Government of Western Australia
North Metropolitan TAFE

# Electrical Trades

## Revision Program

## Review Questions

S. G. Brooks, MEd.
November 2010

# Electrical Trades

# Revision Program

# Review Questions

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# Revision and/Assessment Program

## Balga Campus

| Day | Time | Activity | Supervisor | Notes |
|---|---|---|---|---|
| Mon | 8.00 – 12.00 | Electrical Revision | | |
| | | Lunch | | |
| | 12.45 – 2.45 | Electrical Revision | | |
| | | | | |
| Tues | 8.00 – 12.00 | Electrical Revision | | |
| | | Lunch | | |
| | 12.45 – 2.45 | Electrical Revision | | |
| | | | | |
| Wed | 8.00 – 12.00 | Practical Wiring Assessment<br>Equipment Testing Assessment | | |
| | | | | |
| Wed | 1.00 – 2.45 | Practical Wiring Assessment<br>Equipment Testing Assessment | | |
| Thurs | 8.00 – 2.45 | Written Assessments:<br>Isolation Procedure<br>Theory Tests<br>Installation Design | | |

**Note**: This program is a guide only timings are nominal and may be altered by supervisors to meet special requirements if necessary.
Re-sit opportunities will be discussed if necessary

# Resource Book Contents

| # | Part | Notes |
|---|---|---|
| Part 1 | Underpinning knowledge worksheets. | |
| Part 2 | Answers to underpinning knowledge | |
| Part 3 | Installation design projects | |
| Part 4 | Equipment testing | |
| Part 5 | Isolation procedure | |
| Part 6 | Simulated installation testing | |

# EPC 32 Check Book

## Introduction

Essential Performance Capabilities (EPCs) are published by the National Uniform Electrical Licensing Advisory Council as the 66 essential or minimum capabilities expected of an A grade licensed Electrician in any State/Territory in Australia. To put this statement into a workplace competency context where relevant, a person seeking an A grade electrician licence needs to be capable of competently and safely perform the tasks set out in the tables, in a wide variety of typical industry environments, working independently and without supervision.

This Check Book is intended to provide prospective applicants for an A Grade Electrical Worker‟s Licence in WA with the opportunity to practice answering typical questions on the underpinning knowledge related to the **32 critical** EPCs.

## References and Texts

The following references and texts may be required to answer some of the questions.

**Current Editions with appropriate Amendments**

| |
|---|
| AS/NZS 3000 - Wiring Rules. Standards Australia. |
| AS/NZS 3001 - Electrical installations – Relocatable premises (including caravans and tents) and their site installations. |
| |
| AS/NZS 3008.1.1 - Electrical Installations. Selection of cables. |
| AS/NZS 3012 - Electrical installations - Construction and demolition sites. |
| |
| Electrical Principles for the Electrical Trades - J R Jenneson. |
| Electrical Wiring Practice - Volumes 1&2 - Pethebridge & Neeson. |
| Electrical Trade Principles - A Practical Approach - J Hampson |
| Electrotechnology Practice - J Hampson |
| |
| AS/NZS 3017 - Electrical Installations - Testing guidelines. |
| AS/NZS 3018 - Electrical Installations - Domestic Installations. |
| AS/NZS 3760 - In-service safety inspection and testing of electrical equipment. |
| WA Electrical Requirements: Energy Safety WA. |
| Western Power Distribution Connection Manual |
| AS/NZS 4836 - Safe working practice on low-voltage electrical installations. |
| Code of Practice. Safe electrical work on low voltage electrical installations. Energy Safety WA. |
| |
| Safety Guidelines for Electrical Workers, WA Office of Energy Safety. |
| WA Electricity (Licensing) Regulations 1991 (2008 reprint) |
| The Occupational Safety and Health Regulations 1996 (WA). |
| AS/NZS 2381.1 - Electrical equipment for explosive gas atmospheres - Selection, installation and maintenance. Part 1: General requirements. |
| |

# LIST OF ESSENTIAL PERFORMANCE CAPABILITIES FOR PROSPECTIVE ELECTRICIANS
## (with "Critical Items" shown)

| | ESSENTIAL CAPABILITY | Critical Item |
|---|---|---|
| 1. | Demonstrate a knowledge of basic electrical and energy concepts. | |
| 2. | **Demonstrate a knowledge of the various effects of electric current.** | Critical |
| 3. | Demonstrate a knowledge of resistivity and resistors. | |
| 4. | Demonstrate a knowledge of the various sources of electromotive force (e.m.f.). | |
| 5. | **Explain the operation of a simple practical circuit.** | Critical |
| 6. | **Determine the resistance, voltage, current and power in any part of a DC circuit using theory and actual measurement methods.** | Critical |
| 7. | Demonstrate a knowledge of the theory and application of Capacitors and Inductors | |
| 8. | Demonstrate a knowledge of permanent and electromagnetic theory and application | |
| 9. | Demonstrate a knowledge of electromagnetic induction and state practical examples which make use of this principle. | |
| 10. | Demonstrate a knowledge of Capacitance and Inductance in AC circuits and their effects. | |
| 11. | **Demonstrate a knowledge of alternating voltage & current generation, phase relationships, energy in an AC circuit, and actual measurement methods.** | Critical |
| 12. | Describe Star and Delta three-phase AC systems and the reason why three phase is used. | |
| 13. | **Demonstrate an understanding of the fundamental safety principles of the AS/NZS 3000 Section 1.** | Critical |
| 14. | Demonstrate a knowledge of power factor, power factor improvement principles and power measurement techniques to AC circuits in 1 and multiphase systems. | |
| 15. | Describe the rationale and operating principles and characteristics of three phase induction motors and generators. | |
| 16. | **Describe methods of electric motor selection, starting, connection and protection.** | Critical |
| 17. | Describe the AS/NZ 3000 and local Supply Authority requirements for three-phase motor installations and starters. | |
| 18. | Describe the possible causes of malfunction of three phase induction motors and demonstrate the tests required for diagnosing faults | |
| 19. | Describe the operating principles, typical control methods and characteristics of single phase motors and their key components. | |
| 20. | Describe the suitability of various types of single phase motors for particular applications and describe the fault finding methods. | |
| 21. | **Describe and apply in practice the requirements of AS/NZ 3000 in relation to earthing arrangements and fault loop impedance calculations.** | Critical |
| 22. | **Demonstrate a comprehensive knowledge and understanding of the MEN system and its application, including on sub-installations.** | Critical |
| 23. | Describe the basic construction of transformers. | |
| 24. | Demonstrate an understanding of the principle of operation of transformers. | |
| 25. | List the main types of transformers. | |
| 26. | **List typical applications of various types of transformers and key safety issues.** | Critical |
| 27. | **Describe and apply in practice the requirements for circuit protection using AS/NZS 3000 and other relevant Australian Standards. Eg AS/NZS 3018.** | Critical |
| 28. | **Demonstrate a knowledge of the SELV, PELV and earth leakage current protection systems and their application in accordance with AS/NZS 3000.** | Critical |
| 29. | **Demonstrate the ability to select cables for mains and submains using AS/NZS 3000 and AS/NZS 3008.1 based on current carrying capacity, short circuit capacity, maximum demand and voltage drop, for single phase and three phase installations including multiple installations.** | Critical |

