance with *established procedures* and *requirements*

Elements		Performance criteria	
211.3	Reconnect *electrical equipment*	211.3.1	*Cables* are connected without damage to terminals or components
		211.3.2	Connections are checked and tested to confirm correct polarity and continuity
		211.3.3	*Electrical equipment* is assembled to comply with the relevant *Standards* for the given explosion protection technique
		211.3.4	*Electrical equipment* is tested for safety and correct operation
211.4	Prepare *electrical equipment* for service	211.4.1	Isolation devices are removed and work clearance is released in accordance with *established procedures*
		211.4.2	Documentation is completed in accordance with *established procedures*
		211.4.3	Operational personnel are notified when *electrical equipment* is ready for service 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.

Additional definitions

Designated electrical equipment – is *electrical equipment* so designated to operate in *hazardous areas*, and includes the designated *explosion-protection technique* applicable to such equipment.

Fixed wiring – a system in which cables are fixed or supported in position in accordance with the requirements determined by Australian/New Zealand Standards for wiring. This also includes catenary, open and underground wiring systems.

Accessory - any device such as a switch, fuse, plug, socket-outlet, lampholder, fitting, adaptor or ceiling rose which is associated with wiring, luminaries, switchboards or appliances.

Scope of work

This unit describes competency within the scope of:

- Isolating, disconnecting and reconnecting existing flame proof, increased safety and intrinsic safety *electrical equipment* to supplies up to 1,000 volts a.c. or 1,500 volts d.c. under restrictions of *designated electrical equipment* and *conditions specified*.

- The *electrical equipment* having been isolated.

Conditions specified

This unit is not intended to cover:

- competencies associated with high current faults;
- complex electrical work;
- nor competencies associated with fixed wiring or installation of fixed wiring and related equipment/apparatus (other than to disconnect and reconnect *electrical equipment*).

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 across a *representative range* of specified *electrical equipment* in the scope of work and for which *endorsement* of competency for the specified *electrical equipment* is being sought; autonomously and to requirements. To requirements means meeting all relevant safe working practices, manufacturers specifications, codes of practice, statutory and regulatory requirements, Standards both Australian and International and OH&S Standards.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace for the *endorsement* sought and scope of work in the Range Statement.
- demonstrating an understanding of the underpinning knowledge and skills identified for the scope of work 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 specified *electrical equipment* for the *endorsement* and scope of work for which competency is being sought; autonomously and to requirements. Equivalent evidence from other sources, e.g., formal assessment, is also acceptable. Although it is preferred that assessing competency be carried out in the workplace it can be undertaken in a simulated work environment approved for that purpose by the industry.

Interdependent assessment of units

Competency in this unit should be determined only after competency has been achieved in:

- the relevant field to which restricted electrical work is incidental, this is expected to include competencies related to occupational health and in the selection, knowledge and use of general hand tools at AQF Certificate III level.
- Additional competencies will be required where conditions in the workplace are such that specific precaution and techniques must be used to ensure safety. For example, situations where high fault currents are possible; hazardous areas where explosion-protection techniques must be used; damp situations and the like.

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 would ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments within the scope for which competency is being sought.

This section includes that set of knowledge and skills additional to that specified in each pre-requisite unit, see point 3 above ‘Interdependent assessment of units’.

Unsafe (electrical) work practices

Safe use of tools and plant

Safe use of ladders and elevated work platforms

Safe use of protective clothing

Hazards in the (electrical) work environment: shock hazards; fire hazards; chemical hazards

Hazardous areas classification standards and requirements

Procedures for dealing with fires associated with electrical equipment

Procedures for dealing with PCBs

Electric shock victim rescue methods and procedures: basic first aid treatment for shock, burns and bleeding; Expired air resuscitation (EAR) (purpose of each procedure and application); external cardiac-compression (ECC) (purpose of each procedure and application); cardio-pulmonary resuscitation (CPR) (combined application of EAR and ECC) (purpose of each procedure and application)

Basic electrical circuit(s): source; control; protection; load

Circuit diagrams: symbols; conventions; interpretations; free sketches

Circuit connections and functions: open circuit; closed circuit; short circuit

Basic electrical measurement: use of multimeters; use of ammeter; use of voltage measuring and indicating devices; testing of measuring instruments; care of measuring instruments; voltage, current and resistance measurement; estimating values of voltage, current and resistance

Fundamental electrical concepts: effects of current; practical resistors; sources of emf; simple practical circuit; series, parallel and series-parallel circuits; electrical measurement; capacitors; inductors; magnetism

Insulation resistance measurement and requirements

Earthing principles and systems

Cable types and conductor termination methods and techniques

Single and three phase systems and loads: number of active and live conductors required; line and phase voltage; typical loads

Electrical distribution arrangement: power systems; within a premises; purpose of switchboards/distribution boards

Motors: basic principles of operation (non mathematical); motor identification; motor ratings; fault conditions and symptoms; test equipment; fault types in “phase splitting” and universal type motors

Circuit isolation and protection devices

Isolation procedures: work clearance; testing for voltage; lock-off and tagging; techniques, regulations, codes of practice and procedures

Disconnection practices and requirements

Replacement equipment

Ensuring equipment is safe to connect to supply

Reconnection practices and requirements

Return equipment to service.

Explosion protection: methods and techniques; flameproof (EX d) enclosures; increased safety (EX e) terminals; actions that void explosion protection; intrinsic safety basics (EX i); cables and cable glands; cable termination methods; application of relevant standards; selection of approved test equipment and use

UTE NES212 A
Disconnect & re-connect HV electric propulsion components on engine driven, earth moving vehicles t 3.3kv

Descriptor: Isolate, disconnect and reconnect HV Electric Propulsion Components on Engine Driven, Self-Propelled Earth Moving Vehicles under the restrictions of *designated electrical equipment* and *conditions specified*, operating at 3,300 volts.

Alignment: This unit is based on the National Electrotechnology Benchmark Standard EBS 708 Disconnection and re-connection of HV Electric Propulsion Components on Engine Driven, Self-Propelled Earth Moving Vehicles, operating at 3,300 volts.

Elements		**Performance criteria**	
212.1	Prepare for disconnection or reconnection	212.1.1	*Designated electrical equipment* to be replaced is identified and purpose of the work to be carried out is verified with the *authorised personnel*
		212.1.2	*OH&S policies and procedures* and other statutory *requirements* and *established procedures* are followed
		212.1.3	*Work clearances* are obtained, isolation and disconnection *procedures* are followed in accordance with *established procedures*
212.2	Disconnect *designated electrical equipment*	212.2.1	Relevant electrical characteristics and protection specifications are identified
		212.2.2	Where appropriate on –board *cables* are identified and marked and connection sequence recorded
		212.2.3	*Designated electrical equipment* is inspected for damage to components, and conclusions verified with *authorised personnel*
		212.2.4	On –board *cables* are, where appropriate, disconnected without unnecessary damage to terminals or components
		212.2.5	*Designated electrical equipment* is dismantled, removed and/or replaced in accordance with *requirements* to the extent necessary for disconnection, and without unnecessary damage

Elements		Performance criteria	
		212.2.6	*Designated electrical equipment* parts and/or associated components are stored appropriately to protect them against damage
		212.2.7	Repairs, where appropriate, to the removed equipment are carried out in accordance with *requirements* and *established procedures*
212.3	Reconnect *designated electrical equipment*	212.3.1	*Cables*, where appropriate, are re-connected without damage to terminals or components
		212.3.2	Connections are checked and tested to confirm correct polarity and continuity
		212.3.3	*Designated electrical equipment* is assembled and checked to comply with the relevant *Standards* for the given technique
		212.3.4	*Designated electrical equipment* is tested for safety and correct operation
212.4	Prepare *designated electrical equipment* for return to service	212.4.1	Isolation devices are removed and work clearance is released in accordance with *established procedures*
		212.4.2	Documentation is completed in accordance with *established procedures*
		212.4.3	Operational personnel are notified when *designated electrical equipment* is ready for return to service 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.

Additional definitions

Designated Electrical equipment – refers to plant and equipment such as:

- Engine Driven, Self-Propelled Earth Moving Vehicles, operating at 3,300 volts,
- On board HV Electric propulsion components and control devices associated with such equipment.

Fixed wiring – a system in which cables are fixed or supported in position in accordance with the requirements determined by Australian/New Zealand Standards for wiring. This also includes catenary, open and underground wiring systems.

Conditions specified – refers to engine driven mobile plant used in generating electrical energy and referred to as *designated electrical equipment.*

Scope of work

This unit describes competency within the scope of:

- designated electrical equipment as defined.
- isolating *designated electrical equipment* for safe disconnection/reconnection.
- disconnecting/reconnecting designated electrical equipment.
- replacement of designated electrical equipment like for like.
- the relevant work being carried out under the restrictions of *designated electrical equipment* and *conditions specified,* operating at 3,300 volts.
- the relevant work being carried out in *non-hazardous areas* and on *electrical equipment* and/or *designated electrical equipment* that is not part of an *explosion protection* technique.

Conditions specified

This unit is **not** intended to cover:

- competencies associated with high current faults.
- complex electrical work.
- nor competencies associated with *fixed wiring* (other than *designated electrical equipment*).

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 across a *representative range* of specified *designated electrical equipment* and/or *electrical equipment* in the scope of work for which competency is being sought; autonomously and to requirements. To requirements means meeting all relevant safe working practices, manufacturers specifications, codes of practice, statutory and regulatory requirements, Standards both Australian and International and OH&S Standards.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace for the scope of work in the Range Statement.
- demonstrating an understanding of the underpinning knowledge and skills identified for the scope of work 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 at *consistently performed* across a *representative range* of specified *designated electrical equipment* and/or *electrical equipment* in the scope of work for which competency is being sought; autonomously and to requirements. Equivalent evidence from other sources, e.g., formal assessment, is also acceptable. Although it is preferred that assessing competency be carried out in the workplace it can be undertaken in a simulated work environment approved for that purpose by the industry.

