ELECTRICAL WORKERS REGISTRATION BOARD

PRESCRIPTION FOR LINE MECHANIC (DISTRIBUTION) EXAMINATION

AND

TEACHING GUIDELINES FOR LINE MECHANIC (DISTRIBUTION) PRACTICAL ASSESSMENTS

Issued by:
N J J Sickels
Registrar
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Contents

1. Introduction

The Electricity Act 1992 requires the Electrical Workers Registration Board to ensure the competency of all persons applying for electrical registration. To become registered as a line mechanic, an individual must satisfy the requirements set out in section 76 of the Electricity Act 1992; and regulation 4(3) and schedule 3 of the Electricity Regulations 1997.

These Line Mechanic (Distribution) Examination Prescription and Teaching Guidelines have been prepared to assist tutors in the development and delivery of courses for line mechanics and trainees who need to complete any or all of the following for registration as a line mechanic (distribution):

- Pass the Theory/Regulations Examination.
- The Practical Assessment.

Tuition provided for Theory or Regulations or the Practical Assessment must cover **ALL** of the subject matter in the relevant part of this document.

While the prescription and guidelines aim to be a detailed as possible, they do not cover every detail. For example, it should not be inferred that a particular subject is limited to the examples listed.

Please note that the release of this document is consistent with section 76 of the Electricity Act 1992 and does not reflect any decisions the board may make in relation to future categories of registration as required by the Electricity Amendment Act 2006.

2. Structure of Guidelines and Prescriptions

All Guidelines and Prescriptions have the same structure and numbering system. The system is based around the 66 essential capabilities for electricians agreed between the Board and Australian Licensing Authorities. These capabilities have been placed in the following groups:

A	Basic Theory	I	Switchboards
B	d.c. Theory	J	Damp and Wet Areas
C	a.c. Theory	K	Testing, Certification and Inspection
D	System Theory	L	Safety, Safe Working Practices, Basic First Aid and CPR
E	Three-phase Motors, Generators and Starters	M	Semi Conductor Devices and Circuits
F	Single-phase motors and starters	N	d.c. Motors
G	Transformers	O	Lighting
H	Circuit and Cable Installation and Protection	P	Legislation

Example H1a.27, H1b.28, H1c.31

These 3 topics relate to protection and control. For "H1b.28"
- "H" relates to the group
- "1" denotes the first topic (or set of related topics) in the group
- "b" denotes that this is the 2nd topic in the set
- "28" is the core capability

Therefore, subject matter for the Guidelines or Prescriptions - other than for electricians – is "aligned" to the equivalent electrician core capability. Also some groups and capabilities do not apply to particular guidelines. For example, capabilities relating to certification of prescribed electrical work do not apply to Electrical Service Technician Guidelines.

3. Scope

The Theory/Regulations Prescription are for examination purposes and cover the requirements in parts 2(a) and (b) of schedule 3 of the Electricity Regulations and the equivalent elements in the National Certificate in Electricity Supply (Line Mechanic Distribution) (Level 4).

The Practical Assessment Guidelines cover the requirements of part 2(c) of schedule 3 of the Electricity Regulations and the equivalent elements in the National Certificate in Electricity Supply (Line Mechanic Distribution) (Level 4).

Therefore, a candidate who is undergoing tuition in accordance with the prescription and guidelines should have received the full range of theory, regulations and practical tuition as part of the National Certificate requirements or under the Electric Linemen Training Committee system or in an overseas jurisdiction.

4. Safety

At all times, safety must be emphasised to students in both classroom tuition and in carrying out practical exercises. Safety, not only for themselves, but for others who may later depend on the standard of their workmanship.

5. Practical Tuition

Wherever possible, students must be given the opportunity to gain confidence in the recognition, handling and use of electrical equipment. Students must use equipment in particular as frequently as possible in order that they can competently use and rely on such aids for personal safety.

6. Examinations

Students must be advised that the content of the practical assessment exercises are also examinable in the written examination.

7. Definitions

Unless the context otherwise requires, within these guidelines:

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 Regulations 1997 and

Standard means any of the following:

- New Zealand Standard (NZS)
- a joint Australian/New Zealand Standard (AS/NZS)
- a British Standard (BS)
- ☐an International Electrotechnical Commission Standard (IEC)

Section

- means a section of the Electricity Act 1992

All other terms are as defined in the Electricity Act 1992, Electricity Regulations 1997 and AS/NZS 3000

8. Reference Texts

Training providers must use the applicable parts of the reference texts detailed in this part when providing tuition in accordance with these Guidelines. Providers:

1. Must use the most recent edition of a reference text and the current amendments.

2. May also need to use the edition of a reference text that was issued prior to the most recent edition. This may occur where a newer edition has been published after the one cited in regulations.