| | | |
|---|---|---|
| 30. | **Demonstrate the ability to select cables for final subcircuits using AS/NZS 3000 and AS/NZS 3008.1 based on current carrying capacity, short circuit capability, maximum demand, earth loop impedance and voltage drop.** | Critical |
| 31. | **Describe the control and protection requirements for installations and equipment. Demonstrate the ability to select suitable equipment and switchgear for a particular installation or part of an installation.** | Critical |

| | **ESSENTIAL CAPABILITY** | **Critical Item** |
|---|---|---|
| 32. | Demonstrate an understanding of the AS/NZS 3000 and regulatory requirements for the location of switchboards and arrangement of switchboard equipment in installations | |
| 33. | **Demonstrate an understanding of the AS/NZS 3000 and regulatory requirements for the installation of electrical equipment in given damp situations and wet areas.** | Critical |
| 34. | **Demonstrate the appropriate methods for the installation, modification and testing of electrical installations and equipment for construction and demolition sites, complying with AS/NZS 3012 and applicable workplace safety legislation.** | Critical |
| 35. | **Demonstrate knowledge of AS/NZS 3000 requirements for the installation of aerial conductors and underground wiring.** | Critical |
| 36. | **Demonstrate a knowledge of the AS/NZS 3000 requirements for electrical installations in hazardous areas and an awareness of the standards to which it refers (e.g. AS 2430, AS/NZS 2381.1).** | Critical |
| 37. | Demonstrate knowledge of the AS/NZS 3000 requirements and the standards referenced for special electrical installations including emergency systems, and construction/demolition sites. | |
| 38. | **Describe and perform to AS/NZS 3000 and AS/NZS 3017 standards the electrical checks and tests required to ensure electrical installations are safe.** | Critical |
| 39. | Demonstrate the reporting of test results for an electrical installation as typically required to satisfy regulatory requirements. | |
| 40. | **Demonstrate the knowledge and skill to perform effective safe isolation of any equipment, including switch and lock off, circuit isolation, equipment testing and tagging procedures.** | Critical |
| 41. | Describe the construction, specifications, colour coding and application of various types of cords and cables. | |
| 42. | Demonstrate the skill to prepare and terminate cords and cables. | |
| 43. | Demonstrate the Selection and attachment of electrical accessories, using appropriate fixing devices and methods. | |
| 44. | **Demonstrate the knowledge and skill to install and terminate a variety of electrical cables in a wide range of applications (including final subcircuits) to AS/NZS3000.** | Critical |
| 45. | Demonstrate the knowledge and skills for the installation of wiring support systems | |
| 46. | **Describe and perform the circuit tests required for electrical cables in a range of installations, with attention to the final subcircuit tests.** | Critical |
| 47. | **Install final subcircuit wiring into switchboards and connect to switchboard equipment in accordance with AS/NZS 3000 and local supply authority requirements.** | Critical |
| 48. | **Connect consumers mains to an installation, in accordance with AS/NZS 3000 and local supply authority requirements.** | Critical |
| 49. | Determine and apply AS/NZS 3000 and AS/NZS 3008 requirements for the installing, terminating and testing of MIMS and Armoured cables. This is to include the cable type selection to AS/NZS 2381 (or other standards) requirements. | |
| 50. | Determine and apply AS/NZS 3000 requirements for the installing, terminating and testing of catenary supported cables, pendant-type socket outlets and trailing cables. | |
| 51. | **Demonstrate the ability to read, sketch and interpret electrical diagrams.** | Critical |
| 52. | Design and connect switching circuits, including via electronic logic controls, as per AS/NZS 3000. | |

| | | |
|---|---|---|
| 53. | **Describe basic statutory occupational safety and health responsibilities for employers and employees, including supervisory requirements and employees' own "duty of care".** | Critical |
| 54. | **Demonstrate an understanding of the requirements for personal safety in the workplace including safe isolation and application of safety practices.** | Critical |
| 55. | Describe a workplace safety check, identify potential workplace hazards and suggest measures for accident prevention. | |
| 56. | Demonstrate the knowledge and practices that are essential for working safely with electrical equipment and tools and knowledge of testing and tagging procedures to AS/NZS 3760. | |
| 57. | **Describe the method of rescuing a person in contact with live electrical conductors or equipment.** | Critical |

| | ESSENTIAL CAPABILITY | Critical Item |
|---|---|---|
| 58. | **Describe the emergency first aid requirements for an electric shock victim and demonstrate the knowledge and application skill of EAR and CPR.** | Critical |
| 59. | **Demonstrate knowledge and understanding of the significant dangers of High Voltage equipment and distribution systems.** | Critical |
| 60. | Describe the types of potential operational situations that may be encountered in various areas of industry that will require assistance from more experienced industry personnel. | |
| 61. | Describe the type of assistance that may be needed for operational situations that could be encountered in various areas of industry. | |
| 62. | **Describe methods of commissioning and/or decommissioning electrical equipment or an installation, using a systems approach.** | Critical |
| 63. | Describe the functioning of basic electronic circuits used in common electrical power circuit applications including related hazards and safety requirements. | |
| 64. | Describe basic control techniques and diagnostic methods for simple DC motor control circuits and applications | |
| 65. | Demonstrate an understanding of the basic operation of various types of luminaires and the purpose of components and ancillary equipment including related hazards and their safety requirements. | |
| 66. | **Demonstrate the knowledge and skills for diagnosing and rectifying faults in electrical apparatus and associated circuits.** | Critical |

Note 1: Under the Capstone Assessment covering the “critical” items, items 57 and 58 are expected to be covered only by a written assessment, although proper practical skill and knowledge will be expected to be developed during the course of training.