Interdependent assessment of units

Competency in this unit should be determined only after competency has been achieved in:

- the relevant field to which restricted electrical work is incidental, this is expected to include competencies related to occupational health and in the selection, knowledge and use of general hand tools and work on mining and construction self-propelled mobile plant and equipment at AQF Certificate III level.
- Additional competencies will be required where conditions in the workplace are such that specific precaution and techniques must be used to ensure safety. For example, situations where high fault currents are possible; complex electrical work is required, hazardous areas where explosion-protection techniques must be used; damp situations and the like.

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 would ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments within the scope for which competency is being sought.

This section includes that set of knowledge and skills additional to that specified in each pre-requisite unit, see point 3 above 'Interdependent assessment of units'.

Unsafe (electrical) work practices

Safe use of tools and plant

Safe use of ladders and elevated work platforms

Safe use of protective clothing

Hazards in the (electrical) work environment: shock hazards; fire hazards; chemical hazards

Procedures for dealing with fires associated with electrical equipment

Procedures for dealing with PCBs

Electric shock victim rescue methods and procedures: basic first aid treatment for shock, burns and bleeding; Expired air resuscitation (EAR) (purpose of each procedure and application); external cardiac-compression (ECC) (purpose of each procedure and application); cardio-pulmonary resuscitation (CPR) (combined application of EAR and ECC) (purpose of each procedure and application)

Basic electrical circuit(s): source; control; protection; load

Basic electronic theory and circuits

Extra-low voltage power logic control systems and associated circuitry

Basic “Boolean” logic abbreviations, symbols and equations

Circuit diagrams: symbols; conventions; interpretations; free sketches

Circuit connections and functions: open circuit; closed circuit; short circuit

Basic electrical and electronic measurement: use of multimeters and ammeters; portable test units and/or chart recorders; use of voltage measuring and indicating devices; testing of measuring instruments; care of measuring instruments; voltage, current and resistance measurement; estimating values of voltage, current and resistance

Fundamental electrical and electronic concepts: effects of current; practical resistors; sources of emf; series, parallel and series-parallel circuits; electrical measurement; capacitors; inductors; magnetism

Type, function of and inter-relationships, between relay, static and programmable control systems

Control system equipment such as panel, demand and feedback modules and cards

Conductor termination methods and techniques

System electrical loads: number of active and live conductors; line voltages; typical loads

Insulation resistance measurement and requirements

Disconnection practices and requirements

Replacement equipment

Circuit isolation and protection devices

Isolation procedures: work clearance; testing for voltage; lock-off and tagging; techniques, regulation, codes of practice and procedures

Reconnection practices and requirements

Ensuring safety to reconnect: isolation and clearance procedures for high voltage (HV)

HV circuit component diagram symbols

Insulation resistance measurement and requirements for HV circuits

HV cable types and conductor termination methods and techniques

Function and inter-dependence of electric propulsion components

Inter-relationships between electrical, mechanical, fluid and other mobile (self-propelled) plant and equipment systems

Ensuring HV *designated electrical equipment* is safe to connect to supply

Returning equipment to service

Motors: basic principles of operation (non mathematical); motor types; motor identification; motor ratings; motor starter principles; basic principles of operation of control equipment and protection devices; fault conditions and symptom; safe isolation procedures; safe testing procedure

UTE NES213 A
Attach flexible cables & plugs to electrical equipment connected to a high voltage supply

Descriptor: Attach flexible cable(s) and plugs, including trailing and feeder cables, to *high voltage electrical equipment* connected to a supply exceeding 1,000 volts A.C. or 1,500 volts D.C. incidental to a principle function in the workplace.

Alignment: This unit is based on the National Electrotechnology Benchmark Standard EBS 702 – Disconnect and reconnect fixed wired electrical equipment which is connected to a supply up to 650 volts.

Elements		Performance criteria	
213.1	Plan and prepare to attach flexible cable(s) and plug(s)	213.1.1	Work is planned and prepared to ensure *OH&S policies and procedures* are followed, and the work is appropriately sequenced in accordance with *requirements*
		213.2.1.	*Condition and ratings* under which the flexible cable(s) and plug(s) is to operate is determined from *requirements* and in consultation with *appropriate personnel* followed by written instruction
		213.2.2	Flexible cable(s) and plug(s) are selected to comply with standards and *requirements* for the *condition and rating* to be determined
		213.2.3	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		213.2.4	*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
		213.2.5	Flexible cable(s) is prepared without damage to insulation and conductors and in accordance with *requirements*
213.3	Attach flexible cable(s) and plug(s)	213.3.1	*OH&S policies and procedures* are followed
		213.3.2	Equipment is earthed in accordance with *requirements*
		213.3.3	The integrity of insulated equipment is maintained in accordance with *requirements*.

Elements		Performance criteria	
		213.3.4	Conductors are connected to terminals in accordance with *requirements* to ensure the required polarity is effected
213.4	Test equipment for operation and safety	213.4.1	Appropriate tests are conducted of the *electrical equipment high voltage* to ensure safe installation and operation
		213.4.2	Approval is obtained from *authorised personnel* to confirm completion of work is in accordance with *established procedures* before supply is connected
213.5	Provide status report(s)	213.5.1	Status 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.

Additional definitions

Electrical equipment high voltage – refers to:

- high voltage operating plant and equipment, e.g. draglines
- control devices associated with high voltage plant and equipment.
- a single controlled device contained in an enclosure and which is not part of a control panel or distribution board/switch board.

Fixed wiring – a system in which cables are fixed or supported in position in accordance with the requirements determined by Australian/New Zealand Standards for wiring. This also includes catenary, open and underground wiring systems.

Designated electrical equipment high voltage – is *electrical equipment high voltage* so designated to operate in *hazardous areas*, and includes the designated *explosion-protection technique* applicable to such equipment.

Accessory - any device such as a switch, fuse, plug, socket-outlet, lampholder, fitting, adaptor or ceiling rose which is associated with wiring, luminaries, switchboards or appliances.

Scope of work

This unit describes competency within the scope of:

- any electrical equipment high voltage so defined;
- isolating *electrical equipment high voltage* for safe disconnection/reconnection;
- attaching flexible cable(s) and plugs to and/or *electrical equipment high voltage* connected to high voltage supply;
- determining the *condition and rating* of the flexible cable(s) and plugs;
- attaching flexible cable(s) and plugs in *hazardous areas* including mining.
- attaching flexible cable(s) and plugs, including trailing and feeder cable(s), to *electrical equipment high voltage* connected to a supply exceeding 1,000 volts A.C. or 1,500 volts D.C. which is complimentary to a principle function in the workplace.
- isolating flexible cable(s) and plugs;
- *high voltage* environment.
- hazardous environment;

Conditions specified

This unit is **not** intended to cover:

- competencies associated with high current faults.
- complex electrical work.
- nor competencies associated with *fixed wiring*.

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 across a *representative range* of *electrical equipment high voltage* in the scope of work for which competency is being sought; autonomously and to requirements. To requirements means meeting all relevant safe working practices, manufacturers specifications, codes of practice, statutory and regulatory requirements, Standards both Australian and International and OH&S Standards.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace for the scope of work in the Range Statement.
- demonstrating an understanding of the underpinning knowledge and skills identified for the scope of work 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 at *consistently performed* across a *representative range* of *electrical equipment high voltage* in the scope of work for which competency is being sought; autonomously and to requirements. Equivalent evidence from other sources, e.g., formal assessment, is also acceptable. Although it is preferred that assessing competency be carried out in the workplace it can be undertaken in a simulated work environment approved for that purpose by the industry.

Interdependent assessment of units

Competency in this unit should be determined only after competency has been achieved in:

- a relevant field to which the electrical work is incidental, this is expected to include competencies related to occupational health and in the selection, knowledge and use of general hand tools and power tools at AQF Certificate III.
- in the switching of High Voltages
- additional competencies will be required where conditions in the workplace are such that specific precaution and techniques must be used to ensure safety. For example, situations where high fault currents are possible; hazardous areas where explosion-protection techniques must be used; damp situations and the like.

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 would ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments for which competency is being sought.

This section includes that set of knowledge and skills additional to that specified in each pre-requisite unit, see point 3 above 'Interdependent assessment of units'.

Unsafe (electrical) work practices

Safe use of tools and plant

Safe use of ladders and elevated work platforms

Safe use of protective clothing

Hazards in the (electrical) work environment: shock hazards; fire hazards; chemical hazards

Procedures for dealing with fires associated with electrical equipment

Procedures for dealing with PCBs

Electric shock victim rescue methods and procedures: basic first aid treatment for shock, burns and bleeding; Expired air resuscitation (EAR) (purpose of each procedure and application); external cardiac-compression (ECC) (purpose of each procedure and application); cardio-pulmonary resuscitation (CPR) (combined application of EAR and ECC) (purpose of each procedure and application)

Basic electrical circuit(s): source; control; protection; load

Circuit diagrams: symbols; conventions; interpretations; free sketches

Circuit connections and functions: open circuit; closed circuit; short circuit

Basic electrical measurement: use of multimeters; use of ammeter; use of voltage measuring and indicating devices; testing of measuring instruments; care of measuring instruments; voltage, current and resistance measurement; estimating values of voltage, current and resistance

Fundamental electrical concepts: effects of current; practical resistors; sources of emf; series, parallel and series-parallel circuits; electrical measurement; capacitors; inductors; magnetism

Circuit isolation and protection devices

Isolation procedures: work clearance; testing for voltage; lock-off and tagging; techniques, regulation, codes of practice and procedures

Cable types and conductor termination methods and techniques

Disconnection procedures, practices and requirements

Replacement equipment

Ensuring equipment is safe to connect to supply

Reconnection procedures, practices and requirements

High Voltage apparatus: basic principles of High Voltage apparatus (non mathematical); apparatus identification; apparatus ratings; basic principles of operation of control equipment and protection devices; fault conditions and symptoms; safe isolation procedures; safe testing procedure, including continuity; fault types in apparatus

High voltage, current and resistance measurement and calculation

Step and touch potential

Insulation resistance measurement and requirements

Earthing principles and techniques

Cable types and conductor termination methods and techniques

High voltage flexible cables, including feeder and trailing cables, for use with single and three phase apparatus: types and loading; service duty

High voltage plugs for use with single and three phase apparatus: types and loading; IP rating

Safety testing to connect to supply

Returning to service

High Voltage in hazardous environments

UTE NES214 (A to Z qualifier) A
Maintain equipment in hazardous areas

Descriptor: Carry out maintenance on *electrical equipment* situated in a hazardous area and *other items* of equipment located in a safe area that may influence the explosion-protection technique.

