Electrical Workers Registration Board
SAFETY | COMPETENCY | COMPLIANCE

Teaching Guidelines for Electrical Service Technician

Programme Outline for Examination and Practical Skill Assessments

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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New Zealand Government
Te Kāwanatanga o Aotearoa

Electrical Workers Registration Board
SAFETY | COMPETENCY | COMPLIANCE

More information

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1. Introduction

Under the Electricity Act the Electrical Workers Registration Board (the Board) has a responsibility to set the registration criterion and ensure that all persons applying for electrical registration are competent.

To be eligible for registration as an electrical service technician, an applicant must comply with the Board minimum requirements and satisfy the Board that they are competent.

The examination prescription and practical skills assessments in these teaching guidelines are structured around essential capabilities that are considered relevant to maintenance and "servicing work". These guidelines have been prepared to assist tutors in the development and delivery of courses for trainees and candidates who need to complete the following to be eligible to apply for registration:

- capstone testing – that is, pass the written examination, and
- the practical skills assessment programme.

Tuition courses provided for the electrical service technician registration must include theory, Regulations and Standards and cover all of the subject matter in relevant parts of this document, and practical skill assessments must cover all the relevant skill tasks as listed.

2. Scope

The written examination prescription is for capstone purposes and covers essential capabilities and critical items that are considered relevant to maintenance and servicing of appliances, fittings and equipment.

For the purposes of the Board's registration classes "servicing" means: "any prescribed electrical work that involves the dismantling, repair, adjustment, reassembly and replacement of electrical fittings, other than the installation of permanently wired conductors, of works or electrical installations intended for the generation, conversion, transformation, conveyance, or control of electrical supplies".

A candidate undergoing tuition in accordance with these prescriptions should receive the full range of theory, regulations tuition and practical training that incorporate the appropriate relevant capabilities by:

- completing a Board-approved competency-based training programme, **or**
- completing training under an experience pathway in New Zealand, **or**
- completing registration requirements as an overseas-trained electrical worker.

Practical skills assessments cover the requirements under the "Rules of the Board".

Practical skill assessments apply to candidates who have not satisfactorily completed a Board-approved competency-based training programme or candidates that have been trained in overseas jurisdictions recognised by the Board (or as required by the Board to be eligible to apply for registration).

Note: The subject matter in these prescriptions and guidelines reflect what a trainee or candidate is expected to achieve from tuition courses provided.

3. Electrical Service Technician Registration Requirements

To be eligible for registration as an electrical service technician (EST), an applicant must provide evidence that they have:

1. Passed a Board-approved Electrical Service Technician written theoretical examination; and
2. Passed a Board-approved Electrical Service Technician practical examination; and
3. Completed 2 years of practical work experience and on job training in the PEW of an Electrical Service Technician that is satisfactory to the Board and includes at least 6 months of on multi-phase appliances or fittings;

   or in place of (1) to (3) inclusive:

4. Completed a Board-approved Electrical Service Technician competency-based training programme.

4. Limits of work

An Electrical Service Technician may, subject to the limitations set out below:

a. Carry out low-risk PEW on installations, **excluding:**
   I. replacement of conductors in installations,
   II. any work on a switchboard;
   III. maintenance of any work included in regulation 6A(2) of the ESR.
b. Carry out the maintenance of fittings in works, **excluding** replacement of electric lines in works
c. Carry out PEW on appliances.
d. Test any PEW of the type they are authorised to carry out.
e. Certify any PEW of the type they are authorised to carry out.
f. Supervise one or two persons at one time to carry out PEW.

Limitations

An Electrical Service Technician must **not**:

a. Carry out general or high-risk PEW on any installations
b. Inspect PEW
c. Carry out PEW in a hazardous area, medical cardiac protected area, mining operation or mains parallel generation system
d. Supervise more than two persons at one time to carry out PEW.

4. Written Examination

Written examinations will cover any of the aspects in this prescription. This examination includes electrical theory, referencing the Electricity Regulations and relevant Standards where those information sources are expected to be known by the candidate.

For example, minimum insulation resistance values for an electrical installation or an electrical appliance, including requirements from AS/NZS 3000 and AS/NZS 3760, will be incorporated into examination questions relating to testing.