**Work Sheet -**

**EPC 02**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 02 | **Demonstrate a knowledge of the various effects of electric current.** | Physiological effects on humans, heating and other energy conversion effects and principles. |

## EPC 02 - Effects of current flow

1. State two common examples of the beneficial effect of the chemical effect of electric current flow.

2. State four common examples of the beneficial effect of the magnetic effect of electric current flow.

3. State two common examples of the non-beneficial effect of the magnetic effect of electric current flow.

4. State the main application of the beneficial effect of the thermal effect of electric current flow.

5. State two common examples of the non-beneficial effect of the thermal effect of electric current flow.

6. What is meant by the term „electrolyte"?

7. What conditions can result in electrolytic „corrosion" as referred to in AS/NZS 3000 Clause 5.5.5.3?

8. What are two of the most dangerous effects of high current passing through the human body?

9. What is the lowest value of electric current which could be considered to be hazardous (approximately)?

10. List four factors which affect the severity of an electric shock.

11. Which part of the human body is affected by the condition known as „ventricular fibrillation"?

**EPC 05**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 05 | **Explain the operation of a simple practical circuit.** | Include current path, circuit control, load, EMF source and conductors. |

## EPC 05 Operation of practical circuits

1. What are the three BASIC parts of an electrical circuit?

2. A typical practical electrical circuit can consist of three BASIC components and two additional ones. What are the two additional components?

**Work Sheet -**

3. What is the purpose of a FUSE or Circuit Breaker in an electrical circuit?

4. At what approximate current would a 10 amp circuit breaker trip?

5. What must essential safety precaution be taken before attempting to replace a fuse or reset a circuit breaker?

6. What is the name of the most common type of cartridge fuse for high current circuits?

7. Draw a circuit diagram of a three-way switching circuit in which one 60 watt incandescent lamp can be switched on or off from either of three switch positions.

**Work Sheet -**

**EPC 06**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 06 | **Determine the resistance, voltage, current and power in any part of a DC circuit using theory and actual measurement methods.** | Theoretical and practical knowledge of measuring instrument use and safe practices whilst using instruments. Include a series and/or parallel circuit analysis. |

**EPC 06 - Series, parallel and series/parallel circuits**

1. What value must be the same in all parts of a series circuit?

2. What value must be the same in all parts of a parallel circuit?

3. What general statement can be made about the sum of the voltages (potential differences) across each component in a series circuit?

4. The resistances in Figure 1 series circuit are R1 = 2Ω, R2 = 4Ω, R3 = 6 Ω and R4 = 8Ω. The applied voltage is 24 d.c. volts. What is the volt drop across each resistor in the circuit?

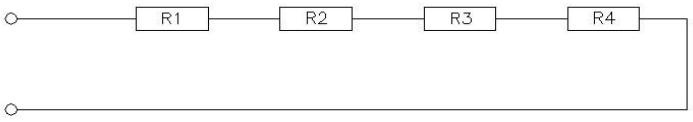



**Figure 1**

5. Calculate the total resistance of four resistors in Figure 2 if their resistances are R1=4 Ω, R2=8Ω, R3=12 Ω and R4=24 Ω ohms respectively.

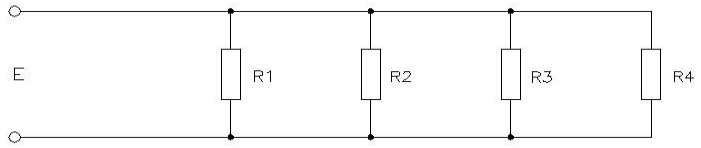


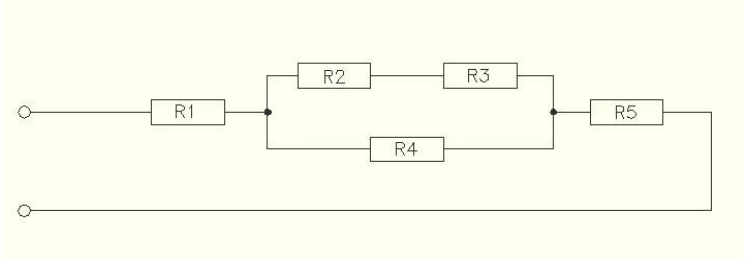

**Figure 2**

6. What general statement can be made about the sum of the individual currents in the components in a parallel resistor circuit on d.c.?

7. What does 'Ohm's Law' state?

8. What is the total resistance of the circuit below (Figure 3 )

R1 6 Ω
R2 10 Ω
R3 5 Ω
R4 30 Ω
R5 8 Ω



**Work Sheet -**

**Figure 3**

9. What effect would it have on the line current in a parallel resistive circuit if one of the parallel resistors was open circuited?

**EPC 11**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 11 | **Demonstrate a knowledge of alternating voltage & current generation, phase relationships, energy in an AC circuit, and actual measurement methods.** | Explain sinusoidal voltage generation and resultant current flow. Define key terms, calculate and apply measuring techniques to derive required parameters. Eg power factor. |

**EPC 11 - AC generation and phase relationships**

1. What condition is necessary for a voltage to be induced in a conductor by a magnetic field?

2. How much voltage is induced in a conductor when it is moved parallel to the flux in a magnetic field?

3. A conductor loop is rotated uniformly within a two-pole magnetic field system. At what point(s) is the induced voltage maximum?

4. What are four 'values' of alternating current?

5. What value of d.c. Would voltage be required to produce the same heating effect as 100 volts peak a.c.?

6. What value of a.c. is most standard measuring instruments designed to indicate?

7. What type of a.c. Is the waveform produced by a typical single phase alternator?

8. What is the phase displacement between the voltages in a three-phase distribution system?

9. Draw a circuit diagram showing how a voltmeter, ammeter and wattmeter can be connected to determine the power factor of a single-phase a.c. circuit.

10. Calculate the power factor of a 240 volt 50 Hz a.c. the inductive circuit in which the ammeter is indicating 10 amps and the wattmeter is reading 1920 watts.

11. Calculate the total input power to a three-phase motor if it is drawing 10 amps from a 415 volt supply at a power factor of a 0.85 lagging. $P = \sqrt{3}VI \cos \varnothing$

-

**Work Sheet EPC 13**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 13 | **Demonstrate an understanding of the fundamental safety principles of the AS/NZS 3000 Section 1.** | Definitions, alterations, protection, design, selection and installation of electrical equipment for electrical safety requirements. This includes protection from direct and indirect contact with live parts. |

**EPC 13 - Safety principles of AS/NZS 3000**

1. Which Clause in the Wiring Rules defines the meaning of the term „Basic Protection‟ or 'DIRECT CONTACT'?

2. Which Clause in the Wiring Rules defines the meaning of the term „Fault Protection‟ or 'INDIRECT CONTACT'?

3. List four general methods of providing protection against direct contact according to the Wiring Rules.

4. List three general methods of providing protection against indirect contact with exposed conductive parts which can become live under fault conditions.