Alignment: This unit aligns to the Competency Standard 'Electrical equipment in hazardous areas' CS-EEHA-001-1998, unit NEE 004.

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 NES214T A	Maintain equipment in hazardous areas *(Mixed explosion-protection techniques Ex mixed)*
UTE NES214U A	Maintain equipment in hazardous areas *(Pressurised enclosure Ex p)*
UTE NES214V A	Maintain equipment in hazardous areas *(Dust-exclusion ignition-proof Dip)*
UTE NES214W A	Maintain equipment in hazardous areas *(Non-sparking Ex n)*
UTE NES214X A	Maintain equipment in hazardous areas *(Intrinsic safety Ex i)*
UTE NES214Y A	Maintain equipment in hazardous areas *(Increased safety equipment Ex e)*
UTE NES214Z A	Maintain equipment in hazardous areas (*Flameproof enclosure Ex d)*

Elements		Performance criteria	
214.1	Prepare to carry out maintenance	214.1.1	*OH&S policies and procedures* for preparing to work in a hazardous area are followed
		214.1.2	Area classification and details of explosion-protected equipment and wiring are ascertained from hazardous area layout drawings and equipment certification documents held in *hazardous area records*

Elements		Performance criteria	
		214.1.3	Extent of maintenance to be conducted is established from the maintenance schedule and reports held in *hazardous area records*
		214.1.4	*Special tools, equipment* and *testing devices* needed to carry out the maintenance work are obtained and checked for correct operation and safety
214.2	Carry out maintenance	214.2.1	*OH&S policies and procedures* for working in a hazardous area are followed
		214.2.2	Work is carried out to planned schedule to ensure all items are correctly maintained
		214.2.3	Equipment is checked and tested in accordance with *established procedures* to determine whether it functions correctly, complies with approval documentation and is not subject to deterioration or damage
		214.2.4	Equipment is adjusted or repaired within the limits permitted by the equipment *certification* and in accordance with manufacturers' instructions
		214.2.5	*Certification documentation* for replacement equipment is sighted to ensure that it is identical to the equipment it replaces and is in accordance with the explosion-protection system design
		214.2.6	Circuits of equipment being withdrawn from service are terminated or isolated safely and in manner approved for the classification of the area
		214.2.7	Flexible cables and cords are examined and removed from service if they are not in immediate use or are found to be non-conforming or damaged
		214.2.8	Spare equipment, flexible cables and cords are maintained and suitably stored where they are not likely to suffer deterioration or damage

Elements		Performance criteria	
214.3	Complete maintenance work inspections and documentation	214.3.1	*Detailed inspection* of explosion-protected equipment and systems subject to the maintenance work is arranged in accordance with *established procedures* and *requirements*
		214.3.2	Results of inspections and maintenance activities are recorded in accordance with *established procedures* and *requirements*
		214.3.3	*Appropriate personnel* is notified of the completion of maintenance and details are documented in accordance with *established procedures* and *requirements*

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 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;
- identifying non-conformances and faults;
- interpreting certification documentation in relation to maintenance, repair and replacement;
- following established maintenance procedures;
- documenting maintenance details.

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

This unit should be addressed only after competency in unit UTE NES010 A of this standard has been achieved.

Competency in this unit should be assessed only after competency related to the maintenance of general electrical equipment has been achieved at *AQF* Certificate III level Similar competency and qualifications related to instrument and electronic equipment would be sufficient pre-requisite 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 a explosion-protection technique:

Methods 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 detailed initial/sample and close/visual inspections; standards and procedures for terminating and connecting cables; relationship between equipment, cables and glands; standards and requirements for the installation of equipment and wiring; purpose, 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); requirements of programmed maintenance; maintenance requirements and procedures for an explosion-protection technique

UTE NES215 (A to Z qualifier) A
Overhaul & repair explosion-protected equipment

Descriptor: Overhaul and repair *explosion-protected equipment* and issue documented authorisation confirming that the overhauled/repaired equipment meets the *requirements* of the original compliance *certification.*

Alignment: This unit aligns to the Competency Standard 'Electrical equipment in hazardous areas' CS-EEHA-001-1998, unit NEE 006.

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 NES215T A	Overhaul & repair explosion-protected equipment *(Mixed explosion-protection techniques Ex mixed)*
UTE NES215U A	Overhaul & repair explosion-protected equipment *(Pressurised enclosure Ex p)*
UTE NES215V A	Overhaul & repair explosion-protected equipment *(Dust-exclusion ignition-proof Dip)*
UTE NES215W A	Overhaul & repair explosion-protected equipment *(Non-sparking Ex n)*
UTE NES215X A	Overhaul & repair explosion-protected equipment *(Intrinsic safety Ex i)*
UTE NES215Y A	Overhaul & repair explosion-protected equipment *(Increased safety equipment Ex e)*
UTE NES215Z A	Overhaul & repair explosion-protected equipment (*Flameproof enclosure Ex d)*

Elements		Performance criteria	
215.1	Prepare for overhaul/repair of equipment	215.1.1	Instructions on overhaul and/or repair are received and expected outcomes of the work confirmed with *appropriate personnel*
		215.1.2	*Certification documents* for the equipment are sought and received in order to check that the equipment complies with the *certification*

Elements		Performance criteria	
		215.1.3	Where *certification documents* for the equipment are not available arrangements are made to seek *re-certification* in accordance with *requirements*
		215.1.4	Tools, measuring/testing devices and equipment, needed to check compliance with *certification* and determine the extent of the work, are obtained and checked for correct, accurate and safe operation
215.2	Establish the level of overhaul required	215.2.1	Measurements, tests and inspections are carried out on the equipment in accordance with *OH&S policies and procedures* and other *established procedures*
		215.2.2	The extent of work to be done is determined from measurement, test and inspection results and their correspondence with original certification and the requirements of *standards*
		215.2.3	Specifications and instructions for the overhaul/repair work are documented in accordance with *requirements*
215.3	Arrange overhaul/repair work	215.3.1	Arrangements are made for the overhaul/repair work to be done in accordance with *established procedures*
		215.3.2	A copy of overhaul/repair specifications and instructions is provided to personnel responsible for carrying out the work
215.4	Verify that equipment complies with original *certification*	215.4.1	Level of testing required to verify that overhauled/repaired equipment complies with original *certification* specifications is determined in accordance with *requirements*
		215.4.2	Verification tests are conducted in accordance with *established procedures*
215.5	Document overhaul/repair work	215.5.1	*Equipment marking* is checked and marked where applicable, in accordance with original *certification*
		215.5.2	Overhaul/repair work is documented in accordance with *requirements* and stating the equipment complies with the original *certification*

Elements	**Performance criteria**
	215.5.3 Documentation of the repair work is filed in *hazardous area records* and a copy is issued with the equipment

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 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-protected technique for which competency is sought. It is essential that the following aspects of competency be demonstrated:

- following OH&S procedures;
- interpreting certification documentation and standards;
- measuring, testing and inspecting equipment for compliance with certification and standards;
- specifying overhaul/repair work;
- documenting overhaul/repair work;
- using quality systems.

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

Competency in this unit should be assessed only after competency related to the repair of electrical equipment has been achieved at *AQF* Certificate III level or equivalent. Similar competency and qualifications related to instrument and electronic equipment would be sufficient pre-requisite 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; standards and procedures for terminating and connecting cables; relationship between equipment, cables and glands; standards and requirements for the installation of equipment; purpose, selection and application of sealing compounds; actions and conditions that will void explosion-protection; requirements for establishing and maintaining hazardous area records (site dossier); arrangements for approval for use of equipment in a hazardous area requirement and processes of marking equipment; requirements and processes for managing and maintaining equipment overhaul records; assessing equipment for compliance to standards; compliance specifications and requirements of equipment design; interpretation of standards to determine critical dimensions and/or electrical parameters of equipment; procedures for verifying that overhauled equipment complies with standards ; requirements and processes for selecting equipment; requirements and processes for selecting wiring systems and cables; purpose of certification of explosion-protected equipment.

UTE NES216 A
Perform basic servicing to plant/equipment associated with remote area essential services operation

Descriptor: Undertake basic servicing to plant and equipment involving the replacement of consumable items, cleaning of plant and equipment and replacement of minor components. This unit can only apply in a *utility* context.

Alignment: Nil.

Elements		Performance criteria	
216.1	Plan and prepare for basic servicing	216.1.1	Basic servicing is planned and prepared for to ensure *OH&S policies and procedures* are followed and the work is appropriately sequenced in accordance with *requirements*
		216.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		216.1.3	Location in which servicing is to be carried out is determined from job *requirements*
		216.1.4	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		216.1.5	*Tools*, *equipment* and *testing devices* needed to carry out the servicing work are obtained in accordance with *established procedures* and checked for correct operation and safety, if needed
		216.1.6	Observations are undertaken to ensure no damage has previously occurred to *plant* or *equipment*
216.2	Carry out servicing operations	216.2.1	*OH&S policies and procedures* for servicing operations are followed
		216.2.2	Servicing is carried out in accordance with *requirements*, without damage or distortion to *equipment* or the surrounding environment
		216.2.3	Unplanned events or conditions are responded to in accordance with *established procedures*

Elements		Performance criteria	
		216.2.4	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		216.2.5	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
216.3	Inspect and notify completion of work	216.3.1	Final inspections are undertaken to ensure the servicing conforms to *requirements*
		216.3.2	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

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

First aid.

Role of the first aider: basic structure and function of the body; priorities for casualty management; importance of airway clearance; recognition of unconsciousness; recognition and management of – stroke casualty, diabetic casualty, seizures, fainting

Resuscitation techniques: expired air resuscitation; cardiopulmonary resuscitation

Injuries: breathing disorders; heart conditions; severe bleeding; shock

Wounds and related infections: burns; poisoning; bites and stings; overexposure to heat and cold

Other injuries: bone joint and muscle injuries; injuries of the abdomen; head, face and jaw injuries; chest, injuries

Remote area essential services.