5. Safety

Safety must be promoted at all times, whether it be classroom tuition, carrying out practical exercises or practical skill assessments.

Safety applies not only to tutors, assessors and candidates, but also to others who may in future depend on the candidate's standard of workmanship and competency.

6. Definitions

Unless the context otherwise requires, within these guidelines:

Term	Definition
Act	means the Electricity Act 1992
Code or ECP	means New Zealand Electrical Code of Practice issued under Part IV of the Act
Regulation	means the Electricity (Safety) Regulations 2010
Standard	means any of the following: • New Zealand Standard (NZS) • A Joint Australian / New Zealand Standard (AS/NZS) • A British Standard (BS) • An International Electro-Technical Commission Standard (IEC)

Other terms and interpretations are defined in the Electricity Act 1992, Electricity (Safety) Regulations 2010, AS/NZS 3000 and the Companion Standards as prescribed in Schedule 2 of the Regulations.

7. Reference Texts

The applicable parts of the following texts must be used when providing tuition in accordance with these Guidelines. Note that:

(a) The most recent edition of the reference texts together with the latest amendments must be used.

(b) For Standards and Codes, the most recent edition and the edition prior may have to be used - this may occur where a newer edition has been published after the one cited in regulations.

(c) EWRB Supervision companion guide.

Training providers however may use any other material they consider relevant to the tuition course, but this material will not be permitted in the examination.

7.1 Legislation

The Electricity Act 1992 and the Electricity (Safety) Regulations 2010.

8. Electrical Service Technician Written Examination Prescription

Subject matter has been taken from essential capabilities incorporating critical items. Subject matter considered critical has been allocated A and B knowledge designations.

Letters “A”, “B”, “C” and “D” appearing in the right-hand margin represent levels of knowledge candidates are expected to attain by completing Board accredited or Board approved courses of study. These designations are:

Knowledge Level	Description
A	Thorough knowledge
B	Good working knowledge
C	General knowledge
D	Basic understanding

8.1 Basic Electrical Theory

(a)	Describe the elements of an electric circuit, including: • Source (battery, generator, a.c. mains, etc). • Conductors (positive, negative, phase, neutral, earth). • Insulation (to contain the conductors within defined limits) • Control (switches, thermostats, energy regulators, etc). • Protection (fuses, circuit breakers, etc). • Metering (voltmeter, ammeter, watt-hour meter, etc). • Load (current using devices)	**B**
(b)	Demonstrate how energy is converted through heat, chemical, magnetic and mechanical processes.	**C**
(c)	Demonstrate knowledge of Ohm’s law, material resistivity, resistor parameters, and introduction to measuring methods.	**C**
(d)	Demonstrate knowledge of how electrical energy is produced from various forms of energy.	**C**
(e)	Explain the operation of a simple practical circuit including current path, circuit control, load, EMF source and conductors.	**C**
(f)	Determine the resistance, voltage and power in any part of a d.c. series and/or parallel circuit using practical knowledge and safe use of measuring instruments.	**C**

(g)	Understand that the total opposition to current flow in an a.c. circuit is impedance (Z).	**B**
(h)	State the formula Z = V/I and perform simple calculations to obtain a value for current (I) when the supply voltage and impedance values are known.	**B**

8.2 Electrical Circuits

(a)	Describe a series circuit.	**B**
(b)	State the characteristics of a series circuit.	**B**
(c)	Draw and label series circuit diagrams incorporating commonly used components.	**B**
(d)	Recognise and use the correct standard symbols for circuit components.	**C**
(e)	Describe a parallel circuit.	**B**
(f)	State the characteristics of a parallel circuit.	**B**
(g)	Draw and label diagrams of simple parallel and series-parallel circuits incorporating commonly used components.	**B**
(h)	Indicate on the diagrams the correct connections for the voltmeter, ammeter and ohmmeter.	**B**
(i)	Explain why electrical appliances are normally parallel connected rather than series connected.	**B**
(j)	Describe the essential differences between a.c. and d.c. current.	**C**
(k)	Transpose the formula for impedance (Z) and perform simple calculations to obtain unknown values for both V or I.	**B**