5. What are the five general factors which must be taken into account in the design of any electrical installation? Rule No:-

6. What are the two general factors which must be taken into account when selecting electrical equipment for any installation according to the Wiring Rules – Rule No:-

7. What voltage range is defined as „extra-low voltage‟ according to the Wiring Rules? – Rule No:-

8. Which clause in AS/NZS 3000 lists the characteristics of the electricity supply which must be considered when designing an electrical installation? Rule No:-

9. Which type of protective device would provide the best protection against indirect contact in a pool zone? – Rule No:-

10. What general condition applies to all alterations or additions to an existing electrical installation? - Rule:-

**Work Sheet EPC 16**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 16 | **Describe methods of electric motor selection, starting, connection and protection.** | Reduced current starting, methods of starting (star-delta etc), typical motor lead terminations and protection (including by electronic devices) of the motor from environmental, overload, internal faults and supply variation conditions. |

**Work Sheet -**

**EPC 16 - Motor starting, connection and protection**

1. Name three different types of three-phase current limiting motor starter.

2. What are three of the most likely causes of overheating of a typical three phase squirrel cage induction motor on load?

3. What is the usual name of a common device used to protect a 415 volt three phase squirrel cage induction motor from overheating due to excessively high line currents?

4. What general type of electrical devices requires a fuse with a high rupturing „slow-blow" capability?

5. What type of protection is provided by ALL magnetically operated three-phase motor starters?

6. How many line cables are required between an electromagnetic autotransformer starter and the associated squirrel cage induction motor?

7. What type of three-phase motor starter causes the motor to draw the highest starting current?

8. A particular 415 volts three phase motor squirrel cage induction motor is designed for delta operation on full load and has a standard six-terminal terminal block. Draw a wiring diagram showing how the motor should be connected to a typical single-stage primary resistance starter (not including the internal connections in the starter or motor)

9. How can the direction of rotation of a three-phase induction motor be reversed?

10. What determines the thermal overload setting of a three-phase D.O.L. connected motor?

**EPC 21**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 21 | **Describe and apply in practice the requirements of AS/NZ 3000 in relation to earthing arrangements and fault loop impedance calculations.** | Earthing arrangements for protective and functional purposes, earthing connections and conductor selection. Calculation of the correct cable size for an installation to achieve protective device and cable co-ordination. |

**EPC 21 - Earthing systems and fault loop impedance**

1. Is it necessary to earth metallic boxes which form part of a wiring system if they are isolated from all other conductive material (other than metal which is earthed), and in no part accessible to personal contact? – Rule No:-

2. Is it permissible to install an all insulated luminaire (such as an insulated batten holder) indoors without providing an earthing conductor at the lighting point? – Rule No:-

3. Is it necessary to earth accessible metal parts of low voltage equipment if the accessible metal is separated from live parts by double insulation? – Rule No:-

-

4. What is the internationally recognised symbol which means 'Double insulated - Do not earth'?

5. What precaution must be taken to prevent an internal conductor from coming into contact with accessible metal if it becomes detached from its terminal in a double insulated appliance? – Rule No:-

6. Is it necessary to earth exposed metal in a 32-volt portable hand-lamp? – Rule No:-

7. Is it permissible to loop a MAIN earthing conductor into a luminaire to avoid having to run another earthing conductor to the luminaire? – Rule No:-

8. Is it permissible to connect a subsidiary earthing conductor to a main earthing conductor using a soldered tee joint? – Rule No:-

9. Is it permissible to earth equipment by connecting exposed metal to an earthing conductor which is being used to earth equipment supplied from another distribution board? – Rule No:-

10. What is the minimum permissible size of a single insulated TPI copper main earthing conductor? – Rule No:-

11. A steel wire armoured (SWA) cable is installed in such a way that the armouring is required to be earthed. At which point in the installation must the armouring be earthed? Rule No:-

12. What limitation is placed on the use of metal conduit as the protective earthing conductor for cables which are contained in the conduit? – Rule No:-

13. A particular electric motor is to be fixed in position using four bolts with nuts. Is it permissible to use one of the fixing bolts as the earthing terminal?

14. In general, where must a driven earth electrode be located? – Rule No:-

15. What is the general meaning of the term 'equipotential bonding'? – Rule No:-

16. What is the minimum permissible size of copper equipotential bonding conductor? State the Clause number

17. Any situation which is external to a building and within .....?..... of exposed earthed metal is deemed to be an earthed situation. (Give the Wiring Rules Clause or Table Number)

18. What are two requirements for an effective earth joint? – Rule No:-

19. Is it necessary to earth the metal frame of a domestic installation? – Rule No:-

20. What is the main reason why single insulated 240-volt equipment must be earthed?

21. An EARTHED SITUATION is where there is a reasonable chance of a person touching .....?..... and at the same time coming in contact with an earth. (Give the Wiring Rules Clause or Table Number)

22. Domestic final sub-circuit supplies a load consisting of 10 A socket outlets and is protected by a 20 A Type C circuit breaker. Determine the maximum internal fault-loop impedance of the final sub-circuit, based on 230 V, when the supply is unavailable:

23. A 2.5 $mm^2$ final sub-circuit in a 230-volt domestic installation supplies a load consisting of 10 A socket outlets and is protected by a 16 A Type C circuit breaker. The internal fault-loop impedance, measured at the furthermost socket outlet is 1.99 ohms. Does this value of internal fault-loop impedance satisfy the requirements of AS/NZS 3000?

24. List the internal and external parts of a MEN system which comprise the „fault-loop" according to AS/NZS 3000. State the Clause number.

**Work Sheet -**

**EPC 22**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 22 | **Demonstrate a comprehensive knowledge and understanding of the MEN system and its application, including on sub-installations.** | Multiple Earthed Neutral arrangement, resultant fault current path and magnitude, operation of protective devices and implication of MEN link absence during fault condition. |

**EPC 22 - The MEN system of earthing**

1. Under the multiple earthed neutral (MEN) system, the main earthing conductor is required to be connected to the neutral bar or link. At what point on the neutral bar or link should the connection be made? (Give the Wiring Rules Clause or Table Number)

2. What is an „MEN link‟ or „MEN connection‟ and where is it located? (Give the Wiring Rules Clause or Table Number)

3. What is the only permissible colour for the insulation on an MEN link? – (Give the Wiring Rules Clause or Table Number)
4. What is the minimum permissible size of the MEN link if the consumer‟s mains are not protected on the supply side by a short circuit protective device? – (Give the Wiring Rules Clause or Table Number)

5. Is it permissible to install an MEN link at a distribution board in an outbuilding which is detached from the main building? (Give the Wiring Rules Clause or Table Number)

6. What potentially hazardous situation can arise if the MEN link is not connected correctly in an MEN installation?

7. An installation with a MEN earthing system develops a fault that results in a person receiving an electric shock from metal water pipes. What is the most likely cause?