Telephone Operations: answer calls promptly and clearly, using designated business protocol procedures; make and receive telephone calls in a workplace related context; obtain accurate telephone numbers from an appropriate source; establish contact using designated business protocol procedures; convey purpose of call clearly and concisely

Mathematics: use basic mathematical skills to perform calculations with whole numbers

Electrical: identification and basic function of electrical components used for generating and distributing; electricity safety procedures when working with electricity; identification of faulty electrical components; reporting of faulty electrical components

Fire lighting equipment: fire extinguishers and signage; types of fire extinguishers; contents and colour; correct identification; use of fire extinguishers; use of water hose and reel; safety awareness

Basic welding and cutting.

Brazing: process description; consumables; flame setting; joints; typical uses; safety; application; horizontal welding

Thermal cutting: principles of operation; process description; manual cutting; machine straight line cutting; gases: oxygen, acetylene, LPG; nozzles; cutting aids; machine cutting; cutting fault; safety; application, flame cut shapes and bevels

Manual metal arc welding: process description; equipment; consumables; typical uses; safety; application, fillet weld in the flat position

Hazardous locations; confined spaces; containers used for flammable materials; safety procedures and responsibilities

Hand tools.

Hand tools safety types: spanners, screw drivers, pliers, vica grip, punches, torque wrenches, hammers, chisels, files, snips, hacksaws, nibblers, drill bits, taps, dies, wire cutters, side cutters

Measuring and marking out tools: rules; tapes

Portable power tools: safety; power sources; types – drills, grinders, jig saw

Repairs and maintenance to community facilities.

Repair and maintenance to fences and gates: emergency repairs; locks and catches; security fencing; fence maintenance; gates; safety awareness

Maintenance painting: preparation of surfaces; blockwork; concrete; timber; steel; paint selection; brush and roller selection; paint application; clean up process; paint and accessories storage; safety awareness

Essential services facilities lighting: incandescent light globes; fluorescent tubes; fluorescent light starters; diffusion devices; safety awareness

Essential services facilities safety/security and emergency checks: broken windows; faulty lighting; damaged gates; logging the inspections; notification of the situation; safety awareness

Specialisation: Combined utilities

Minor maintenance of a generating plant.

Minor servicing of the power stations generating plant: engine oil and filters; fuel filters; coolant filters; water trap devices; air cleaners

Minor maintenance of the power stations generating plant: fan and accessory drive belts; repair of minor leaks – coolant, oil, fuel; station services – fuel tank dip, lubricating oil tank level, fuel flow meter

Use of the information gathered from the instruments/meters for ordering of: fuel, lubricating oil, coolant; schedule regular servicing and maintenance for – engine oil and filter changes, fuel filters, drive belt (condition/adjustment), valve adjustments (if applicable), major and minor mechanical servicing by outside agents, air cleaner (both dry paper and oil bath types)

Power station log sheets and readings: completed log sheets; forwarding information to appropriate person/location at regular intervals (weekly)

Lead acid batteries: battery construction; battery electrolyte; operation; connection of cells (parallel and series); polarity; safety awareness

Battery maintenance: cleanliness of the battery; terminal condition; electrolyte level; distilled water; battery charging; specific gravity; hydrometer; battery security; terminal load; safety awareness

Battery hazards: types of hazards; precautions; first aid procedures; safety awareness

Radio equipment (as required) – antenna types, antenna insulators, cleanliness of the antenna, antenna deterioration, radio set, weather protection, radio security, radio connections (leads), safety awareness

Radio operation – phonetic alphabet, call signs, transmitting and receiving messages, special use periods

Power station and compound maintenance.

General cleanliness of the power stations plant and buildings: generation plant; oil leaks; water leaks; fuel leaks; safety awareness

Plant buildings: internal floor area; used consumables; spare parts storage; spider webs and other pests; rubbish containers; ventilation; safety awareness

Servicing of the power stations generating plants battery systems: starting battery set; switchboard (nicad) batteries

Photovoltaic array: basic construction; operating principles; connections and maintenance

Potable water distribution system (reticulation).

Valve operation: types of valves; location; identification; isolation operations; make safe procedures; maintenance; safety awareness

Fault conditions: location; identification; notification; make safe protection; rectification; safety awareness

Power station compound: fence and gate; weeds; grass; rubbish containers; fuel and oil supply (drums); water reticulation; safety awareness

Tools and equipment: location/storage; cleanliness; maintenance; drain/drip tins; safety awareness

Safety signage: location; condition; suitability

Waste water connection point.

Fault identification: location of faults; identification of faults; fumes and gases; breathing apparatus; public awareness; protective barricading; signage; recording; notification; safety awareness

Corrosion control: identification; descaling; repair as necessary; prevention procedures; reporting procedures; safety awareness

Leaking pipes: location; identification; repairing of the leak/s; area protection; isolation; excavation; emergency repairs; safety awareness

Water meters: identification and location; reading and recording; fault identification; isolation of the system; changing a faulty meter; notification; safety awareness

Water supply – sources collection and storage.

Operation of water pumps: pump selection; pump types; water pump operation; diesel engine service; bore operation; safety awareness

Reading and recording of the systems instruments: reading and recording of information; mechanical instruments; electrical instruments; bore instruments; flow meters; notification of faults; safety awareness

Operation and isolation of components: isolation valves; flow devices; identification and operation; systems isolation; filtration equipment; inspection of the system; recognition of faults; notification of repairs and maintenance (R and M) performed; lock out devices; safety awareness

Maintenance: painting preparation; corrosion control; paint selection; application methods; cleaning and storage; solar panels; structural; storage tank; reporting problems; housekeeping; safety awareness

Water sampling (analysis): cleaning and scouring; weeds and debris; water samples; recording and reporting of information; reporting of findings; safety awareness

Potable water treatment facility.

Valve systems isolation: location; identification; isolation of valve systems; operation of valve systems; make safe procedures; maintenance (filtration); recording of work performed; safety awareness

Treatment plant instrumentation: location; identification; reading and recording; recognition of fault/s; fault condition/s; notification of fault condition/s; safety awareness

Facilities maintenance: corrosion control; painting; descaling; bolt replacement; water leaks; site clearing (debris and weeds); notification of work; emergency repairs; safety awareness

Chemicals: identification; storage procedures; ventilation; signage; hazard-chemical awareness; fire control; emergency procedures; application; personal protective equipment; safety awareness

Gas cylinders/liquids/powders: location; identification; hoses and fittings; storage and handling; signage; personal protective equipment; safety awareness

Stock control: recording; receiving; gas cylinders; filters and seals; chemicals

Water sampling for analysis: cleaning and scouring; water samples; chemical addition; recording and reporting of information; report findings; safety awareness

UV water treatment: safety awareness; isolation procedures; globe replacement; reading and recording

Gas treatment of water (as required): safety awareness; safe handling of chemical treatment compounds; procedures for adding chemical treatment compounds to water; changing of gas bottles for automatic treatment systems; power and water authority procedures

Waste water treatment and storage.

Identification and isolation of fault condition/s: identifying fault/s; types of fault/s; make safe procedures; isolating the fault/s; gas and fume detection; notification; personal hygiene; safety awareness

Emergency repairs and blockages: identifying the emergency; locating the emergency; prioritising the repairs; notifying the appropriate person/s; public safety precautions; breathing apparatus; safety signage; repairing the system; reactivating the system; personal hygiene; safety awareness

Treatment and storage of pumping equipment maintenance: identifying the systems pumping equipment; identifying the systems control mechanism/s; isolating the system; make safe procedures; operating the pumps; maintenance of the system; recording work details; notification; personal hygiene; safety awareness

Manhole and grounds maintenance: safety barricades and fences; safety signage; manhole cover condition; clearing debris; grounds maintenance; personal hygiene; safety awareness

Treatment pond maintenance: weed and grass control; pest control; scraping of the pond/s; closing pen stocks; cleaning trash baskets; reactivating the system; removing the waste; burying the waste; housekeeping; personal hygiene; safety awareness

Instrumentation, reading and recording of information: locating the instrumentation; identify the instruments; read the displayed information; log the information; notification; personal hygiene; safety awareness

Radio equipment (as required) – antenna types, antenna insulators, cleanliness of the antenna, antenna deterioration, radio set, weather protection, radio security, radio connections (leads), safety awareness; radio operation – phonetic alphabet, call signs, transmitting and receiving messages, special use periods

Specialisation: Power

Minor maintenance of a generating plant.

Minor servicing of the power stations generating plant: engine oil and filters; fuel filters; coolant filters; water trap devices; air cleaners

Minor maintenance of the power stations generating plant: fan and accessory drive belts; repair of minor leaks – coolant, oil, fuel; station services – fuel tank dip, lubricating oil tank level, fuel flow meter

Use of the information gathered from the instruments/meters for ordering of: fuel, lubricating oil, coolant; schedule regular servicing and maintenance for – engine oil and filter changes, fuel filters, drive belt (condition/adjustment), valve adjustments (if applicable), major and minor mechanical servicing by outside agents, air cleaner (both dry paper and oil bath types)

Power station log sheets and readings: completed log sheets; forwarding information to appropriate person/location at regular intervals (weekly)

Lead acid batteries: battery construction; battery electrolyte; operation; connection of cells (parallel and series); polarity; safety awareness

Battery maintenance: cleanliness of the battery; terminal condition; electrolyte level; distilled water; battery charging; specific gravity; hydrometer; battery security; terminal load; safety awareness

Battery hazards: types of hazards; precautions; first aid procedures; safety awareness

Radio equipment (as required) – antenna types, antenna insulators, cleanliness of the antenna, antenna deterioration, radio set, weather protection, radio security, radio connections (leads), safety awareness; radio operation – phonetic alphabet, call signs, transmitting and receiving messages, special use periods

Power station and compound maintenance.

General cleanliness of the power stations plant and buildings: generation plant; oil leaks; water leaks; fuel leaks; safety awareness

Plant buildings: internal floor area; used consumables; spare parts storage; spider webs and other pests; rubbish containers; ventilation; safety awareness

Servicing of the power stations generating plants battery systems: starting battery set; switchboard (nicad) batteries

Photovoltaic array: basic construction; operating principles; connections and maintenance

Specialisation: Water

Potable water distribution system (reticulation).