8.3 Power and energy

(a)	Understand the relationship between voltage, current and power.	**A**
(b)	State the units in which power is measured.	**A**
(c)	State the formulae for power where: $P = V^2/R$, $P = I^2R$, $P = V \times I$.	**B**
(d)	Transpose the power formulae and perform simple calculations to obtain an unknown value.	**B**
(e)	Understand the relationship between voltage, current, time and energy.	**A**
(f)	State the units in which energy is measured.	**A**
(g)	Convert horsepower to watts and vice versa.	**B**

8.4 Electrical conductors

(a)	Describe the properties of commonly used conductors for • use in flexible cord or flexible cable and • rigid use, e.g. o contacts o terminals o heating elements o lamp filaments.	**C**
(b)	Compare the practical advantages and disadvantages of commonly used conductors when exposed to heat, moisture, corrosive materials, dust, gases, tension, compression and vibration, e.g. • Copper • Silver • Aluminium • Tungsten • Carbon • Nichrome • Brass • Bi-metals.	**C**
(c)	Understand the importance of secure, well-made connections in prolonging the service life of a conductor.	**B**
(d)	Identify suitable conductors for various practical applications.	**B**

8.5 Electrical insulators

(a)	State the purpose for which insulating materials are used, e.g. • Protection against accidental personnel contact with live conductors • Protection against short circuiting between conductors • Protection against leakage to earth.	**B**
(b)	Describe the properties of an ideal insulator for: • use on a flexible cord conductor or as sheathing, • rigid use e.g. o supports for electrical elements o framework for portable electrical appliances o separation barriers between live and earthed components.	**C**
(c)	Compare the practical advantages and disadvantages of commonly used insulators when exposed to heat, moisture, corrosive materials, dusts, gases, tension, compression and vibration, e.g. • glass • mica • oils • ceramics • rubber • plastics (various)	**C**

(d)	State the importance of insulation resistance as an indicator of an insulator's condition.	**A**
(e)	Identify suitable insulators for various practical purposes.	**B**

8.6 Flexible cords and cables

(a)	Describe commonly used types of flexible cord and list typical applications for each, e.g. • twin and three core, • twisted, parallel and circular construction • TRS and TPS sheathing • PCP, HO-FR and PVC sheathings for oil and petrol contact.	**B**
(b)	State the types of sheathing suitable for use in high temperature environments and give typical applications for each type.	**B**
(c)	State the New Zealand approved distinguishing colours by which each core in a flexible cord and cable may be identified.	**A**
(d)	Explain the effects of conductor length, cross sectional area and ambient temperature on the current carrying capacity of flexible cords.	**B**
(e)	Understand and explain the effects that oils, petrol, excessive weight or strain, and extremes of temperature have on the insulation and sheathing of commonly used flexible cords.	**B**
(f)	Understand and explain that the selection of a flexible cord for an electrical appliance may depend on environmental conditions prevailing at the cord entry point and the temperature within the electrical appliance where the conductors are terminated.	**B**
(g)	Demonstrate the use of cable manufacturers' tables and AS/NZS 3008.1.2 relating to current ratings, voltage drop and temperature rating factors for various sizes and types of: • flexible cables; AND • flexible cords.	**B**
(h)	Understand that flexible cords are conductors up to and including 4 mm^2 cross sectional area.	**C**
(i)	Understand that flexible cables are conductors having a cross-sectional area greater than 4 mm^2 cross sectional area.	**C**

8.7 Cables

(a)	Understand and apply the general requirements of AS/NZS 3000 in relation to the termination of cables.	**A**
(b)	Understand and explain the construction of the following flexible cables, flexible cords and cables listed below: • TPS and TRS cables • neutral screened cables • MIMS cables	**B**

	• steel wired armoured cables • cables installed in metal and plastic conduit • PVC cables installed in flexible conduit • copper braided sheath flexible cords and cables.	
(c)	Provide typical applications where each of the following types of cables are likely to be encountered: • TPS and TRS cables • Neutral screened cables • MIMS cables • Flexible cables and cords • Cables installed in metal and plastic conduit • PVC cables installed in flexible conduit • Copper braided sheath flexible cords and cables.	**C**