3. Select the course material and reference texts to be provided by students.

4. May use any other material they consider relevant to the course they are providing.

8.1 Legislation

The Electricity Act 1992 reprint, dated 19 August 2005.
The Electricity Regulations 1997 reprint, dated 5 September 2005.
The Health and Safety in Employment Act 1992

8.2 Standards

AS/NZS 3000	(Wiring Rules)
AS/NZS 3760	(Inservice safety inspection and testing of electrical equipment)
AS/NZS 60479-1	Effects of current in human beings and livestock - Part 1:General aspects
NZS 3019	Electrical installations – In-service testing

8.3 Codes

NZECP 34	New Zealand Electrical Code of Practice for Electrical Safe Distances.
NZECP 35	New Zealand Electrical Code of Practice for Power Systems Earthing.
NZECP 41	New Zealand Electrical Code of Practice for Single Wire Earth return Systems

8.4 Other Documents

SMEI	Part 1 - Minimum safety requirements Part 2 - General safety guide Part 3 - Rules for work on equipment)

The Line Mechanics Handbook
Electrical Service Technician "A" Handbook
Electrical Service Technician "B" Handbook

Safe work at heights	Department of Labour

9. Theory/Regulations

THE SUBJECT MATTER FOR EACH TOPIC REFLECTS WHAT A STUDENT (OR CANDIDATE) IS REQUIRED TO ACHIEVE FROM THE TUITION PROVIDED. While the subject matter is as comprehensive as possible, it will not detail every single item that should be covered in a topic.

"Regulations" subject matter can generally be considered to be that which contains direct reference to the Act, Regulations, Standards or Code.

It is expected that candidates will have a thorough knowledge of the electrical theory and statutory requirements that will underpin the knowledge required to understand the subject matter in this section.

A. Basic Theory

A1.1 Theory
Electrical and energy concepts

1. Understand and describe the functions of:

Conductors	Insulators	Insulation
Poles	Towers	Stay straps
Stay wires	Fuses	Switches
Transformers	Pilot wires	Cables
Contactors	Relays	Substations
Plinth	Earthing systems	

2. Understand and define the following terms:

Open	Close	Check
Approved	Energised	De-energised
Live	Dead	Isolated
Earthed	Tested	Safe entry
Tagged	Locked	Low voltage
High voltage	Associated equipment	Confined spaces
Supervisor	Ensure	Assurance
Permits	Restricted area	Issuer
Recipient	Safety observer	Safety measures
Local instructions	Industry procedures	Switching instruction

3. Identify materials commonly used for conductors, insulators and semiconductors including:

   - Conductors – copper, brass, silver, gold, aluminium, steel;
   - Insulators – rubber, polyvinyl chloride (PVC), ceramics, polymer, glass;
   - Semiconductors – silicon and germanium

4. Understand the intermediate nature of semiconductors - between conductors and insulators - with opportunities for change in either direction.

5. State the orders of resistance of materials commonly used for conductors, insulators and semiconductors including

   - Conductors – copper, brass, silver, gold, aluminium, steel;
   - Insulators – rubber, polyvinyl chloride (PVC), ceramics;
   - Semiconductors – silicon and germanium

6. State typical uses of conductors and insulators including:

   - Conductors – copper, brass, silver, gold, aluminium, steel;
   - Insulators – rubber, polyvinyl chloride (PVC), ceramics;

7. Identify and select conductors and insulators for given environmental conditions including:

   - Conductors – copper, silver, aluminium, tungsten, carbon, nichrome, brass;
   - Insulators – glass, oil, ceramics, rubber, PVC;
   - Environmental conditions – heat, moisture, corrosive materials, dust, tension, compression, vibration.

A2.2 Theory
Effects of current

Understand and explain the nature of electric shock in relation to how it may arise, its physiological effect, and the effects of voltage and current on the human body as described by Figure 14 of IEC 60479-1.

A3.3 Theory - Resistance

Understand and explain resistance, resistivity, and resistors including:

(a) Describing resistance in relation to current flow.

(b) Stating the unit for resistance and drawing the symbol.

(c) Defining Ohm's Law.

(d) Explaining the relationship between resistance, voltage, and current in relation to the effect that a change in any quantity has on the other two.

(e) Explain the insulation resistance of a cable in relation to typical values and the effect of cable length.

C. a.c. Theory

C2.11 a.c. – Measurements V, A, P, pf

1 Power and energy

(a) Define power in relation to voltage, current, and resistance.

(b) State the unit and symbol for power.

(c) Define energy in relation to power and time taken

(d) State the units and symbols for energy

(e) Calculate the quantity and cost of energy from given data for a simple domestic loading, and express the result in kilowatt-hours and dollars.

2. Compare calculated and measured values in series and parallel resistive circuits including:

(a) Values – resistance, applied electromagnetic field (EMF), volt-drop, current, power.

(b) Calculating values for a given circuit.

(c) Comparing calculated and measured values for the same circuit.

D System Theory

D1.12 System theory – 1 & 3 –phase systems

1. (a) Define the relationship of line voltage to phase voltage to earth.

   (b) Understand and explain the terms:

   - Delta
   - Star
   - Phasors
   - √3 factor.

2. State the common transmission line voltages (350kv d.c., 220kV, 110kV, 66kV, and 50kV) and sub-transmission, distribution and reticulation line voltages (66kV, 50kV, 33kV, 22kV, 11kV, and 400V)

3. Describe the common overhead power line and power cable configurations including:

   - Single phase and multi-phase phase conductors including SWER systems
   - Bundled conductors
   - Insulators
   - Towers
   - Poles
   - Cross-arms
   - Earthing conductors.

4. Understand the basic principles of high voltage direct current transmission.

5. Describe standard sub-transmission and distribution substation configurations in relation to high voltage switchgear, transformer(s), low voltage switchgear, protection equipment, and local transformer.

6. Identify systems to be worked on or in the immediate vicinity of the work including:

   - Transmission lines
   - Distribution lines
   - Telecommunication lines
   - Traction lines
   - Underground cables

7. Understand the requirements of the Regulations in relation to the strength of works and warning notices

D3.21 System theory - Earthing of installations fittings and appliances

1. Understand and explain the connection of systems to the general mass of earth in relation to safety, insulation levels, and protection.