8. Which clause in AS/NZS 3000 describes the parts of the earth fault loop in an installation?

**EPC 26**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 26 | **List typical applications of various types of transformers and key safety issues.** | Distribution and transmission systems, large consumers‟ installations, within electrical equipment, appliances including welders. Safe working procedures when connecting and testing transformers. |

**EPC 26 - Applications for transformers**

1. What type of transformer would be most suitable for a single high voltage single phase transformer for a neon lighting system?

**Work Sheet -**

2. What type of transformer would be most suitable for reducing the voltage to a single phase shaded pole motor for speed control purposes?

3. What fault would be indicated if the resistance between the two output terminals of a 100 VA 240:12 volt double wound step down transformer was 15 megohms?

4. Transformers are often rated in VA (kVA) rather than watts. Why is this so?

5. What is a typical application for a 100 kVA three phase oil-cooled transformer?

6. If a double wound step down transformer had a turns ratio of 10:1 what would be the voltage ratio and the current ratio?

7. How would you determine if a transformer has shorted turns?

8. What instrument and setting is used to test the insulation resistance of transformers winding to earth?

9. How is a short circuit test between the winding of a transformer carried out?

10. What is the maximum resistance of the earthing connection of a transformer?

**EPC 27**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 27 | **Describe and apply in practice the requirements for circuit protection using AS/NZS 3000 and other relevant Australian Standards. Eg AS/NZS 3018.** | Causes of excess current (and voltage) within a circuit. Calculation and selection of protective devices to satisfy the required Standards. |

**EPC 27 - Circuit protection requirements**

1. What effects can it have on an electrical circuit if the maximum safe working current is exceeded?

2. Which clause in AS/NZS 3000 specified the requirements for coordination between conductors and protective devices?

3. What two factors govern the value of current which can flow in a circuit if a „short circuit" or „bolted fault" occurs?

4. If a distribution transformer had an impedance of 5%, what value of short circuit current would flow if the primary current was 100 amps.

5. Calculate the rated full load current of a 500 kVA, 400/230 volt three phase distribution transformer with an impedance of 5%.

6. Calculate the prospective short circuit current of a 500 kVA, 400/230 volt three phase distribution transformer that has an impedance of 5%.

**Work Sheet -**

7. When providing protection against indirect contact in a 230 volt installation, what is the maximum permissible disconnection time for final subcircuits that supply 10 amp socket outlets? (Give the Wiring Rules Clause or Table Number)

8. When providing protection against indirect contact (fault protection), what is the maximum permissible disconnection time for a final subcircuit supplying a fixed-wired air conditioning unit? (Give the Wiring Rules Clause or Table Number)

9. A 230 volt final subcircuit supplies 10 amp socket outlets and is protected by a 16 amp Type C circuit breaker. Calculate the maximum internal fault-loop impedance of the final subcircuit if the supply is unavailable. (Give the Wiring Rules Clause or Table Number)

10. List the internal and external parts of an MEN system which comprise the „fault-loop" according to AS/NZS 3000. (Give the Wiring Rules Clause or Table Number)

**EPC 28**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 28 | **Demonstrate a knowledge of the SELV, PELV and earth leakage current protection systems and their application in accordance with AS/NZS 3000.** | Protection against both direct and indirect contact using SELV and PELV systems. Protection using Residual Current Device. |

**EPC 28 - SELV, PELV and earth leakage protection**

1. What is meant by SELV and PELV?

2. Is it permissible for SELV circuits to be connected to earth? Give the Wiring Rules Clause number.

3. Which clause in the Wiring Rules specifies requirements for installing ELV cables in the same wiring enclosure as low voltage cables?

4. Is it permissible to install a standard 240 volt 10 amp three flat-pin socket outlet to supply a 12 volt garden light in a domestic installation?

5. What is the main type of protection provided by a 'residual current device' or RCD?

6. To what value of tripping current are small domestic RCD's commonly set?

7. What are two common installation wiring faults that may cause an RCD to trip?

8. Is an RCD designed to protection against electric shock if a person comes in contact with the active and neutral at the same time?

9. All lighting and power circuits in a domestic installation must be protected by an RCD. What is the exception? SAA Wiring Rules No

**Work Sheet -**

10. Is it compulsory for final subcircuits supplying outlets in non-domestic installations such as a workshop to be protected with residual current devices? Give the AS/NZS 3000 Clause number.

11. What is the minimum number of RCDs which may be installed in a domestic installation according to the Wiring Rules?

12. What is the maximum number of circuits that can be protected by one RCD? SAA Wiring Rules No

**EPC 29**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 29 | **Demonstrate the ability to select cables for mains and submains using AS/NZS 3000 and AS/NZS 3008.1 based on current carrying capacity, short circuit capacity, maximum demand and voltage drop, for single phase and three phase installations including multiple installations.** | Determination of maximum demand, voltage drop, interpretation of cable supplier data tables and the impact of various installation methods. Selection of the appropriate cable installation route/method. |

**EPC 29 - Cable selection for mains and submains**

1. Calculate the maximum demand for the following single phase 240 volt single domestic installation. Note: A sample calculation sheet is given at the end of this Work Sheet.

    24 lighting points
    03 single 10 amp socket outlets
    10 double 10 amp socket outlets
    02 ceiling mounted exhaust fans (60 W each)
    01 15 A socket outlet
    01 10 kW cooking range
    01 4.8 kW storage water heater

2. Select the mains cable from cable size from AS/NZS3008:1.1 for the above installation. Installation condition “enclosed underground”

3. Calculate the maximum demand for the following single phase 230 volt single domestic installation.

    02 ceiling mounted exhaust fans (60 W each)
    02 single 10 amp socket outlets
    16 double 10 amp socket outlets
    01 8 kW single phase cooking range
    01 15 A socket outlet for a dishwasher
    32 indoor lighting points
    01 3.6 kW single phase storage water heater
    01 Air conditioner 18 amps

**Work Sheet -**

4. Select the mains cable from cable size from AS/NZS3000 for the above installation. Installation condition “enclosed underground”