8.8 Cable and cord termination methods

(a)	Understand and explain the methods by which electrical equipment and fittings may be connected to the fixed wired supply, including: • by flexible cord using approved plugs and sockets • by flexible cord from a ceiling rose • by flexible cord or flexible cable from a permanent connection unit, • by flexible cord or flexible cable using suitable connectors housed in an approved box, switch or terminal unit • by direct connection of fixed wiring cables to the appliance terminal box • installation couplers complying with AS/NZS 61535.	**B**
(b)	Understand and explain the connection methods listed above and offer reasons for the selection of one or another in the following circumstances: • portability of the electrical appliance • effects of moisture or vibration • special tariff circuits • loading involved • multi-phase requirements	**C**

8.9 Systems of supply

(a)	Illustrate with labelled diagrams the New Zealand electrical supply system showing the generation, transmission and distribution systems.	**A**
(b)	State the typical voltages involved in each of the above supply areas.	**B**

(c)	Draw and label the three phase four wire New Zealand distribution system to show how it can be used to supply a: • three phase consumer • two phase consumer • single phase consumer.	**A**
(d)	State the advantages of balancing the load over the three phases.	**A**

8.10 Multiple Earth Neutral System

(a)	Explain how the MEN system of supply in New Zealand is configured.	**A**
(b)	Explain reasons why the neutral is earthed at multiple points in the supply system.	**B**
(c)	Understand and explain the principal purpose of the multiple earth neutral system used in New Zealand, including: • maintaining a low neutral/earth parallel return circuit impedance to the distribution transformer • rapid disconnection of supply under fault conditions • ensuring that voltage cannot rise above 230 V to earth.	**B**
(d)	Understand and explain the importance of maintaining reliable low resistance earth circuit values for both protective earth and bonding conductors.	**A**
(e)	Understand and explain the danger high resistance protective earth conductor or bonding conductor connections would present under fault conditions.	**A**
(f)	Explain the implications of a missing MEN link in an installation during fault conditions in respect to line voltage to earth, fault current path, earth loop impedance and operation of protective devices.	**B**
(g)	Distribution type system – explain the circumstances in which an alternative system can be connected downstream of an MEN system.	**B**

8.11 Protection

(a)	State what is meant by the terms rated current and excess current protection.	**A**
(b)	Describe the danger of excess current to cables and equipment.	**A**
(c)	State forms of excess current protection: • close excess current protection • coarse excess current protection.	**A**
(d)	Explain the following terms applicable to sub-circuit protection: • voltage rating • current rating • utilisation categories that replace fusing factors • breaking capacity and kVA rating.	**A**

(e)	Describe, with the aid of labelled diagrams, the construction, operating principles and applications of the following protective devices: • semi-enclosed rewirable fuses • HRC fuses labelled in accordance with BS 88:1998, IEC and AS/NZS 60269, • miniature circuit breakers • HRC fuse cartridge fuses • fusible links • magnetic overload relays • thermal overload relays.	**A**
(f)	Understand and explain the following terms as related to protective devices: • current rating, • voltage rating • fusing current • utilisation category • tripping factor • cut-off characteristic • time versus current characteristic • category of duty • discrimination • back-up protection • rupturing capacity • prospective short-circuit current • earth-fault loop impedance.	**A**

8.12 Electrical safety – personal

Effects of Current

(a)	Demonstrate knowledge of the physiological effects of electricity on humans.	**A**
(b)	Explain: • Why peak voltages are an important consideration in respect to insulation resistance values providing protection from exposure to electric shock. • The danger of simultaneously contacting active and neutral or active and earth conductors. • The effects that varying values of voltages, current, duration of contact and other conditions (wet or punctured skin, etc.) have on the severity of electric shock received by the victim.	**A**

8.13 Personal Protection Devices

8.13.1 Residual current devices (RCDs)

(a)	Understand that RCDs provide supplementary protection to users of electrical appliances and equipment.	**A**
(b)	Demonstrate knowledge of the maximum tripping current and operating times as stated in regulation 24.	**A**