2. Understand the requirements of the Regulations in relation to the impedance of supply systems.

3. Understand the requirements of the Regulations in relation to the earthing requirements for works

D4.22 System theory - MEN systems

1. Understand and explain the hazards of short circuits and uncontrolled fault currents in relation to the risk of fire and/or other damage to persons and property.

2. Understand the MEN system of supply as used in New Zealand including:

    - MEN switchboards and MEN links
    - The consumer earth electrode
    - The importance of sound neutral connections
    - Dangers of phase/neutral transpositions on mains
    - Earth loop impedances

G. Transformers

D4.22 System theory - MEN systems

1 Understand and explain "current-turns balance" in transformers in relation to magnetising current, primary and secondary ampere-turns.

2. Understand the purpose of transformers used in networks in relation to step-up and step-down secondary electromotive force including:

    - Transformer connections and winding arrangements for single phase, two-phase centre tap, three-phase (star and delta and SWER.
    - Understand the importance of earthing transformers and resistors.

H. Circuit and Cable Installation and Protection

H1a.27 Protection and Control
Protection characteristics

1. Understand and describe how fault currents are detected in relation to overcurrent and earth fault protective relays.

2 Understand and describe the principles of overcurrent and earth fault protective relays in relation to current transformers, protective relays, definite time, and inverse time.

3. Understand principles of various types of fuses including rewireable, HRC, drop-pout and their comparative advantages and disadvantages.

4. Understand the uses and capabilities of various types of circuit breakers including, air, vacuum, SF6 types

5. Understand how surge protection devices work and how they are installed.

6. Understand the requirements of the Regulations in relation to protective fittings and protection against fault currents.

H1b.28 Protection and Control
RCD characteristics

Understand and explain the operation of RCDs including:

(a) Describing the principles of operation in relation to the construction of the device

(b) How an RCD reduces the impact of an electric shock.

(c) Understanding the purpose of a RCD when compared to fuses and circuit breakers.

(d) Explaining the need for, and the nature of, regular testing.

H1c.31 Protection and Control
Selection of control and protection equipment

1. Describe the use of disconnectors and earth switches in relation to the isolation and earthing of conductors and plant.

2. Describe the common means of remote control of switching stations and substations in relation to system control and data acquisition (SCADA) and telecommunications.

H3c.35 Cables and Cords
Overhead and underground

1. Describe how to install HV conductors including:

   (a) Understanding and explaining how to install high voltage overhead conductors

   (b) Explaining how to string high voltage conductors

   (c) Explaining how to tension and terminate conductors

   (d) Explaining how to conduct pre-commissioning checks and tests on overhead conductors

2. Describe how to install structure mounted equipment including:

   (a) Determining the scope of work for installing structure mounted electrical equipment

   (b) Describing how to install structure mounted electrical equipment

3. Describe how to install LV conductors including:

   (a) Interpreting the scope of work for installing low voltage conductors

   (b) Describing how to string conductors

   (c) Describing how to tension and terminate conductors

   (d) Describing how to install and attach conductors to line hardware

   (e) Describing how to conduct pre-commissioning checks and tests on overhead conductors

4. Describe how to install and replace poles including:

   (a) Establishing the pole type and size

   (b) Establishing the structure arrangement

   (c) Establishing the installation method

   (d) Establishing pole setting arrangements

   (e) Checking and locating underground services

(f) Describing how to install electricity network pole hardware

(g) Describing how to erect a pole and replace electricity network pole structures

5. Describe how to install and maintain street lighting including:

(a) Identifying street light systems and types

(b) Identifying lamp types and circuits

(c) Describing how to test and inspect street lights

(d) Describing how to install and service street light fittings including understanding the associated hazards

(e) Describing how to install and service street light circuits

6. Describe how to joint overhead conductors including:

(a) Interpreting the scope of work for jointing overhead conductors

(b) Describing how to prepare conductors for jointing, including where dissimilar metals are used.

(c) Describing how to joint conductors

7. Understand and apply the requirements of the Regulations, AS/NZS 3000 and ECP 34 in relation to the installation of overhead lines and underground cables in electrical installations

8. (a) Understand where the point of supply is located.

(b) Understand the requirements of the Regulations in relation to the voltage supplied at the point of supply

9. Describe how to maintain distribution lines including:

   (a) Explaining the preparation for overhauling distribution pole and tower hardware

   (b) Explaining how to service and/or repair insulators

   (c) Explaining how to replace pole hardware

   (d) Selecting pole hardware for repair and repairing that hardware.

   (e) Selecting pole structures to be repaired

   (f) Explain how pole structures are repaired (fungal control, paint, patching, pole nailing, re-tightening, strapping, bandaging, concrete repair)

H3d.41 <u>Cables and Cords</u>
Specifications

1. Understand and explain conductor current carrying capacity in terms of cross-sectional area, current density, conductor resistance, heating, and heat flow balance.

2. Understand and explain the requirements for insulation of conductors in electrical systems in relation to safety, segregation of conductors of differing phases, and insulation coordination.

H3e.42 <u>Cables and Cords</u>
Termination of cords

1. Describe how to terminate LV polymeric insulated cables including:

   (a) Explaining how to prepare a work site to terminate LV polymeric insulated cables

   (b) Explaining how to terminate LV polymeric insulated cables

   (c) Explaining how to carry out insulation and phase testing on terminated polymeric insulated cables.