5. Calculate the maximum demand for the 400 volt three phase domestic installation.

02 36 W fluorescent lights
03 60 W ceiling mounted exhaust fans
04 300 W outdoor lights
10 single 10 amp 240 V socket outlets
01 15 amp three phase socket outlets
01 10 amp three phase water pump motors
20 double 10 amp single phase socket outlets
40 Lighting points
01 3.0 kW single phase solar hot water booster

6. Select the mains cable from cable size from AS/NZS3008:1.1 for the above installation. Installation condition “enclosed underground”

7. What is the maximum current carrying capacity of the following cable. Give the AS/NZS 3008.1.1 Table Number:

Installation: Domestic
Size: 1 square mm
Type: V 75 TPS copper Final Subcircuit
Circuits: Single
Enclosure: Unenclosed, clipped to the side of a ceiling joist.
Protection: Type C circuit breaker
Phases: 1
Temperature: Up to 40 degrees C

8. What is the maximum current carrying capacity of the following cable. Give the AS/NZS 3008.1.1 Table Number.

Installation: Non-domestic
Size: 2.5 square mm
Type: V75 TPS copper Final Subcircuit
Circuits: Bunched group of four
Enclosure: Enclosed in air
Protection: HRC fuses
Phases: 3
Temperature: Up to 40 degrees C

9. What is the maximum current carrying capacity of 2.5 square mm V75 copper TPS cable in a single phase final subcircuit protected by circuit breaker and installed in direct contact with a ceiling in the roof space of a domestic installation?

Give the AS/NZS 3008.1.1 and AS/NZS 3000 Table Numbers

Sample Maximum Demand Calculation Sheet (Single or Three Phase)

Electrical Trade Revision Program Review Questions

| Load Group | Load | Remarks | Calculations | Contribution per phase (amps) | | |
|---|---|---|---|---|---|---|
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Sample Maximum Demand Calculation Sheet (Single or Three Phase)

| Load Group | Load | Remarks | Calculations | Contribution per phase (amps) | | |
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Sample Maximum Demand Calculation Sheet (Single or Three Phase)

| Load Group | Load | Remarks | Calculations | Contribution per phase (amps) | | |
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Sample Maximum Demand Calculation Sheet (Single or Three Phase)

| Load Group | Load | Remarks | Calculations | Contribution per phase (amps) | | |
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Sample Maximum Demand Calculation Sheet (Single or Three Phase)

| Load Group | Load | Remarks | Calculations | Contribution per phase (amps) | | |
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Sample Maximum Demand Calculation Sheet (Single or Three Phase)

| Load Group | Load | Remarks | Calculations | Contribution per phase (amps) | | |
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**Work Sheet EPC 30**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 30 | **Demonstrate the ability to select cables for final subcircuits using AS/NZS 3000 and AS/NZS 3008.1 based on current carrying capacity, short circuit capability, maximum demand, earth loop impedance and voltage drop.** | Application of maximum demand methods to calculate current requirements and ensure voltage drop is within specification, evaluation of the installation method. |

**EPC 30 - Cable selection for final subcircuits**

1. What is the „maximum demand" of a single purpose lighting final subcircuit in a domestic installation if it is wired in 1 $mm^2$ twin and earth TPS installed clipped to ceiling joists in the roof space? The circuit is protected by a 6 amp miniature circuit breaker.

2. What is the maximum demand of a single purpose final subcircuit supplying a 9 kW 230 V single phase fixed electric cooking range in a domestic installation?

3 A single purpose final subcircuit for a 14 amp 230 volt fixed reverse cycle air conditioner is to be installed in a domestic installation using 5 metres of twin and earth TPS in the cavity and clipped to the side of ceiling joists in the roof space. The circuit is to be protected by 16 amp miniature circuit breaker.

   a) What is the 'installation condition' for this arrangement?

   b) What is the minimum permissible size of cable for Question 3?

   c) What is the minimum permissible size of cable for Question 3 above if the air conditioner was located 30 metres from the associated switchboard and it was a nondomestic installation with bulk thermal insulation on the ceiling?

4. Calculate the voltage drop in one single phase circuit of 16 square mm twin TPS V90 cable installed partially surrounded by bulk thermal insulation. The route length is 25 metres and the maximum demand is 50 amps. Show all working.

5. Which table in AS 3008.1.1 gives the values of three phase voltage drop in mV/A.m (Vc) for aerial copper conductors?

6. What is the lowest permissible voltage at any given three phase appliance in a 415 volt factory installation? Give the AS/NZS 3000 Clause number.

7. What is the lowest permissible voltage at any given appliance in a single 230 volt single domestic installation? Give the AS/NZS 3000 Clause number.

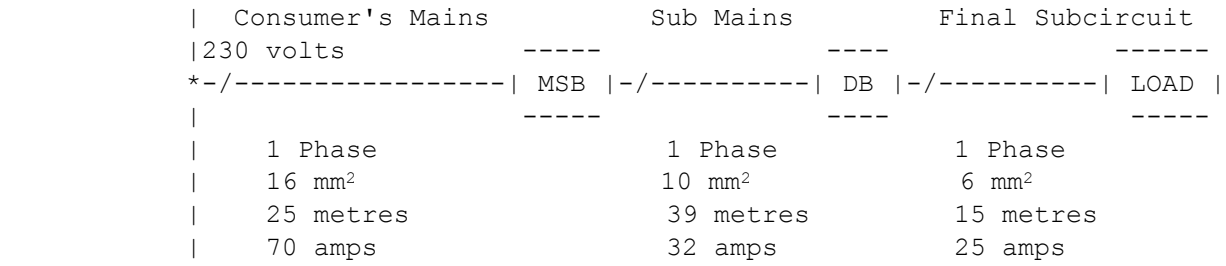
8. Determine the maximum permissible route length for a 2.5 square mm single phase 230 V hot water system V90 TPS final subcircuit which is protected by a 16 A Type C circuit breaker. The voltage drop must not exceed 6 volts. Show all working. Give the AS/NZS 3008.1.1 Clause or Table number.