(c)	Explain the verifying and testing requirements in New Zealand to ensure that RCDs installed for protection against shock are **Type A**.	**A**
(d)	Explain, with the aid of a labelled diagram, the operating principles of an RCD used for personal protection.	**A**
(e)	Understand different types of RCDs including: • residual current-operated circuit breakers (RCCB) • residual current-operated circuit breakers with over current protection (RCBO) • socket-residual current protection devices (SRCD) • portable residual current protection devices (PRCD) • RCDs functionally independent of line voltage (used in residential type switchboards and SRCDs) • RCDs functionally dependent on line or auxiliary voltage (used in PRCDs) • typical residual current ratings 10 mA and 30 mA. • classification of RCDs according to the presence of d.c. components. • load leakage currents	**A**
(f)	Understand and apply the principles relating to protection for safety in AS/NZS 3000 and the role RCDs can play in protection for additional safety in damp situations.	**A**
(g)	Understand and apply the requirements regarding the use of RCDs with hand-held electrical appliances.	**A**
(h)	Understand the considerations of installing 10 mA RCDs for protecting areas of increased risk and children against electric shock as detailed in section 2.6.1 of AS/NZS 3000.	**A**
(i)	Testing RCDs to ensure compliance with regulation 24.	**A**

8.13.2 Isolating transformers

(j)	Describe the basic operating principle of an isolating transformer.	**B**
(k)	Explain why the isolating transformer provides maximum safety when used with only one electrical appliance connected.	**C**
(l)	Explain why it is necessary, when two or more electrical appliances are connected simultaneously to one isolating transformer, their earth continuity conductors are bonded together at the transformer but must not be earthed.	**B**
(m)	Understand that the isolating transformer may be used in conjunction with other approved safeguards for extra protection where considered desirable.	**C**
(n)	Explain why transformers are rated in kVA and not watts.	**C**

8.14 Safety tagging system

(a)	Explain the safety tagging system.	**A**
(b)	State the benefits of using the safety tagging system to promote safety in the workplace.	**A**
(c)	Explain methods employed to isolate and lock off equipment, and the importance of using danger tags when working on equipment which may become live.	**A**

(d)	Explain the importance of the Prove-Test-Prove safety rule and the benefits of testing before touch to prevent electric shock.	**A**
(e)	Explain the conditions covering the use of safety tags, their correct placement and removal procedures.	**A**
(f)	Detail written isolation procedures.	**A**

8.15 Legislative requirements for workplace safety

(a)	Understand that employers are required by legislation to provide and maintain equipment and PPE supplied for employees' use in a safe condition.	**B**
(b)	Understand that employees must use the PPE supplied by the employer and comply with all safety procedures established.	**B**

8.16 Safe Working Practices

(a)	Explain that it is essential to identify hazards and potential hazards and take appropriate steps to eliminate, isolate or minimise the hazard risk by observing safety measures at all times to ensure the safety of: • electrical workers or trainees • other workers • members of the public • equipment and property.	**A**
(b)	Explain that electrical service technicians are required to be conversant with the Electricity Safety Regulations to be competent.	**A**
(c)	Explain the importance of using the correct tools, clothing and equipment that is appropriate for the job and being trained to competently use any specialised equipment required.	**A**
(d)	Explain the importance of preliminary safety checks and observing proven safety rules when working at height and when ladders and scaffolding are involved.	**A**
(e)	Understand that good housekeeping and tidy work habits promote a safety culture in the workplace.	**A**
(f)	Explain that personal protective equipment such as covers, mats, gloves, safety harnesses, insulated tools and glasses or goggles are required to be manufactured to an approved safety standard.	**A**
(g)	Explain that regular checks are required to retain the integrity of the safety equipment.	**A**
(h)	Explain why it is necessary to use insulated tools of an approved type when working on electrical fittings.	**A**
(i)	Explain that when working in outdoor or damp situations it is important to supply electrical appliances from either an isolating transformer or from an RCD.	**A**
(j)	Detail the dangers when working with metal ladders, tape, tools and the like on or near electrical supplies or equipment.	**A**

(k)	Explain the dangers of working in explosive atmospheres and stress the importance of ensuring that all electrical equipment is correctly isolated before removing any covers.	**A**
(l)	Explain the procedures when a fire is discovered.	**A**
(m)	Explain the procedures for rescue of a person or persons in contact with live conductors or equipment.	
(n)	Detail the types of fire extinguishers that are suitable for use on electrical fires and explain how each type is used.	**A**
(o)	Detail the dangers and hazards involved when working on high voltage fittings.	**A**
(p)	Explain the precautions necessary when working on circuits which have capacitors connected or other sources of stored energy.	**A**
(q)	Detail the requirements and the need for the presence of a second competent person, in situations where a danger or a potential risk exists.	**A**
(r)	Explain the dangers and hazards associated with short circuits and where potentially high prospective short circuit currents could be present.	**A**
(s)	Explain that electrical arcing exposes victims of electric shock to additional hazards such as arc eye and serious burns.	**A**