2. Describe how to install pad mounted electrical equipment including:

   (a) Establishing pad arrangement

   (b) Establishing the installation method:

   (c) Checking and locating underground services

(d) Selecting hardware and electrical equipment to match scope of work

(e) Describing how to install pad mounted hardware and electrical equipment including:

- Safe working zone
- Site risk assessment

3. Describe how to joint LV cables including:

(a) Determining the scope of work

(b) Identifying cables:

(c) Establishing a safe working zone

(d) Testing cables for jointing

(e) Describing the jointing of LV polymeric insulated cables:

(f) Describing how to test cables and report joint locations in polymeric insulated cable installations

H3i.48 Cables and Cords
Consumer main termination

1. Understand and apply the requirements of AS/NZS 3000 in relation to the termination of cables at the electrical installation/distribution system interface.

2. Understand the typical requirements of a network company in relation to the termination of cables at the electrical installation/distribution system interface.

H6.43 Selection of fittings and Appliances

Understand and explain how double insulation is used for protection including:

(a) Describing how equipment is double insulated

(b) How double insulation of an appliance protects the user from electric shock.

(c) Recognising the symbol for double insulation from an appliance nameplate or graphical representation.

(d) Stating typical uses of double insulation including portable tools, domestic appliances, extension leads.

(e) Describing the essential differences between an earthed appliance and a double insulated appliance.

(f) Stating the reasons why exposed metalwork on double insulated equipment must not be connected to earth.

H8.52A Design and connect switching circuits

1. Describe common switching station and circuit layouts in relation to single and double busbar, duplicate feeders, and ring feeders.

2. Develop work plans:

   (a) Interpret electricity line design information

   (b) Interpret electricity line design drawings and specifications

   (c) Describe how to plan work using electricity supply line design information

H9.62 Commission and decommission equipment and appliances

1. Switching instructions

   Describe how switching instructions are actioned for the safe removal and return of equipment to service

2. Dismantle line and structures

   (a) Identify scope of work

   (b) Establish work procedures and methods

   (c) Describe how to disconnect conductors

   (d) Describe how to dismantle structures – poles and towers

H10.66 Fault diagnosis

1. Describe how to locate and diagnose faults on network equipment including:

   (a) Diagnosing circuit faults to determine if fault conditions are present

   (b) Responding to fault conditions in accordance with standard procedures.

   (c) Monitoring and documenting fault indications from protection equipment for maintenance purposes

2. Describe how to restore power to network equipment including:

   (a) Resetting all relay flags immediately after documenting the operations (relay flags, fault indicators)

   (b) Restoring supply and re-livening network equipment in accordance with procedures:

   - Industry safety rules
   - Network operating standards.

K. Testing, Certification and Inspection

H10.66 Fault diagnosis

1. Testing and inspection – General

   (a) Understand and define the terms "testing" and "inspection".

   (b) List the types of line mechanics work which can only be inspected by a registered electrical inspector.

2. Testing of electrical installations

   (a) Describe the methods of carrying out the tests required by AS/NZS 3000 in relation to overhead electrical lines and underground cables, stating the minimum and maximum values (where appropriate) that are acceptable.

   (b) Understand the Regulations relating to the line mechanics work requiring inspection by a registered electrical inspector prior to connection to the power supply.

   (c) Understand the Regulations relating to all the tests and compliance documentation required to be completed prior to inspection.

3. Connection of electrical installations

   Understand and apply the requirements for the connection of installations including polarity and phase rotation, protection devices, safety of revenue meters and load control and verification of main earthing system

4. Testing of RCDs used for personal protection

   (a) Understand and explain the specific tests that are required by AS/NZS 3760 and state the types of test instruments required to perform those tests.

   (b) Describe the methods of carrying out the tests referred to in AS/NZS 3760, stating the minimum and maximum values (where appropriate) that are acceptable.

   (c) Understand the method of verifying RCDs suitable for personal protection in accordance with NZS 3019 as an alternative to testing.

5. Testing of Isolating Transformers

   (a) Understand and explain the specific tests that are required by AS/NZS 3760 and state the types of test instruments required to perform those tests.

   (b) Describe the methods of carrying out the tests referred to in AS/NZS 3760, stating the minimum and maximum values (where appropriate) that are acceptable.

K3.39 Certification, verification, WOEF

1. Understand and define "certification"

2. List the types of work requiring testing and certification by a registered line mechanic.

3. Explain who is responsible for performing the prescribed tests associated with the completion of the compliance documentation involving:

   - Self certification – work which does not require inspection
   - Work requiring inspection – by a registered electrical inspector.

4. Understand what certifying prescribed electrical work means including:

   - The work is electrically safe and has been tested in accordance with the Regulations
   - The work has been done in accordance with the Regulations. [Regulations 37, 39 and 40].

5. Understand that the Certificate of Compliance must be:

   - Completed within one day of the work being completed or the termination of the contract for the work [Regulation 39(5)]; and
   - One copy of the Certificate must be given to the person for whom the work was carried out with 20 days of the certificate being completed [Regulation 40(2)]; and
   - One copy must be retained for three years or returned to the EWRB [Regulation 40 (4)].

6. Understand the circumstances where a certificate of verification is required to be sighted before reconnection an electrical installation to the supply.

7. Understand the checks and tests required under the Regulations before connecting an electrical installation to the supply.

K4.46 Testing and inspection methods

1. Understand and describe the requirements for testing to take measurements and testing for indication on electricity networks.