Valve operation: types of valves; location; identification; isolation operations; make safe procedures; maintenance; safety awareness

Fault conditions: location; identification; notification; make safe protection; rectification; safety awareness

Power station compound: fence and gate; weeds; grass; rubbish containers; fuel and oil supply (drums); water reticulation; safety awareness

Tools and equipment: location/storage; cleanliness; maintenance; drain/drip tins; safety awareness

Safety signage: location; condition; suitability

Waste water connection point.

Fault identification: location of faults; identification of faults; fumes and gases; breathing apparatus; public awareness; protective barricading; signage; recording; notification; safety awareness

Corrosion control: identification; descaling; repair as necessary; prevention procedures; reporting procedures; safety awareness

Leaking pipes: location; identification; repairing of the leak/s; area protection; isolation; excavation; emergency repairs; safety awareness

Water meters: identification and location; reading and recording; fault identification; isolation of the system; changing a faulty meter; notification; safety awareness

Water supply – sources collection and storage.

Operation of water pumps: pump selection; pump types; water pump operation; diesel engine service; bore operation; safety awareness

Reading and recording of the systems instruments: reading and recording of information; mechanical instruments; electrical instruments; bore instruments; flow meters; notification of faults; safety awareness

Operation and isolation of components: isolation valves; flow devices; identification and operation; systems isolation; filtration equipment; inspection of the system; recognition of faults; notification of repairs and maintenance (R and M) performed; lock out devices; safety awareness

Maintenance: painting preparation; corrosion control; paint selection; application methods; cleaning and storage; solar panels; structural; storage tank; reporting problems; housekeeping; safety awareness

Water sampling (analysis): cleaning and scouring; weeds and debris; water samples; recording and reporting of information; reporting of findings; safety awareness

Potable water treatment facility.

Valve systems isolation: location; identification; isolation of valve systems; operation of valve systems; make safe procedures; maintenance (filtration); recording of work performed; safety awareness

Treatment plant instrumentation: location; identification; reading and recording; recognition of fault/s; fault condition/s; notification of fault condition/s; safety awareness

Facilities maintenance: corrosion control; painting; descaling; bolt replacement; water leaks; site clearing (debris and weeds); notification of work; emergency repairs; safety awareness

Chemicals: identification; storage procedures; ventilation; signage; hazard-chemical awareness; fire control; emergency procedures; application; personal protective equipment; safety awareness

Gas cylinders/liquids/powders: location; identification; hoses and fittings; storage and handling; signage; personal protective equipment; safety awareness

Stock control: recording; receiving; gas cylinders; filters and seals; chemicals

Water sampling for analysis: cleaning and scouring; water samples; chemical addition; recording and reporting of information; report findings; safety awareness

UV water treatment: safety awareness; isolation procedures; globe replacement; reading and recording

Gas treatment of water (as required): safety awareness; safe handling of chemical treatment compounds; procedures for adding chemical treatment compounds to water; changing of gas bottles for automatic treatment systems; power and water authority procedures

Waste water treatment and storage.

Identification and isolation of fault condition/s: identifying fault/s; types of fault/s; make safe procedures; isolating the fault/s; gas and fume detection; notification; personal hygiene; safety awareness

Emergency repairs and blockages: identifying the emergency; locating the emergency; prioritising the repairs; notifying the appropriate person/s; public safety precautions; breathing apparatus; safety signage; repairing the system; reactivating the system; personal hygiene; safety awareness

Treatment and storage of pumping equipment maintenance: identifying the systems pumping equipment; identifying the systems control mechanism/s; isolating the system; make safe procedures; operating the pumps; maintenance of the system; recording work details; notification; personal hygiene; safety awareness

Manhole and grounds maintenance: safety barricades and fences; safety signage; manhole cover condition; clearing debris; grounds maintenance; personal hygiene; safety awareness

Treatment pond maintenance: weed and grass control; pest control; scraping of the pond/s; closing pen stocks; cleaning trash baskets; reactivating the system; removing the waste; burying the waste; housekeeping; personal hygiene; safety awareness

Instrumentation, reading and recording of information: locating the instrumentation; identify the instruments; read the displayed information; log the information; notification; personal hygiene; safety awareness

Radio equipment (as required) – antenna types, antenna insulators, cleanliness of the antenna, antenna deterioration, radio set, weather protection, radio security, radio connections (leads), safety awareness; radio operation – phonetic alphabet, call signs, transmitting and receiving messages, special use periods

UTE NES217 A
Maintain environmental conditions of a remote area utilities operation

Descriptor: Maintaining environmental conditions involving the removal of industrial waist, fluids and used components and including hazard minimisation of naturally occurring combustible fuels and general housekeeping. This unit can only apply in a *utility* context.

Alignment: Nil.

Elements		Performance criteria	
217.1	Plan and prepare for maintaining environmental conditions	217.1.1	Environmental maintenance is planned for and prepared to ensure *OH&S policies and procedures* are followed and the work is appropriately sequenced in accordance with *requirements*
		217.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		217.1.3	Location in which environmental maintenance is to be carried out is determined from job *requirements*
		217.1.4	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		217.1.5	*Tools* and *equipment* needed to carry out the environmental maintenance work are obtained in accordance with *established procedures* and checked for correct operation and safety, if needed
		217.1.6	Observations are undertaken to ensure no damage has previously occurred to *plant* or *equipment*
217.2	Carry out environmental maintenance	217.2.1	*OH&S policies and procedures* for environmental maintenance operations are followed
		217.2.2	Environmental maintenance is carried out in accordance with *requirements*, without damage or distortion to *equipment* or the surrounding environment

Elements		Performance criteria	
		217.2.3	Unplanned events or conditions are responded to in accordance with *established procedures*
		217.2.4	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		217.2.5	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
217.3	Inspect and notify completion of work	217.3.1	Final inspections are undertaken to ensure the environmental maintenance conforms to *requirements*
		217.3.2	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

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

First aid.

Role of the first aider: basic structure and function of the body; priorities for casualty management; importance of airway clearance; recognition of unconsciousness; recognition and management of – stroke casualty, diabetic casualty, seizures, fainting

Resuscitation techniques: expired air resuscitation; cardiopulmonary resuscitation

Injuries: breathing disorders; heart conditions; severe bleeding; shock

Wounds and related infections: burns; poisoning; bites and stings; overexposure to heat and cold

Other injuries: bone joint and muscle injuries; injuries of the abdomen; head, face and jaw injuries; chest, injuries

Remote area essential services.

Telephone Operations: answer calls promptly and clearly, using designated business protocol procedures; make and receive telephone calls in a workplace related context; obtain accurate telephone numbers from an appropriate source; establish contact using designated business protocol procedures; convey purpose of call clearly and concisely

Mathematics: use basic mathematical skills to perform calculations with whole numbers

Electrical: identification and basic function of electrical components used for generating and distributing; electricity safety procedures when working with electricity; identification of faulty electrical components; reporting of faulty electrical components

Fire lighting equipment: fire extinguishers and signage; types of fire extinguishers; contents and colour; correct identification; use of fire extinguishers; use of water hose and reel; safety awareness

Basic welding and cutting.

Brazing: process description; consumables; flame setting; joints; typical uses; safety; application; horizontal welding

Thermal cutting: principles of operation; process description; manual cutting; machine straight line cutting; gases: oxygen, acetylene, LPG; nozzles; cutting aids; machine cutting; cutting fault; safety; application, flame cut shapes and bevels

Manual metal arc welding: process description; equipment; consumables; typical uses; safety; application, fillet weld in the flat position

Hazardous locations; confined spaces; containers used for flammable materials; safety procedures and responsibilities

Hand tools.

Hand tools safety types: spanners, screw drivers, pliers, vica grip, punches, torque wrenches, hammers, chisels, files, snips, hacksaws, nibblers, drill bits, taps, dies, wire cutters, side cutters

Measuring and marking out tools: rules; tapes

Portable power tools: safety; power sources; types – drills, grinders, jig saw

Repairs and maintenance to community facilities.

Repair and maintenance to fences and gates: emergency repairs; locks and catches; security fencing; fence maintenance; gates; safety awareness

Maintenance painting: preparation of surfaces; blockwork; concrete; timber; steel; paint selection; brush and roller selection; paint application; clean up process; paint and accessories storage; safety awareness

Essential services facilities lighting: incandescent light globes; fluorescent tubes; fluorescent light starters; diffusion devices; safety awareness

Essential services facilities safety/security and emergency checks: broken windows; faulty lighting; damaged gates; logging the inspections; notification of the situation; safety awareness

Specialisation: Combined utilities

Minor maintenance of a generating plant.

Minor servicing of the power stations generating plant: engine oil and filters; fuel filters; coolant filters; water trap devices; air cleaners

Minor maintenance of the power stations generating plant: fan and accessory drive belts; repair of minor leaks – coolant, oil, fuel; station services – fuel tank dip, lubricating oil tank level, fuel flow meter

Use of the information gathered from the instruments/meters for ordering of: fuel, lubricating oil, coolant; schedule regular servicing and maintenance for – engine oil and filter changes, fuel filters, drive belt (condition/adjustment), valve adjustments (if applicable), major and minor mechanical servicing by outside agents, air cleaner (both dry paper and oil bath types)

Power station log sheets and readings: completed log sheets; forwarding information to appropriate person/location at regular intervals (weekly)

Lead acid batteries: battery construction; battery electrolyte; operation; connection of cells (parallel and series); polarity; safety awareness

Battery maintenance: cleanliness of the battery; terminal condition; electrolyte level; distilled water; battery charging; specific gravity; hydrometer; battery security; terminal load; safety awareness

Battery hazards: types of hazards; precautions; first aid procedures; safety awareness

Radio equipment (as required) – antenna types, antenna insulators, cleanliness of the antenna, antenna deterioration, radio set, weather protection, radio security, radio connections (leads), safety awareness

Radio operation – phonetic alphabet, call signs, transmitting and receiving messages, special use periods

Power station and compound maintenance.