8.17 Electrical testing and measuring instruments

(a)	Identify the correct instrument to measure: • Voltage • Current • Resistance • Insulation resistance • Earth continuity • Power	**B**
(b)	Explain the purpose and give typical applications of the following types of test instruments: • ohmmeter • insulation resistance tester • voltmeter • ammeter • phase rotation meter • earth loop impedance tester • RCD tester.	**A**
(c)	Detail any specific precautions required when using the above instruments.	**A**
(d)	Explain how the above types of test instrument should be connected to test a circuit.	**A**
(e)	Explain the importance of ensuring that the correct connections, functions and range are selected on the test instrument before it is used to test a circuit.	**A**
(f)	List the usual functions available in a multi-meter and understand the relationship existing between different ranges of the same function.	**C**

8.18 Electrical appliance testing

(a)	Identify the appropriate instrument for testing an electrical appliance for circuit continuity, • circuit continuity (open or short circuits, dry or loose connections) • insulation resistance (to earth and between phase and neutral) • polarity (phase-neutral or phase-earth reversal) • earth continuity (open circuits, dry, loose or corroded connections) • effectiveness of controls and safety devices.	**B**
(b)	Describe methods of carrying out the tests listed above and state minimum and maximum results, where appropriate, that are considered satisfactory.	**A**
(c)	Understand the reasons for each of the tests listed above.	**B**
(d)	Explain the limitations of the multi-meter and insulation resistance tester when used for testing insulation resistance and earth continuity.	**C**
(e)	Explain why it is necessary to carry out insulation resistance testing at 500 V d.c. and above the normal applied voltage.	**B**
(f)	Describe the various conditions, indications and defects that can be found by visual examination of an electrical appliance being checked for compliance, general electrical and mechanical safety.	**A**
(g)	Describe the precautions that must be observed when connecting a test instrument into a circuit, e.g. • use the correct instrument (or function if using a multi-meter) • observe correct polarities where necessary • use the range appropriate for the expected result • check that connections are clean, tight and safe.	**B**
(h)	Understand the essential safety procedures when using instruments to test live circuits, e.g.: • Do not energise the circuit until appropriate instrument connections have been completed. • Maintain adequate insulation and clearances between instrument clips, probes or leads. • Avoid personal contact with either live conductors or earth when using instruments on live circuits.	**A**

8.19 Electric motors

8.19.1 Three-phase induction motors

(a)	Develop a rotating field using three rotating phasors.	**B**
(b)	Describe the basic components of a three phase induction motor, i.e. • Rotor • Stator windings • Iron circuit	**B**

(c)	Explain the principles of operation of a three phase induction motor in terms of the stator rotating field, rotor currents and flux, relative motion between the rotating field and direction of rotation.	**B**
(d)	Describe motor frame types, ventilation methods available and state a typical application for each type.	**C**
(e)	Understand and explain, with the aid of labelled diagrams, how motor windings can be configured for Star or Delta connections.	**B**
(f)	Understand and explain, with the aid of labelled diagrams, how a motor with six individual winding terminations can be either Star or Delta connected.	
(g)	Explain the effects on a three-phase induction motor if one supply line is open circuited when: • connected in Star • connected in Delta.	**A**

8.19.2 Three-phase induction motor starters

(a)	Describe the types of protection a motor starter can provide and explain how this can be achieved.	**A**
(b)	Describe how phase reversal protection can be provided by a motor starter.	**A**
(c)	Draw a labelled diagram of the control wiring for a 400 V motor including fuse protection, overload unit, stop-start station and a remote stop-start station.	**A**
(d)	State advantages, disadvantages and typical applications for D.O.L. starting.	**B**
(e)	Explain why reduced voltage starting is required in some installations, including advantages and disadvantages.	**A**