2. (a) Identify and describe the functions of electrical test instruments (analogue or digital) including:

   - Voltmeters
   - Ammeters (including clip-on ammeters)
   - Ohmmeters
   - Multimeters
   - Insulation resistance testers
   - Phase rotation meters
   - Earth resistance testers
   - Proximity voltage detectors
   - HV voltage testers.

   (b) Identify and describe the types of measurements taken by test instruments including:

   - LV and HV voltage measurements
   - Current
   - Resistance
   - Insulation resistance
   - Earth resistance
   - Rotation
   - Phasing (LV and HV)
   - Polarity

3. Describe how to take voltage, current, resistance, insulation resistance, earth resistance, rotation, phasing and polarity measurements and indications including:

   (a) Selecting the test instrument to match the type of measurement or indication.

   (b) Visually inspecting the test instrument for safety prior to testing (instrument condition, open circuit fuse in fused lead, broken test lead, open circuit test lead)

   (c) Setting the test instrument for correct measurement by selection of correct function and range.

   (d) Setting up test instruments and connections with the aid of fully labelled

   (e) Demonstrating the 'prove-test-prove' method during testing.

   (f) Describing the consequences of incorrect use of test instruments in relation to polarity reversal, use of wrong instrument, incorrect connection to the circuit, incorrect selection of function or range.

   (g) Take accurate measurements and record results

4. Understand and explain power supply polarity requirements including:

   (a) Describing polarity terms:

   - High and low voltage
   - Naming of conductors
   - Conductor identification and colours
   - Neutral conductors
   - Live conductors.

   (b) Describing the reasons for ensuring correct supply polarity in LV systems:

   - Safety (to life and property)
   - Prevention of risk of exposure to shock and fire damage
   - Live conductors to be switched
   - Neutral conductors at zero or earth potential
   - Commissioning and re-commissioning of equipment.

   (c) Describing the effects of incorrect polarity, high impedance neutral and open circuit neutral in a LV installation in relation to:

   - Phase – neutral reversal
   - Voltage to remote earth
   - Rise of earth potential
   - Fluctuations in supply voltage with change of load.

(d) Describing methods for testing polarity in LV systems including:

- Voltage measurement to a remote earth
- Measurement of current in phase
- Neutral and earthing lead conductors
- Continuity tests to identify conductors prior to connection.
- Voltage detectors
- Marking of phase, neutral and earthing conductors

5. Understand and explain phasing in LV and HV installations and works including:

(a) Describing phasing terms:

- Vector grouping of transformers
- Phase marking and identification of conductors (R, W, B, A, B, C).

(b) Describing the purpose of phasing checks:

- Paralleling supplies and transformers
- Reconnection of conductors (cables and overhead) after repair
- Commissioning new equipment and re-commissioning after repair
- Phase rotation of supplies.

(c) Describing methods for testing of phasing in LV and HV systems:

- Use of phasing phones
- Continuity tests
- Comparison of voltages between a known source and connections being tested
- Use of high voltage phasing and voltage detection equipment.

6. Describe how to inspect lines

(a) Interpret the work specifications for determining the condition of electric lines

(b) Select the inspection method

(c) Obtain access approval

(d) Describe how to conduct inspections of electric lines

(e) Describe how to report condition of electric lines

L. Safety, Safe Working Practices, Basic First Aid and CPR

L1.40/ 54 Isolation Equipment and Personal safety

1. Understand and identify workplace safety principles including:

   (a) Safe work practices.

   (b) Health principles

   (c) Hazard identification systems

   (d) Clear and effective communication

   (e) Communication methods and procedures.

2. Understand and apply safe work practices including:

   (a) Incorporating safe work practices into routine work activities

   (b) Applying communication methods and procedures

   (c) Applying workplace risk assessment and control measures

   (d) Identifying and correcting unsafe work practices

   (e) Identifying and using documents relating to safe work practices

   (f) How worker behaviour promotes safety

3. Identify and apply measures to eliminate or minimise electrical hazards including:

   - Switching off
   - Isolating supply
   - Locking-off and tagging of isolators
   - Disconnecting load side of isolator
   - Proving supply is dead by testing
   - Precautions when leaving unfinished work
   - Precautions for working on live equipment
   - Safety distances
   - Personnel training
   - Safety rules
   - Insulating area
   - Access control
   - Inspection and testing of tools and equipment
   - Inspection of clothing.

4. Earthing

   (a) Understand and describe the requirements for earthing prior to commencing work on networks, including situations where equipotential bonding is necessary.

   (b) Identify and describe the use of HV portable earths, and LV portable earths

   (c) Understand and apply the requirements of the Electricity Regulations and the SMEI in relation to the earthing of for overhead electric line conductors

   (d) Describe how to prepare to apply earths to overhead line conductors of all voltages

   (e) Describe how to prove an earthing point de-energised using a voltage detection device or proving unit or insulation stick

   (f) Describe how to apply and remove the earths from overhead electric line conductors

5. Understand and apply the techniques for testing electrical circuits to ensure safety prior to reconnection including:

   (a) Confirming isolation.

   (b) Confirming by visual inspection the absence of unsafe conditions such as exposed wires, contacts, mechanical faults, and loose connections in accordance with current regulations and standards.

   (c) Confirming by testing with instruments that the circuit is electrically safe including PEC continuity, insulation resistance, polarity, correct circuit connections

6. Identify, explain purpose and use of tags including:

   (a) Danger, warning, beware, caution tags; out-of-service tags; hold cards; in-house tags used for the same effects.