General cleanliness of the power stations plant and buildings: generation plant; oil leaks; water leaks; fuel leaks; safety awareness

Plant buildings: internal floor area; used consumables; spare parts storage; spider webs and other pests; rubbish containers; ventilation; safety awareness

Servicing of the power stations generating plants battery systems: starting battery set; switchboard (nicad) batteries

Photovoltaic array: basic construction; operating principles; connections and maintenance

Potable water distribution system (reticulation).

Valve operation: types of valves; location; identification; isolation operations; make safe procedures; maintenance; safety awareness

Fault conditions: location; identification; notification; make safe protection; rectification; safety awareness

Power station compound: fence and gate; weeds; grass; rubbish containers; fuel and oil supply (drums); water reticulation; safety awareness

Tools and equipment: location/storage; cleanliness; maintenance; drain/drip tins; safety awareness

Safety signage: location; condition; suitability

Waste water connection point.

Fault identification: location of faults; identification of faults; fumes and gases; breathing apparatus; public awareness; protective barricading; signage; recording; notification; safety awareness

Corrosion control: identification; descaling; repair as necessary; prevention procedures; reporting procedures; safety awareness

Leaking pipes: location; identification; repairing of the leak/s; area protection; isolation; excavation; emergency repairs; safety awareness

Water meters: identification and location; reading and recording; fault identification; isolation of the system; changing a faulty meter; notification; safety awareness

Water supply – sources collection and storage.

Operation of water pumps: pump selection; pump types; water pump operation; diesel engine service; bore operation; safety awareness

Reading and recording of the systems instruments: reading and recording of information; mechanical instruments; electrical instruments; bore instruments; flow meters; notification of faults; safety awareness

Operation and isolation of components: isolation valves; flow devices; identification and operation; systems isolation; filtration equipment; inspection of the system; recognition of faults; notification of repairs and maintenance (R and M) performed; lock out devices; safety awareness

Maintenance: painting preparation; corrosion control; paint selection; application methods; cleaning and storage; solar panels; structural; storage tank; reporting problems; housekeeping; safety awareness

Water sampling (analysis): cleaning and scouring; weeds and debris; water samples; recording and reporting of information; reporting of findings; safety awareness

Potable water treatment facility.

Valve systems isolation: location; identification; isolation of valve systems; operation of valve systems; make safe procedures; maintenance (filtration); recording of work performed; safety awareness

Treatment plant instrumentation: location; identification; reading and recording; recognition of fault/s; fault condition/s; notification of fault condition/s; safety awareness

Facilities maintenance: corrosion control; painting; descaling; bolt replacement; water leaks; site clearing (debris and weeds); notification of work; emergency repairs; safety awareness

Chemicals: identification; storage procedures; ventilation; signage; hazard-chemical awareness; fire control; emergency procedures; application; personal protective equipment; safety awareness

Gas cylinders/liquids/powders: location; identification; hoses and fittings; storage and handling; signage; personal protective equipment; safety awareness

Stock control: recording; receiving; gas cylinders; filters and seals; chemicals

Water sampling for analysis: cleaning and scouring; water samples; chemical addition; recording and reporting of information; report findings; safety awareness

UV water treatment: safety awareness; isolation procedures; globe replacement; reading and recording

Gas treatment of water (as required): safety awareness; safe handling of chemical treatment compounds; procedures for adding chemical treatment compounds to water; changing of gas bottles for automatic treatment systems; power and water authority procedures

Waste water treatment and storage.

Identification and isolation of fault condition/s: identifying fault/s; types of fault/s; make safe procedures; isolating the fault/s; gas and fume detection; notification; personal hygiene; safety awareness

Emergency repairs and blockages: identifying the emergency; locating the emergency; prioritising the repairs; notifying the appropriate person/s; public safety precautions; breathing apparatus; safety signage; repairing the system; reactivating the system; personal hygiene; safety awareness

Treatment and storage of pumping equipment maintenance: identifying the systems pumping equipment; identifying the systems control mechanism/s; isolating the system; make safe procedures; operating the pumps; maintenance of the system; recording work details; notification; personal hygiene; safety awareness

Manhole and grounds maintenance: safety barricades and fences; safety signage; manhole cover condition; clearing debris; grounds maintenance; personal hygiene; safety awareness

Treatment pond maintenance: weed and grass control; pest control; scraping of the pond/s; closing pen stocks; cleaning trash baskets; reactivating the system; removing the waste; burying the waste; housekeeping; personal hygiene; safety awareness

Instrumentation, reading and recording of information: locating the instrumentation; identify the instruments; read the displayed information; log the information; notification; personal hygiene; safety awareness

Radio equipment (as required) – antenna types, antenna insulators, cleanliness of the antenna, antenna deterioration, radio set, weather protection, radio security, radio connections (leads), safety awareness; radio operation – phonetic alphabet, call signs, transmitting and receiving messages, special use periods

Specialisation: Power

Minor maintenance of a generating plant.

Minor servicing of the power stations generating plant: engine oil and filters; fuel filters; coolant filters; water trap devices; air cleaners

Minor maintenance of the power stations generating plant: fan and accessory drive belts; repair of minor leaks – coolant, oil, fuel; station services – fuel tank dip, lubricating oil tank level, fuel flow meter

Use of the information gathered from the instruments/meters for ordering of: fuel, lubricating oil, coolant; schedule regular servicing and maintenance for – engine oil and filter changes, fuel filters, drive belt (condition/adjustment), valve adjustments (if applicable), major and minor mechanical servicing by outside agents, air cleaner (both dry paper and oil bath types)

Power station log sheets and readings: completed log sheets; forwarding information to appropriate person/location at regular intervals (weekly)

Lead acid batteries: battery construction; battery electrolyte; operation; connection of cells (parallel and series); polarity; safety awareness

Battery maintenance: cleanliness of the battery; terminal condition; electrolyte level; distilled water; battery charging; specific gravity; hydrometer; battery security; terminal load; safety awareness

Battery hazards: types of hazards; precautions; first aid procedures; safety awareness

Radio equipment (as required) – antenna types, antenna insulators, cleanliness of the antenna, antenna deterioration, radio set, weather protection, radio security, radio connections (leads), safety awareness; radio operation – phonetic alphabet, call signs, transmitting and receiving messages, special use periods

Power station and compound maintenance.

General cleanliness of the power stations plant and buildings: generation plant; oil leaks; water leaks; fuel leaks; safety awareness

Plant buildings: internal floor area; used consumables; spare parts storage; spider webs and other pests; rubbish containers; ventilation; safety awareness

Servicing of the power stations generating plants battery systems: starting battery set; switchboard (nicad) batteries

Photovoltaic array: basic construction; operating principles; connections and maintenance

Specialisation: Water

Potable water distribution system (reticulation).

Valve operation: types of valves; location; identification; isolation operations; make safe procedures; maintenance; safety awareness

Fault conditions: location; identification; notification; make safe protection; rectification; safety awareness

Power station compound: fence and gate; weeds; grass; rubbish containers; fuel and oil supply (drums); water reticulation; safety awareness

Tools and equipment: location/storage; cleanliness; maintenance; drain/drip tins; safety awareness

Safety signage: location; condition; suitability

Waste water connection point.

Fault identification: location of faults; identification of faults; fumes and gases; breathing apparatus; public awareness; protective barricading; signage; recording; notification; safety awareness

Corrosion control: identification; descaling; repair as necessary; prevention procedures; reporting procedures; safety awareness

Leaking pipes: location; identification; repairing of the leak/s; area protection; isolation; excavation; emergency repairs; safety awareness

Water meters: identification and location; reading and recording; fault identification; isolation of the system; changing a faulty meter; notification; safety awareness

Water supply – sources collection and storage.

Operation of water pumps: pump selection; pump types; water pump operation; diesel engine service; bore operation; safety awareness

Reading and recording of the systems instruments: reading and recording of information; mechanical instruments; electrical instruments; bore instruments; flow meters; notification of faults; safety awareness

Operation and isolation of components: isolation valves; flow devices; identification and operation; systems isolation; filtration equipment; inspection of the system; recognition of faults; notification of repairs and maintenance (R and M) performed; lock out devices; safety awareness

Maintenance: painting preparation; corrosion control; paint selection; application methods; cleaning and storage; solar panels; structural; storage tank; reporting problems; housekeeping; safety awareness

Water sampling (analysis): cleaning and scouring; weeds and debris; water samples; recording and reporting of information; reporting of findings; safety awareness

Potable water treatment facility.

Valve systems isolation: location; identification; isolation of valve systems; operation of valve systems; make safe procedures; maintenance (filtration); recording of work performed; safety awareness

Treatment plant instrumentation: location; identification; reading and recording; recognition of fault/s; fault condition/s; notification of fault condition/s; safety awareness

Facilities maintenance: corrosion control; painting; descaling; bolt replacement; water leaks; site clearing (debris and weeds); notification of work; emergency repairs; safety awareness

Chemicals: identification; storage procedures; ventilation; signage; hazard-chemical awareness; fire control; emergency procedures; application; personal protective equipment; safety awareness

Gas cylinders/liquids/powders: location; identification; hoses and fittings; storage and handling; signage; personal protective equipment; safety awareness

Stock control: recording; receiving; gas cylinders; filters and seals; chemicals

Water sampling for analysis: cleaning and scouring; water samples; chemical addition; recording and reporting of information; report findings; safety awareness

UV water treatment: safety awareness; isolation procedures; globe replacement; reading and recording

Gas treatment of water (as required): safety awareness; safe handling of chemical treatment compounds; procedures for adding chemical treatment compounds to water; changing of gas bottles for automatic treatment systems; power and water authority procedures

Waste water treatment and storage.