8.19.3 Single phase motor operation

(a)	Explain how a single phase supply can be used to provide an alternating magnetic field in motor windings.	**C**
(b)	Explain how phase splitting can be used to provide starting torque in a single phase motor.	**C**
(c)	Describe the operation and construction of single phase induction motor types: • split phase (resistance start) • capacitor start • permanently split capacitor (capacitor start and capacitor run) • capacitor start capacitor run (dual value capacitor). Include advantages, disadvantages and applications for each type.	**B**
(d)	Explain, with the aid of labelled diagrams, the winding connections and how connections can be changed to reverse direction of rotation on split phase, capacitor start, permanently split capacitor, and capacitor start capacitor run motors.	**B**
(e)	Explain, with the aid of labelled diagrams, how external start relays may be used to start single phase induction motors. Include advantages and disadvantages of external relays.	**C**

(f)	Explain the operation and construction of additional single phase motor types: universal, shaded pole and synchronous. State the advantages and disadvantages, applications, and how reversal of rotation can be achieved for each type.	**B** **C**
(g)	Explain methods of speed control for universal motors and state typical applications where universal motor speed control is employed.	**B**

8.19.4 Motor fault finding and diagnosis

(a)	Understand and describe the various faults that can occur with three phase motors and starters, e.g. • mechanical overload • loss of one active (phase) • wrong direction of rotation for a specific load type.	**B**
(b)	Understand and describe the various faults that can occur with single phase motors and starters, e.g.: • mechanical overload. • open circuited start winding • open circuited run winding • incorrect winding connected to centrifugal switch.	**B**

8.20 Commission and decommission equipment and appliances

(a)	Describe procedures for disconnecting conductors at an electrical appliance or at a fixed wiring terminating point, e.g. • direction of rotation of motors • attaching safety tags • isolation methods • checking isolation ("prove – test – prove") • securing isolation (lock off) • identification of conductors and terminals as disconnection proceeds • identifying the phase sequence of poly-phase appliances • making all exposed conductor ends safe • ensuring disconnected cables are protected from mechanical damage or interference.	**A**
(b)	Describe procedures for reconnecting conductors at an electrical appliance or at a fixed wiring terminating point, e.g. • checking safety tags that are in place • checking isolation is still effective ("Prove – Test – Prove") • reconnecting conductors to terminals • ensuring correct direction of rotation of motors • ensuring correct phase sequence of polyphase appliances • carrying out prescribed tests including earthing, polarity and insulation resistance, and where appropriate, the insulation resistance between the motor windings • replacing all covers, screens and guards. Understand the importance of connecting three-phase motors to preserve correct rotational direction.	**A**

(c)	Understand the precautions that must be taken when disconnecting and reconnecting conductors from enclosures, e.g: • TPS and TRS cables • neutral screened cables • MIMS cables • flexible cables and cords • cables in metal and plastic conduit • PVC cables in flexible conduit • copper braided sheath flexible cords and cables	**B**
(d)	Understand and explain the importance of ensuring all conductors are correctly identified and correctly terminated to maintain the correct polarity	**A**
(e)	Understand and explain what would occur if the following conductors were accidentally interchanged on the supply to a single-phase 230 volt induction motor: • the active (phase) and neutral conductors • the neutral and earth conductors • the active (phase) and earth conductors	

8.21 Damp situations and wet areas

(a)	Define a damp situation.	**A**
(b)	Apply the requirements of the Regulations and AS/NZS 3000 in relation to damp situations and wet areas.	**B**
(c)	Understand and explain international protection ratings (IP code) in Appendix G of AS/NZS 3000 and specifically what the respective numbers represent, including the first and second digits.	**A**
(d)	Understand that when an electrical appliance is repaired or components are replaced, the correct components must be used to ensure the appliance retains the correct safety standard.	**C**

9. Practical Tasks and Skills Assessment

During the course of practical instruction and assessment stress the importance of understanding how practical skill tasks relate to “on the job” situations.

The candidate shall demonstrate an acceptable level of skill and competency in the practical skill tasks listed for electrical service technician.

9.1 Skill assessment grading

A consistent grading system has been introduced for all registration classes:

Skill Level	Description
C	Competent
NC	Not Competent

Any skill that has not been assessed is to be awarded a NC result and the reason entered into the comments section on the practical assessment record form.

To pass the practical assessment all skills must be successfully completed with “C” entered into the corresponding result column and initialled by a Board approved skill assessor.