   (b) Use the safety tag system in accordance with safe working practice.

   (c) Use the multiple-trade/multiple-tag system in accordance with safe working practice.

7. Understand and apply the requirements for safe entry into restricted areas including:

   (a) Entry and exit procedures.

   (b) Responsibilities when entering sites

   (c) Identifying potential hazards.

   (d) Applying safe work practices

8. Understand and apply the minimum approach distances for work on or near electrical equipment including:

   - Personnel and safety observers
   - Planning and checking work
   - Position movements
   - Using vehicles and vehicle aerials
   - Ladders
   - Mobile plants.

9. Understand and describe the rules for special work locations including:

   - Confined spaces
   - Areas subject to flooding by gas or water.
   - The various forms of live line work

10. Understand and apply the requirements for carrying out work on structures

    (a) Pre-climbing inspections

    (b) Selecting climbing equipment

    (c) Using climbing equipment

L2.53 <u>Statutory safety requirements</u>
H&S, Supervision

1. Demonstrate knowledge of the Health and Safety in Employment Act 1992 in relation to understanding:

   (a) The scope, coverage, and object of the Act

   (b) How the Act is enforced (inspector functions, rights of entry, issue of notices)

   (c) The health and safety for hazard control requirements of the Health and Safety in Employment Act 1992

   (d) Taking all practicable steps to control hazards

2. Identify and explain the systems suitable for working at heights including:

   - Permanent fixed access
   - Platforms
   - Temporary non-fixed access
   - Scaffolding
   - Mechanical plant for the support of personnel.

3. Outline the principles of supervision of apprentices and trainees in accordance with the Supervision Guidelines for Electrical Workers.

4. Understand that all electrical work is to be performed by competent personnel in accordance with the Regulations

5. Understand and apply the requirements of the Regulations in relation to:

   (a) The associated equipment to be provided and maintained by the employer

   (b) The person responsible within the company for testing and inspection of associated equipment

   (c) The employee's responsibilities relating to the use of associated equipment

L4.56 Safe use of electrical equipment

1. Tools etc.

   Understand and describe the safe use of:
   - Hand tools
   - Line and conductor erection equipment
   - Ropes
   - Ladders
   - Insulation sticks
   - Personal protection equipment
   - Delineation equipment (cones, flags, authorisation rope)
   - Danger tape.

2. Explain the general principles relating to safe use of tools and test equipment are explained including:

   (a) Regular inspection of hand tools

   (b) Routine testing of electrical tools in accordance with AS/NZS 3760

   (c) The features and ratings of test equipment for use on live circuits.

   (d) Identifying when tools and test equipment are in poor condition

3. Understand and apply the requirements of the regulations in relation to hand-held electrical appliances.

4. Explain how to inspect portable electrical appliances for defects including:

   (a) A visual check of appliance and cord for defects.

   (b) Operating the appliance verifies that it works as intended.

   (c) Labelling as defective appliances and putting aside for repair by a competent person

5. Understand and explain the operation and use of isolating transformers including:

   (a) Describing the construction and operation of an isolating transformer in relation to its component parts.

   (b) Describing the manner in which an isolating transformer protects people from electric shock in relation to the electric current path through the body.

   (c) Explaining the safe use of isolating transformers including:

   - One appliance for maximum safety
   - Bonding of earth conductors when used with multiple appliances
   - Use of other safeguards in conjunction with isolating transformer.

6. Select, use and care for personal protective equipment including:

   (a) Selecting equipment according to the requirements for a specific task

   (b) Inspecting and/or test equipment to ensure it is safe to use.

   (c) Use equipment is accordance with its purpose and employer requirements

   (d) Clean equipment in accordance with industry standards.

7. Identify and explain the uses of different types of safety belts and harnesses including safety belts, sit-harnesses, line person belts, full body harnesses.

8. Select, use and care for ladders including:

   (a) Selecting ladders for a specific task, including metal ladders.

   (b) Using ladders in accordance with safe working practices

   (c) Maintaining ladders in a safe condition.

   (d) Handling and storing ladders in a manner that prevents damage and accidents.

   (e) Identifying ladder defects

9. Knots

   Describe the uses of various types of knots including figure 8, reef knot, bowline, 3 x ½ hitches, clove hitch, sheep shank, overhand, eye splice, crown splice.

10. Machinery and vehicles

    Understand the uses of the main types of machinery and vehicles including specialist vehicles (Live Work), cranes, elevated work platforms, helicopters, diggers, trenchers, and hole borers.

11. Lifting and rigging equipment

    (a) Identify and describe the use of light lifting and rigging equipment including gantries, chain-blocks, strops and jacks.

    (b) Understand the documentation and standards for light lifting and rigging equipment including test certificates, certification, standards for safety, inspection and testing of equipment, identification tags, and labels.

L5.59 HV, LV distribution systems

1. Understand the requirements to hold an access permit for work on high voltage lines including:

   (a) Describing industry wide access permit types in relation to access and test permits.

   (b) Describing the permit recipient's responsibilities

   (c) Describing the basic access permit requirements in relation to issuer applied safety measures, recipient applied safety measures.

(d) Describing the access permits recipient's job management responsibilities (before starting work, during work, on completion of work)

(e) Describing the access permits issuer's job management responsibilities are described in relation to SMEI

2. Interpret electrical equipment operating specifications including:

(a) Establishing switching capacity:

(b) Establishing an operating method:

3. Describe how to operate electrical equipment associated with electric lines including:

(a) Obtaining permission to operate

(b) Opening or closing equipment

(c) Checking equipment for correct operation:

- Electrical
- Visual
- Mechanical flags.