Identification and isolation of fault condition/s: identifying fault/s; types of fault/s; make safe procedures; isolating the fault/s; gas and fume detection; notification; personal hygiene; safety awareness

Emergency repairs and blockages: identifying the emergency; locating the emergency; prioritising the repairs; notifying the appropriate person/s; public safety precautions; breathing apparatus; safety signage; repairing the system; reactivating the system; personal hygiene; safety awareness

Treatment and storage of pumping equipment maintenance: identifying the systems pumping equipment; identifying the systems control mechanism/s; isolating the system; make safe procedures; operating the pumps; maintenance of the system; recording work details; notification; personal hygiene; safety awareness

Manhole and grounds maintenance: safety barricades and fences; safety signage; manhole cover condition; clearing debris; grounds maintenance; personal hygiene; safety awareness

Treatment pond maintenance: weed and grass control; pest control; scraping of the pond/s; closing pen stocks; cleaning trash baskets; reactivating the system; removing the waste; burying the waste; housekeeping; personal hygiene; safety awareness

Instrumentation, reading and recording of information: locating the instrumentation; identify the instruments; read the displayed information; log the information; notification; personal hygiene; safety awareness

Radio equipment (as required) – antenna types, antenna insulators, cleanliness of the antenna, antenna deterioration, radio set, weather protection, radio security, radio connections (leads), safety awareness; radio operation – phonetic alphabet, call signs, transmitting and receiving messages, special use periods

UTE NES218 A
Maintain office records & administrative systems

Descriptor: Maintain records and administrative systems in an electrotechnology environment.

Alignment: Nil.

Elements		Performance criteria	
218.1	Plan and prepare for maintaining records and administrative systems	218.1.1	Record and administrative activities are planned and prepared for to ensure *OH&S policies and procedures* are followed with the work appropriately sequenced in accordance with *requirements*
		218.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved
		218.1.3	Materials are obtained and checked in accordance with *established procedures* and to comply with *requirements*
		218.1.4	Location in which maintenance activities are to be undertaken is determined from job *requirements*
		218.1.5	Materials necessary to complete the work are obtained in accordance with *established procedures* and checked against job *requirements*
		218.1.6	Preparatory work is undertaken to ensure no unnecessary damage has occurred and complies with *requirements*
218.2	Undertake maintenance of record and administrative systems	218.2.1	*OH&S policies and procedures* for undertaking administrative functions are followed
		218.2.2	Maintenance of record and administrative systems are undertaken in accordance with *requirements*
		218.2.3	Unplanned events or conditions are responded to in accordance with *established procedures*
		218.2.4	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented

Elements		Performance criteria	
		218.2.5	On-going checks of the quality of the work are undertaken in accordance with *established procedures*
218.3	Complete record and administrative system maintenance activities	218.3.1	Documentation/reports are completed to ensure system maintenance *requirements* are met
		218.3.2	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 undertake activities that directly support the operational and business activities of an enterprise. This could include the following:

Typical electrical problems and work practices that may be the subject of customer complaints

How to document customer complaints and forward them to the appropriate personnel

The responsibilities in electrical safety and related regulations

The scope of the Australian Standards and local regulations concerning the supply of electricity

The consequences of unsafe work practices

The need to maintain records of installation testing and completion

The purpose of plans, specifications and tenders

How quotations are prepared from job specifications and customer requests

How quotation letters are prepared from estimators documentation and the information that should and should not be included

How tender documents are prepared for submission

The legal implications in quotations and tenders

Common electrical accessories including their purpose and typical location in a premises, e.g. switches, fuses, circuit breakers, safety switch, electric motor, motor starter, fluorescent light and components, batten holder, socket outlet, main switch, switchboard and meter

How electricity is distributed in a building including the types of circuits and appliances they supply

Ways to adequately and politely question customers to clearly determine the nature of their enquiry or complaint

UTE NES219 A
Co-ordinate maintenance of renewable energy apparatus and systems

Descriptor: Co-ordinate maintenance of renewable energy apparatus and systems and provide technical support to maintenance personnel.

Elements		Performance criteria	
219.1	Plan and prepare for maintenance	219.1.1	Maintenance is planned and prepared to ensure *OH&S policies and procedures* are followed and the work is appropriately sequenced in accordance with *requirements*
		219.1.2	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		219.1.3	Maintenance schedules are obtained to enable appropriate allocation of work
		219.1.4	Materials necessary to complete the work are made available in accordance with *established procedures* and checked against job *requirements*
		219.1.5	*Tools, equipment and testing devices* needed to carry out the work are made available in order that they are checked for correct operation and safety
219.2	Co-ordinate and support maintenance activities	219.2.1	*OH&S policies and procedures* are followed.
		219.2.2	Technical support is provided to maintenance personnel where necessary
		219.2.3	Unplanned events or conditions are responded to in accordance with *established procedures*
		219.2.4	Approval is obtained in accordance with *established procedures* from *appropriate personnel* before any contingencies are implemented
		219.2.5	On-going checks of the quality of work are undertaken in accordance with *established procedures*
219.3	Inspect and notify completion of work	219.3.1	Final inspections are undertaken to ensure the maintenance of *apparatus* and associated systems' *circuits* conforms to *requirements*
		219.3.2	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 applications which includes such things as *apparatus, circuits, wiring systems, plant, equipment, tools, accessories, components* and the like autonomously and to requirements. Equivalent evidence from other sources is also acceptable.

Interdependent assessment of units

This unit should be addressed only after competency in unit UTE NES206 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 - Implementing and monitoring.

Legislation and Australian Standards: AS1470 – 1986; OHSC:7025 (1998); generic competencies A, B and C; relevant acts (electrical); general duty of care

Policy and program development: assigning accountability; focus on improvement

Consultative processes: OH&S committee; meetings and workshops; information gathering

Training and development: provision and type; dissemination of information; cultural considerations; literacy considerations

Hazard identification and assessment: safety audits; workplace inspections; injury and illness records, statistics; complaints and observations; contributing factors to a hazard (exposure, severity, human differences)

Risk assessment and management: hierarchy of control (elimination, substitution, design, mitigation)

Management and improvement: promoting OH&S activities; integration management structures; evaluation of control strategies; evaluation of educational and training programs

Industrial computer systems.

Computer systems overview; PC hardware orientation; basic DOS commands; DOS set-up and utilities; windows operations; word processors; spreadsheets; databases as used for control applications; CAD/vector graphics; introduction to an application package

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; de-rating 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

Electronics for renewable energy systems.

Power switching devices: transistors, darlington pairs, MOSFETs, IGBTs, thyristors (structure, operation and symbol, major device ratings)

Switchmode circuits compared to linear: features/ advantages and disadvantages; efficiency and sources of energy loss in electronic system components; simple photovoltaic voltage regulator; Pulse Width Modulation (PWM) - principles, renewable energy applications; Radio Frequency Interference (RFI) - causes and cures (basic)

DC/DC converters: concept and principles, maximum power point trackers (MPPTs) and other renewable energy applications

Inverters: concept of inversion; inverter bridges; functions and types (output waveforms, use of PWM techniques, block diagram structure single phase and three phase); harmonic content of inverter waveforms (significance in renewable energy systems, trouble shooting)

Differential controllers for SHW systems; hysteresis in switching components

AC load control: phase control, zero-voltage switching, devices for ac load control; SCRs, triacs

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

Generating sets.

Generating sets components

Internal combustion engines: construction; operation; fuel types and ignition methods

Generating sets types, ratings, operating characteristics: petrol, diesel, gas; high and low speed; advantages and disadvantages of different types; prime mover and alternator ratings; alternator waveform; voltage regulation; speed characteristics and governing; response to surge demand

Generating sets sizing: real and apparent power requirements; continuous and surge loads; de-rating factors

Installation requirements: ventilation (cooling and combustion air); exhaust system; vibration isolation; sound attenuation; modifications for long running

Maintenance requirements: fuel system; lubrication; filters; periodic maintenance, diagnose and rectify faults

Safety

Specialisation: Fuel cells

Fuel cells and advanced energy storage technology.

New energy storage technologies – overview: batteries; flywheels; hydrogen production and fuel cells

Redox batteries: principles; types; structure; characteristics

Zinc-bromide batteries: principles; types; structure; characteristics

Fuel cells: principles; types; structure; characteristics

Installation requirements

Maintenance requirements

Safety issues

Specialisation: 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

Specialisation: Wind energy systems

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

UTE NES220 A
Maintain and Repair Digital Televisions

Descriptor: Maintenance and repair of digital television receivers, including the diagnostics of ancillary equipment.

Alignment: Nil

Elements		Performance criteria	
220.1	Plan and prepare the installation	220.1.1	Maintenance and repair is planned and prepared to ensure *OH&S policies and procedures* are followed, and the work is appropriately sequenced in accordance with *requirements*
		220.1.2	Types and location of associated wiring and *apparatus*, are identified from the manufacturers/supplies instructions
		220.1.3	*Appropriate personnel* are consulted to ensure the work is co-ordinated effectively with others involved on the work site
		220.1.4	*Tools, equipment and testing devices* needed for the installation are obtained in accordance with *established procedures* and checked for correct operation and safety
		220.1.5	Where applicable, all relevant regulatory and compliance information, statutory requirements and documentation are obtained prior to commencement of inspection
220.2	Install the video system	220.2.1	*OH&S policies and procedures* are followed
		220.2.2	*Circuits* are checked as being isolated where necessary using specified testing procedures
		220.2.3	Parts or connections of the installation or service that are removed in order to carry out the maintenance and repair are stored to protect against loss or damage and in accordance with *established procedures*
		220.2.4	System is installed to *requirements* , without damage or distortion to the surrounding environment or services.
		220.2.3	Unplanned events or conditions are responded to in accordance with *established procedures*

Elements		Performance criteria	
		220.2.4	Parts, and/or connections removed in the installation process are returned to pre-installation conditions in accordance with *established procedures*
		220.2.5	On-going checks of the quality of the work are undertaken in accordance with *established procedures*.
220.3	Inspect and notify completion of the work	220.3.1	Final inspections are undertaken to ensure the installation conforms to *requirements*
		220.3.2	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 assessed only after competency in unit UTE NES 206 A has been achieved.

Underpinning knowledge

Occupational health and safety implementing and monitoring.

Legislation and Australian Standards: AS1470 – 1986; OHSC:7025 (1994); generic competencies A, B and C; relevant acts (electrical); general duty of care

Policy and program development: assigning accountability; focus on improvement

Consultative processes: OH&S committee; meetings and workshops; information gathering

Training and development: provision and type; dissemination of information; cultural considerations; literacy considerations

Hazard identification and assessment: safety audits; workplace inspections; injury and illness records, statistics; complaints and observations; contributing factors to a hazard (exposure, severity, human differences)

Risk assessment and management: hierarchy of control (elimination, substitution, design, mitigation)

Management and improvement: promoting OH&S activities; integration management structures; evaluation of control strategies; evaluation of educational and training programs

Industrial computer systems.