The practical assessment programme is essential to establish the candidate can competently undertake all practical task skills associated with maintenance and “servicing”, including but not limited to:

(a) Identify the components found on domestic and industrial appliances stating their purpose and principal function

(b) Locate, identify and isolate the source of supply at the switchboard, including the replacement of fuse links and resetting of circuit breakers

(c) Locate, identify and isolate at the switchboard the source of supply to nominated permanently connected single, two or three-phase electrical appliances and/or equipment Carry out isolating practice for:

- a switch, a fuse and a circuit breaker
- Secure isolation by means of appropriate safety tags and personal padlock where possible
- Test for live conductors at an isolated appliance using the Prove-Test-Prove method

(d) Disconnect, label and make safe conductors from fixed wired appliances and equipment using a range of single-phase and three-phase cable types

(e) Reconnect and terminate conductors to fixed wired appliances and equipment using a range of single-phase and three-phase cable types

(f) Carry out instrument testing on appliances and equipment for safety and compliance

(g) Restoration of supply and check appliances and/or equipment for correct operation

10. Practical Assessment Skills

Skill no.	Definition and task requirements	
1	Cardiac pulmonary resuscitation (CPR) training in New Zealand Resuscitation Council approved methods.	
2	Electrical safety and safe working practices by observing candidate's ability to competently use the appropriate tools for the job and apply safety principles while carrying out practical skill tasks.	
3	Make up two single-phase cord extension sets using different types of plug-tops and cord connector fittings.	
4	Make up, test and tag a three-phase industrial type cord extension set.	
5	(a) Locate, identify, withdraw rewireable fuses and correctly replace elements at a functional switchboard, including selection of the correct fuse element for cable current rating. (b) Locate, identify, withdraw and replace HRC fuse links at a functional switchboard, with emphasis on replacing links labelled fusing factor with the correct utilisation category such as gG or gM.	
6	Terminate flexible cord, cables and stranded conductors in crimp lugs, terminal posts, screw terminals and washers.	
7	Solder and de-solder components and flexible stranded conductors onto: • printed circuit board • solder tags.	
8	Replace and terminate 10 amp and 15 amp flat pin socket outlet fittings connected to single-phase TPS sub-circuits protected by RCDs to comply with AS/NZS 3000.	
9	Replace fittings connected to RCD protected sub-circuits incorporating one-way, two-way and intermediate switching of ES and BC lamp holders and ceiling roses. Connect fluorescent light fittings to existing ceiling roses and TPS wiring.	
10	Design, install, terminate and test a three heat switching circuit controlling a suitable load.	
11	Design, install, terminate and test an energy regulator control circuit supplying a suitable load.	
12	Live test single-phase and three-phase sub-circuits using appropriate test instruments to obtain voltage, current and earth fault loop impedance values.	
13	Test two (2) Class I and one Class II portable electrical appliance in accordance with AS/NZS 3760. Affix the appropriate appliance tag and complete a test sheet for each appliance.	
14	Test two (2) used electrical appliances in accordance with the requirements of AS/NZS 5761 and AS/NZS 5762 and affix the appropriate tag, e.g. (ref ER 80 and ER 90).	
15	Test a switchboard mounted 30 mA Type A RCD for current operating time and tripping current (ref. ER 24).	
16	Identify at least ten (10) electrical fittings and accessories and state an application for each.	
17	Identify at least ten (10) flexible cords and cable types and specify the current rating and a typical application for each type.	

18	Connect a single-phase induction motor and direct online motor starter, test for safety, connect to the supply and test run. Isolate and change the motor connections to reverse direction of rotation and test run.	
19	Connect a three-phase induction motor and direct online motor starter, test for safety, liven supply and test run. Isolate and change motor connections to reverse direction of rotation, test and run.	
20	Connect Class I and Class II fixed wired appliances to permanent connection units (PCU) using flexible cord.	
21	Disconnection and re-connection of single-phase fixed wired electrical appliances including safety tagging.	
22	Locate, identify, isolate, test, tag, disconnect and reconnect three-phase sub-circuits wired in a range of cable types that includes: • TPS or TRS • cables enclosed in metal or plastic conduit • neutral screen • copper braided sheath • MIMS or SWA. Tasks can be a combination of two disconnections and one reconnection or one disconnection and two reconnections of sub-circuits.	
23	Basic first aid training – complete a course with St John or Red Cross.	





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