(d) Attaching warning notices (locks and warning notices)

(e) Applying and removing earths and taking tests.

(f) Reporting status of equipment.

L6.57/ 58 CPR and basic first aid

1. Basic first aid

These aspects are covered elsewhere within the training system such as in on-job training or practical assessments or refresher courses.
Assessment will occur in those areas and not in the examination.

2. Describe procedures for rescue from an electrical structure, EPV or cable pit including, where applicable:

(a) Incident evaluation that covers rescuer safety.

(b) Assistance in terms of equipment and personnel.

(c) Climbing route in terms of safety and time restrictions.

(d) An assessment of the victim's condition including:

- Breaking contact between victim and supply
- Victim position
- Airway open or closed.

(e) Describing the lowering method (single person rescue or two-person team rescue).

P. Legislation

P1.13 Legislation
Fundamental principles

1. Describe the scope of the Electricity Act 1992 and Health and Safety in Employment Act 1992

2. Understand and apply the Electricity Regulations in relation to safety in the electricity supply industry.

3. Understand the purpose and requirements of industry handbooks including

- SMEI
- EEA Codes of Practice.

4. Understand the purpose and requirements of approved Codes of Practice relating to safety in the electricity supply industry

5. Understand the purpose of Standards covering safety in the electricity supply industry

6. Understand the difference between "works" and "electrical installations".

P2.13 Legislation
Registration

1. State that electrical work carried out by line mechanics on electrical installations is subject to audit by the Electrical Workers Registration Board.

2. Understand that completing a line mechanic tuition course and passing the examination and practical assessment does not entitle a person to carry out prescribed electrical work (unless under supervision) unless registered by the Board

3. Understand that the registration issued by the Board will be a Line Mechanic registration with a distribution limitation that entitles the holder to carry out the construction and maintenance of overhead lines and underground cables.

4. Understand that the Board may impose certain limits or restrictions on the work that may be undertaken or where or for whom the registered person may work.

5. Describe the responsibilities of persons carrying out prescribed electrical work including:

   (a) The need to ensure compliance with the Electricity Act 1992, Electricity Regulations 1997, Standards and Codes and other legal requirements insofar as they apply to the work undertaken.

   (b) The need to ensure a high standard of workmanship.

   (c) The need to work safely.

   (d) The limits and restrictions that apply to persons who may assist a registered Line Mechanic in carrying out prescribed electrical work.

P3.13 Legislation
Practising licences

Understand the requirements of the Act and Regulations in relation to practising licences

P4.13 Legislation
Discipline

Understand the requirements of the Act and Regulations in relation to discipline including:

- Laying of complaints
- Types of disciplinary offences
- Types of disciplinary action that can be taken by the Board

P5.13 Legislation
Accidents

1. Describe how to report a rescue from electrical structure including:

   (a) Notifying appropriate statutory bodies (Energy Safety Service and the Department of Labour)

   (b) Reporting carried out within required timeframes (requirements of relevant legislation, employer requirements).

2. (a) Examine three case studies of electrical incidents and draw conclusions drawn as to the cause of the accident and the extent and nature of the damage resulting from the incident.
   (b) Identify fundamental errors made that led to the incident in relation to hazardous practices used, testing procedures not followed, and general safety measures not taken.

10. Line Mechanic (Distribution) Practical Assessment

Each student should be able to demonstrate a thorough knowledge of and be able to carry out each skill.

G. Transformers

G4.26 Transformers
Application and safety issues

Skill 4

Demonstrate the ability to isolate a transformer on the primary and secondary sides

Skill 6

Demonstrate the ability to remove, repair and replace fuse links.

(a) Identify and carry out the safe work practices required including:

- Using relevant personal protective equipment
- Applying the relevant safety rules
- Controlling hazards

(b) Correctly identify the transformer

(c) Open the fuses on the HV side and ensure a break is established

(d) Open the fuses on the LV side and test for isolation using a test instrument.

(e) Apply safety tag and/or padlock at point of isolation if applicable.

(f) Repair the HV and LV fuses.

(g) Re-liven transformer commencing on the HV side.

H. Circuit and Cable Installation and Protection

H1c.31 Protection and Control
Selection of control and protection equipment

Skill 4

Demonstrate the ability to isolate a transformer on the primary and secondary sides

Skill 6

Demonstrate the ability to remove, repair and replace fuse links.

(a) Identify and carry out the safe work practices required including:

- Using relevant personal protective equipment
- Applying the relevant safety rules
- Controlling hazards

(b) Correctly identify the transformer

(c) Open the fuses on the HV side and ensure a break is established

(d) Open the fuses on the LV side and test for isolation using a test instrument.

(e) Applying safety tag and/or padlock at point of isolation if applicable.

(f) Repair the HV and LV fuses.

(g) Re-liven transformer commencing on the HV side.

H3c.35 Cables and Cords
Overhead and underground

Skill 1

Demonstrate the ability to install and recover conductors under high voltage lines assumed to be line.