9. What is the minimum permissible size of cable for a single phase DOMESTIC V90 TPS lighting final subcircuit which has a route length of 30 metres and is protected by a 6 A Type C

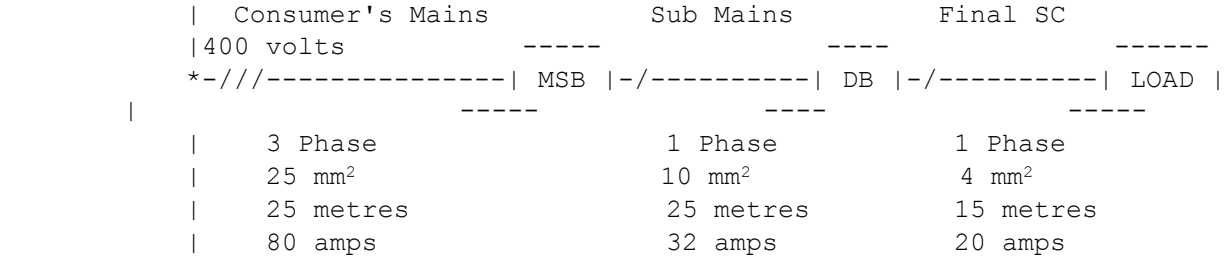
**Work Sheet -**

circuit breaker? Voltage drop must not exceed 3%. Show all workings Give the AS/NZS 3000 Clause/Table Numbers

10. What special condition applies in relation to the voltage drop in final subcircuits which have a distributed load?
11. Calculate the voltage at the LOAD in the following V75 installation: (Show all working.)




12. Calculate the voltage at the LOAD in the following V75 installation: (Show all working.)




13. Determine the current carrying capacity of the active conductors in a 415 V three phase circuit consisting of three 185 square mm V75 thermoplastic insulated unsheathed copper cables laid flat touching as a single circuit clipped to horizontal perforated cable tray installed in free air.

14. What are three possible ways of reducing the voltage drop in a circuit?

15. A 230 volt final subcircuit supplies a 10 amp appliance and is protected by a 16 amp Type C circuit breaker. Calculate the maximum internal fault-loop impedance of the final subcircuit if the supply is unavailable.

**EPC 31**

| # | Essential Performance Capability | Comment |
|---|---|---|

| | | |
|---|---|---|
| 31 | **Describe the control and protection requirements for installations and equipment. Demonstrate the ability to select suitable equipment and switchgear for a particular installation or part of an installation.** | Main board controls, sub-installation control and submain/final subcircuit controls. Assessment of the prospective short circuit current and operating current. Selection of equipment and suitable protection equipment to protect conductors and installed equipment. Inclusion of RCD"s where required. |

**EPC 31 - Control and protection requirements**

1. What are the three main ratings applied to circuit breakers?

2. In relation to “protection against overload current” what is meant by the term coordination in a circuit protection system? State AS/NZS 3000 Clause No

3. If the maximum safe working current for wiring is exceeded and the protection is inadequate or does not operate, how will the wiring be effected.

4. Explain the term inverse time characteristic as applied to fuses and circuit breakers.

5. What limits the value of short circuit current when a short occurs in a final sub-circuit?

6. What is the basic operational difference between a switch and a circuit breaker?

7. Draw a diagram of the switchboard of a typical single phase domestic installation showing the control and earthing arrangements if the installation consists of the following circuits:

    a. Two socket outlet power circuit.
    b. One unprotected power circuit. (Oven)
    c. Two lighting circuits.
    d. One 3.6 kW storage hot water system.
    e. One 7.2 kW cooking range.

-

**Work Sheet EPC 33**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 33 | **Demonstrate an understanding of the AS/NZS 3000 and regulatory requirements for the installation of electrical equipment in given damp situations and wet areas.** | Damp zones and related equipment requirements. Assessment of the earthing requirements and wiring systems for damp and wet areas as per Section 6 of the AS/NZS 3000 Wiring Rules. |

## EPC 33 - Installation in Zone and Specification

1. Which Table in AS/NZS 3000 summaries restrictors in Bathrooms

2. Where may socket outlets be installed in a pool zone for the connection of equipment?

3. What is one method of supply for luminaires immersed in water in a swimming pool?

4. Under what circumstances does steel fence around a pool need to be bonded to exposed metal in the pool zone?

5. Is it permissible to install socket outlets within zone 2 of a bathroom?

6. What is the minimum permissible distance from the internal rim of a 40 litre wash basin to a socket outlet on a vertical wall beside the basin in a bathroom?

7. Select an appropriate IP rating for a light switch which is to be installed in a Zone 1 area near a swimming pool.

8. Is it permissible to install a 240 V socket outlet inside a sauna room?

**EPC 34**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 34 | **Demonstrate the appropriate methods for the installation, modification and testing of electrical installations and equipment for construction and demolition sites, complying with AS/NZS 3012 and applicable workplace safety legislation.** | Assessment of supply requirements, final circuit protection and socket outlet requirements.<br>Portable tool tagging requirements to AS/NZS 3760 and electrical installation testing requirements. |

## EPC 34 - Construction and demolition sites (AS/NZS 3012)

1. Is it permissible to have a mixed final subcircuit supplying lights and socket outlets on a construction site?

2. What is the maximum permissible length of 2.5 square mm, 15 amp three core sheathed extension cord which may be used on a construction site?

**Work Sheet -**

3. What is the maximum length of flexible cord supplying relocatable premises on a construction site?

4. Which clause in AS/NZS 3012 specifies the frequency requirements for the inspection and testing of equipment used on construction sites?

5. What is the minimum permissible height at which festoon lighting may be supported above any floor on a construction site according to AS/NS 3012?

6. Is it mandatory to maintain a record of inspections and tests conducted on relevant equipment on a construction site? Give the AS/NZS 3012 Clause number.

**EPC 35**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 35 | **Demonstrate knowledge of AS/NZS 3000 requirements for the installation of aerial conductors and underground wiring.** | Various types of aerial conductors and their application/installation methods. Assessment of underground and aerial conductor ratings and selection process. Underground cable installation systems. |

**EPC 35 - Aerial and underground wiring requirements**

1. What is the minimum size permissible size for a copper aerial conductor? Give the Wiring Rules Clause number.

2. What is the maximum current carrying capacity of 16 $mm^2$ bare aluminium cable installed where the wind speed is up to 2 metres per second according to AS/NZS 3008.1.1?

3. Single insulated PVC cable can be installed underground enclosed in heavy duty rigid PVC conduit. Which category of wiring system would this come under according to the Wiring Rules? Give the Wiring Rules Clause number.

4. What is the minimum permissible distance between underground wiring and other underground services?

5. An installation requires a Category A underground wiring system to be installed under 50 mm thick paving bricks. What is the minimum permissible depth at which it should be laid? Give the Wiring Rules Table number.

6. What is the rating factor for a 25 $mm^2$ multicore cable buried direct in the ground at a depth of 1 metre according to AS/NZS 3008.1.1?