Computer systems overview

PC hardware orientation

DOS commands

DOS set-up commands

Windows operations

Word processors

Spreadsheets

Databases as used for control applications

CAD/vector graphics

Control applications

Specialisation: Entertainment – TV

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

Display devices.

Picture tubes: types; construction; operational principles; adjustments; drive voltages and waveforms; safety; disposal; EHT voltage measurement; tube rejuvenation and testing

LCD displays: types and operation; construction; scanning techniques; drive voltages and waveforms

Other display devices: plasma; light emitting plastics

Special display types: aspect ratios; HDTV

Projection techniques: front projection; rear projection; 3 tube; single light source; LCD projectors

TV micro controllers.

Micro controller: block diagram; I/O; typical faults; fault-finding

Remote controls: block diagram of transmitter and receiver; service; typical faults; fault-finding

On screen display: circuitry; adjustments; fault-finding

Field storage systems: circuitry; picture-in picture; typical faults

Teletext: operation; circuitry; typical faults

Television servicing practices.

Components and circuits: components and device functions; circuit functions;

interpretation of schematics

Fault-finding: techniques and strategies; analysis of symptoms; locations of faults to component level; repair

Test equipment: TV test signal generators; waveform and voltage measurement; specialised TV test equipment

Safety procedures.

Introduction to camcorders.

Overview: camera block diagram; camcorder block diagram (basic); principles of operation. Standards and tape format: VHS; VHS compact; 8 mm; HI 8; digital (basic)

Pick up tubes and charge coupled devices: newvicon (principles of operation); charge coupled devices (principles of operation)

Lenses and light values: basic lens action; automatic focus (systems and devices); light measurement (light and colour temperature); zoom (optical and electronic)

Adjustment of tube type cameras (monochrome): beam current; focus; beam alignment; video adjustments

Colour separation: early systems; dichroic mirrors; single tube colour stripe filter; colour correction filters

Signal processing (single tube colour camera): static shading correction; dynamic shading correction; white balance (manual and automatic); R-Y/B-Y encoding. Signal processing. (CCD colour camera): CCD charge level; high speed shutter; R-Y/B-Y encoding; digital (basic)

Mechanical overview (basic): video head types – VHS, VHS-C; video 8mm; special tools and equipment

Camcorders power supplies and battery chargers: battery charging requirements; battery types

Digital television principles.

Audio, Audio Encoding, Audio Masking, Audio sub band encoding, MPEG-2 System Layer, PES Packet Construction, Time Stamps, Programme Clock Reference (PCR), Transport Packet Header, Programme Specific Information (PSI), Channel Encoding, Forward Error Correction (FEC), Interleaving, Bit Error Rate (BER), Puncturing, Modulation, Phase Shift Keying (PSK), Quadrature Amplitude Modulation (QAM), Orthogonal Frequency Division Multiplexing (OFDM), Coded Orthogonal Frequency Division Multiplexing, (COFDM), Terrestrial Channel Encoder, Satellite Channel Encoder, Cable Channel Encoder, Carrier to Noise Ratio (C/N), Single Frequency Networks, Guard Interval, Megaframes, Transmission Parameter Signalling (TPS), Pilot Carriers (continuous scattered)

Fast Fourier Transform (FFT), Channel Impulse, Equaliser.

Digital receivers.

The Set Top Box (Integrated Receiver Decoder IRD): System Overview, Programming and Control, The Channel Decoder, Types, Terrestrial, Satellite

Front End Functional Blocks: Tuner, A-D Converter, Types of Demodulator, OFDM, Demodulator, QPSK Demodulator, FEC Decoders, Viterbi, Reed-Solomn, Interleavers

Conditional Access: Free to Air Channels, PAY –TV Channels, Scrambling

Single Chip Set-Top-Box

MPEG Decoding: Transport Demultiplexer, System on Chip Transport Processor (S-o-C), Decoding, Video Decoder, Audio Decoder, Video/audio decoder, SCART Socket

UHF Modulator

Specialisation: Communications – broadcast

Modulation techniques.

Multiplexing: time division multiplexing (TDM); frequency division multiplexing (FDM)

Specialised multiplexing: quadrature modulation (QUAM); compatible quadrature Amplitude Modulation multiplexing (CQUAM); FM stereo multiplexing

Digital modulation: sampling theorem, bandwidth, filtering requirements; pulse code modulation (PCM); pulse width modulation (PWM); delta modulation; quantising noise; compounding; aliasing

Spread spectrum techniques

Frequency selective amplifiers.

Band pass and band stop circuits; tuned amplifiers - using single L.C. load, calculation of gain; amplifiers using frequency selective feedback, active filters; gain stability; higher order filter circuits; multi stage tuned amplifiers; other filter networks - ceramic resonator, surface acoustic wave (SAW) filter, crystal, mechanical, other types; digital filters

Oscillators.

L.O. oscillators using discrete components, colpitts, clapp, hartley, butler, miller (single, multi and overtone operation); variable frequency oscillators; voltage controlled oscillators; synthesised tuning PLL; phase shift; wien bridge; non-sinusoidal - a stable and bistable circuits, 555 integrated circuit, discrete component, crystal, ceramic; buffer amplifiers

Receivers and transmitters.

Receiver block diagrams: principles of dual conversion; DSBFC dual conversion receiver

RF amplifiers: intermodulation; cross modulation; RF amplifier performance

Intermediate frequency (IF) amplifiers: IF amplifier alignment; neutralisation; IF amplifier performance

Demodulation: SSBSC

AGC systems: SSBSC receivers

Phase locked loops (PLL): PLL noise; frequency synthesis using PLLs

Receiver performance criteria: sensitivity test (FM quieting, S/N ratio, SINAD measurements), spurious signal responses; receiver noise figure

NBFM transmitters: operation; tuning and adjustment; testing

Digital transmitters

Transmission towers and equipment.

Earthing, Aviation lighting

Program Input and Monitoring Equipment, digital baseband; routing issues, measuring equipment, digital Radio Frequency (RF) measuring equipment.

Digital Television Terrestrial Broadcast Transmitters, Digital modulators, Digital transmitters, Transmitter: (a) cooling systems (air, liquid), (b) signal measurement techniques

Digital Television Terrestrial Broadcast Transmitters, Combiner and Antenna systems, performance requirements of combiners and antenna systems

DTTB Telemetry, alarm types, simulate various equipment failures, overall system to confirm validity of telemetry responses

Digital television principles.

Audio, Audio Encoding, Audio Masking, Audio sub band encoding, MPEG-2 System Layer, PES Packet Construction, Time Stamps, Programme Clock Reference (PCR), Transport Packet Header, Programme Specific Information (PSI), Channel Encoding, Forward Error Correction (FEC), Bit Error Rate (BER), Puncturing, Modulation, Phase Shift Keying (PSK), Quadrature Amplitude Modulation (QAM), Orthogonal Frequency Division Multiplexing (OFDM), Coded Orthogonal Frequency Division Multiplexing, (COFDM), Terrestrial Channel Encoder, Satellite Channel Encoder, Carrier to Noise Ratio (C/N), Single Frequency Networks, Guard Interval, Megaframes

Digital versatile disc (video) principles.

DVD overview: disc drive unit; disc type and capacity; standard functions of a DVD player

Compression systems: principles of MPEG digital video processing; MPEG standards; reasons for data compression; MPEG2 profiles; hybrid encoding with three technologies - spatial axis compression-discrete cosine transform, time base competition, predictive encoding motion competition, image compression by predictive encoding for predicting motion from neighbouring frames; time base competition; sequence; bidirectional prediction; I,P and B picture sequence; Hoffman encoding - 4:2:0 encoding; data compression: CD ROM(MPEG 1 and 4) – DVD video, DVD ROM; DVD video image quality – variable transfer rate – high image recording efficiency; DVD video sound – 5.1 channel surround sound; Dolby AC3 encoding system, linear PCM

Other DVD features: multiple language – feature, dubbing, subtitles; stream and packet transmission - stream -data flow, packet multiplex transmission system; DVD video interactive features - title menu, DVD menu, multi story, multi angle, multiple aspect ratio, seamless playback, parental control

DVD video copyright protection system: reproduction control - regional codes; copy protection

DVD video software production: disc manufacture (overview)

DVD ROM and other standards: block diagram of a DVD player; RF block; data processor; decryption; buffer control; video decoder; letter box conversion; video equaliser and noise reduction; sub picture; PAL encoder; on screen display; audio detector; audio decoder; clock generation system control; interface control; laser operation principles

Service adjustments: set up, connection and operation of a DVD player

Waveguides and antenna devices.

Safety: RF leakage detection; RF leakage measurement; radio frequency hazards (RADHAZ) markings and precautions

Equipment: microwave test sets (network analysers); PP analysers; RF probes (nada probes); power meters; attenuators; directional couplers; detectors/crystals; build in test equipment (BITE); RF head (injection devices); special purpose RF test sets

Waveguides: frequencies; handling; e and h bends; propagation modes; couplings – RF type; rigid and flexible; rotating joints/bronski couplers (multiple waveguide rotating joints); circulators; dummy loads – air and water cooled; pressurisation and drying (including air, SF6, N2 and other inert gases); teflon; cleaning; RF gaskets and spacers; ferrites – properties and RF applications

Antenna devices: transmit/receive cells; rotary couplings and joints; feed horns; dipoles; reflectors; diplexers; duplexers; end feed slotted array; squint angle correction; squint angle alignment; squint angle compensation

Directional antenna devices: comparators; mechanical scanning (include conical scan on receive only); directional antennae, controllers and feed arrangements; stabilisation – stable elements (mechanical and optical), rate gyros; tracking loops – range and angle; operating modes – designation, search, acquisition and track; search patterns; advanced doppler/pulse doppler; monopulse tracking; RF to optical alignment; FFT and CFAR filters; software control; software elimination of blind/ambiguous ranges and velocities