1. Install conductors

    (a) Establish the required conductor requirements (size, type)

(b) Establish the installation work plan and method:

- Equipment location
- Protection of equipment
- Pull length
- Rigging set-up
- Structure access

(c) Establish and carry out the requirements for earthing prior to commencing work

(d) Identify and carry out the safe work practices required including:

- Using relevant personal protective equipment
- Applying the relevant safety rules
- Controlling hazards
- Controlling entry to worksite

(e) Handle and string low voltage conductors under (assumed) live high voltage conductors in accordance with industry requirements

(f) Pull up conductors to the specified sag and tension

(g) Terminate conductors at the dead end.

(h) Bind-in conductors

2. Dismantle conductors

(a) Establish the work plan and method:

- Equipment location
- Protection of equipment
- Rigging set-up
- Structure access.

(b) Establish and carry out the requirements for earthing prior to commencing work.

(c) Identify and carry out the safe work practices required including:

- Using relevant personal protective equipment
- Applying the relevant safety rules
- Controlling hazards
- Controlling entry to worksite

(d) Handle and dismantle low voltage conductors under (assumed) live high voltage conductors in accordance with industry requirements:

Skill 2

Demonstrate the ability to joint overhead conductors

(a) Identify conductors and select relevant joint based on rating, size, and type.

(b) Determine a suitable jointing method

(c) Prepare conductors for jointing including:

- Removal of insulation and covering
- Cleaning the conductor
- Separating and preparing conductor strands

(d) Complete conductor joints including:

- Non tension compression joints
- Tension compression joints
- Bolted, clamped, lugged and swagged mechanical joints

(e) Test joint

(f) Re-insulate the conductor and join where applicable

K. Testing, Certification and Inspection

K4.46 Testing and inspection methods

Skill 5

Demonstrate the ability to phase-out LV and HV supplies

(a) Identify and carry out the safe work practices required including:

- Using relevant personal protective equipment
- Applying the relevant safety rules

(b) Identify the purpose of phasing checks:

- Paralleling supplies and transformers
- Reconnection of conductors (cables and overhead) after repair
- Commissioning new equipment and re-commissioning after repair

(c) Select equipment and a method for testing of phasing in LV and HV systems:

- Using phasing phones
- Continuity tests using an ohmmeter
- Comparison of voltages between a known source and connections being tested using a voltage tester
- Comparison of voltages using of high voltage phasing and voltage detection equipment.

(d) Explain the outcome of the test carried out in terms of:

- Vector grouping (transformers)
- Phase marking and identification of conductors (R, W, B, A, B, C).

Skill 8

Demonstrate the ability to conduct earth resistance testing

(a) Select the test instrument to match the type of measurement being taken.

(b) Visually inspect the test instrument for safety condition and correct operation prior to testing

(c) Set the test instrument for correct measurement by selection of correct function and range.

(d) Set up test instruments and connections in accordance with instructions given

(e) Take accurate tests and record results

Skill 9

Demonstrate the ability to test and connect mains of electrical installations.

1. Testing de-energised

   (a) Carry out a continuity test on a mains cable.

   - Carry out an insulation resistance test on a mains cable
   - Carry out a continuity test for polarity on a mains cable
   - Select the test instrument to match the type of measurement being taken.
   - Visually inspect the test instrument for safety condition and correct operation prior to testing
   - Set the test instrument for correct measurement by selection of correct function and range.
   - Set up test instrument and connections
   - Take accurate tests and record results

(b) Carry out a visual polarity test — Demonstrate the correct marking of phase(s) and neutral.

2. Testing energised

Carry out a polarity test using the following methods:

(a) Voltage measurements to a remote earth

- Select the test instrument to match the type of measurement being taken.
- Visually inspect the test instrument for safety condition and correct operation prior to testing
- Set the test instrument for correct measurement by selection of correct function and range.
- Set up test instrument and connections
- Take accurate tests and record results

(b) Measurement of the current in the phase

- Select the test instrument to match the type of measurement being taken.
- Visually inspect the test instrument for safety condition and correct operation prior to testing
- Set the test instrument for correct measurement by selection of correct function and range.
- Set up test instrument and connections
- Take accurate tests and record results

L. Safety, Safe Working Practices, Basic First Aid and CPR

L4.56 Safe use of electrical equipment

Skill 7

Demonstrate the ability to tie a variety of knots and splices

Describe the use of and tie a variety of knot and splices including:

- Figure 8
- Reef knot
- Bowline
- 3 x ½ hitches
- Clove hitch
- Sheep shank
- Overhand
- Eye splice
- Crown splice.

L5.59 HV, LV distribution systems

Skill 3

Demonstrate the ability to operate air-break switches and earth isolated conductors.

(a) Identify and carry out the safe work practices required including:

- Using relevant personal protective equipment
- Applying the relevant safety rules
- Controlling hazards

(b) Obtain permission to operate

(c) Open and close the switch

(d) Check switch for correct operation:

- Electrical
- Visual
- Mechanical.

(e) Attach warning notices and locks where applicable

(f) Report status of equipment.

(g) Apply earths to isolated equipment

(h) Remove earths and restore supply

L6.57/58 CPR and basic first aid

Skill 10

Demonstrate the ability to carry out basic first aid

Carry out basic first aid to the degree required by standard 6401

Skill 11

Demonstrate the ability to perform a pole-top rescue (single man or team)

(a) Evaluate the incident including rescuer safety.

(b) Identify assistance in terms of equipment and personnel.

(c) Establish climbing route in terms of safety and time restrictions.

(d) Climb and assess victim's condition including:

- Breaking contact between victim and supply
- Victim position
- Airway open or closed.

(e) Lower victim to ground and carry out an injury assessment.