**EPC 36**

| # | Essential Performance Capability | Comment |
|---|---|---|

**Work Sheet -**

| | | |
|---|---|---|
| 36 | **Demonstrate a knowledge of the AS/NZS 3000 requirements for electrical installations in hazardous areas and an awareness of the standards to which it refers (e.g. AS 2430, AS 2381.1).** | Basics as set out in AS/NZS 3000, awareness of concepts and practices in specialised standards. |

**EPC 36 - Hazardous area installation requirements**

1. What AS/NZS 3000 classification is assigned to areas where combustible dust is likely to create an electrical hazard?

2. What AS/NZS 3000 classification is assigned to areas where flammable gases are present or likely to be present?

3. What are the two general classifications of hazardous areas that are the subject of discussion in AS 2430?

4. Who is generally responsible for the classification of hazardous areas?

5. Which Australian Standard series specifies the requirements relating to the selection and installation of electrical equipment in hazardous areas?

6. AS/NZS 3000 provides information relating to degrees of protection of enclosed equipment.

7. What does IP56 mean?

**EPC 38**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 38 | **Describe and perform to AS/NZS 3000 and AS/NZS 3017 standards the electrical checks and tests required to ensure electrical installations are safe.** | Tests to ensure the requirements of the Standards have been met, include: visual checks, testing energised and de energised circuits – earth continuity, insulation resistance, polarity test, fault loop impedance tests etc. |

**EPC 38 - Installation Testing**

1. Name the two main publications which specify the requirements for testing of domestic and non-domestic electrical installations in WA.

2. Who is responsible for testing a completed installation to ensure that it complies with all legislative requirements and is safe to connect to the electrical supply?

3. List the six types of installation tests which must be completed before a single or three phase electrical installation can be regarded as safe to connect to the electrical supply.

4. Which Australian Standard contains specific guidelines and diagrams describing typical procedures for testing a completed MEN installation?

**Work Sheet -**

5. Which Australian Standard relates to the requirements for installation and testing on Construction and demolition Sites?

6. What is the maximum permissible resistance from the earthing electrode to the point where the main earthing conductor is connected to the neutral conductor in an MEN installation?

7. Why is it essential to disconnect the equipotential bonding conductor of a hot water system when checking the earthing conductor for continuity?

8. What is the minimum permissible insulation resistance to earth in a single phase 230 volt installation which does not include an appliance with a sheathed heating element?

9. What is the minimum permissible insulation resistance to earth in a single phase 230 volt installation which includes an appliance which incorporates a sheathed heating element?

10. What additional action must be taken when measuring the insulation resistance to earth in circuits involving multiple switching such as two-way, three-way and master-on circuits?

11. How must a single phase 10 amp socket outlet be polarised? Give the AS/NZS 3000 Clause number.

12. What fault would be indicated if a resistance of zero ohms was obtained between the active and neutral tails in an installation without a supply connected?

13. What resistance would be expected when measuring the resistance of the heating element of a 230 volt 4.8 kW hot water system?

14. Between what points in a typical domestic installation should the insulation resistance be measured? Rule No. -

15. At what voltage must the insulation resistance to earth be measured in a 415 volt three phase domestic installation?

16. When testing insulation resistance to earth, should the circuit switches be on or off?

**EPC 40**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 40 | **Demonstrate the knowledge and skill to perform effective safe isolation of any equipment, including switch and lock off, circuit isolation, equipment testing and tagging procedures.** | The sequential steps needed to achieve an isolated, tested and safe work area. Preparation of a written isolation procedure. |

**EPC 40 - Safe isolation and tagging procedures**

1. What is the major functional difference between a switch and a typical circuit breaker?

2. What are the main colours used on a danger tag marked 'DANGER, DO NOT OPERATE'?

**Work Sheet -**

3. What are the main colours used on a danger tag marked 'OUT OF SERVICE'?

4. What MAIN precaution must be taken before touching the terminals of any fixed 230/400 voltdevice?

5. What additional precaution must be taken before touching the terminals of any fixed 230/400volt device AFTER you have tested the terminals for zero volts?

6. Who should remove a danger tag from an electrical isolator under normal working conditions?

7. Re-arrange the following actions in the correct sequence for a typical correct isolation procedure:

   Tag Test Isolate Switch off Identify

**EPC 44**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 44 | **Demonstrate the knowledge and skill to install and terminate a variety of electrical cables in a wide range of applications (including final subcircuits) to AS/NZS3000.** | Installation requirements for a wide range of typically used electrical cables in a variety of situations: e.g. thermoplastic, elastomer sheaths, XLPE, high temperature cables. Separation from other services (and fire wall penetrations). |

**EPC 44 - Installation of cables and final subcircuits**

1. What are four factors which must be considered when selecting a wiring system for a particular installation? AS/NZS 3000 Rule No. -

2. Describe eight different types of wiring system and give a typical example of where each one could be used. AS/NZS 3000 Rule No. -

3. According to AS/NZS 3000 what is the maximum number of 10 A socket outlets that may be installed on a 2.5mm² final subcircuit protected by a 16 A circuit breaker in a domestic installation? AS/NZS 3000 Rule No. -

4. Is it necessary to clip cables in a roof space if the roof is less than 0.6 metres above the ceiling? AS/NZS 3000 Rule No. -

5. Is it permissible to clip TPS cables to a ceiling joist within 50 mm of the ceiling? AS/NZS 3000 Rule No. -

6. What is the largest diameter hole that is allowed in a wall for cables to pass through without fire rating protection? AS/NZS 3000 Rule No. -

7. May conductors that form part of a different electrical installation be installed within the same enclosure? AS/NZS 3000 Rule No. -

**Work Sheet -**

8. Underground wiring systems are classified as one of three types. Name them. AS/NZS 3000 Rule No. -

9. What is the minimum depth of cover for a Cat B underground wiring system installed under 80mm of poured concrete, external to the building? AS/NZS 3000 Rule No. -

10. How deep must Orange Marker tape be buried above an underground wiring system? AS/NZS 3000 Rule No. -

**EPC 46**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 46 | **Describe and perform the circuit tests required for electrical cables in a range of installations, with attention to the final subcircuit tests.** | Earth continuity, insulation resistance, fault loop impedance, polarity and correct circuit connection tests. |

**EPC 46 - Circuit tests in installations**

1. List the order in which installation tests should be carried out in a typical new single domestic installation before the supply is connected.

2. Which Table in AS/NZS 3000 gives the maximum permissible values of total earth fault-loop impedance ($Z_s$) in a 230 volt a.c. installation?

3. Which Clause in AS/NZS 3000 gives a method of measuring fault-loop impedance with an instrument capable of measuring and indicating low values of impedance?

4. Which Clause in AS/NZS 3000 lists the mandatory (compulsory) tests which must be carried out on electrical installations?

**Work Sheet -**

**EPC 47**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 47 | **Install final subcircuit wiring into switchboards and connect to switchboard equipment in accordance with AS/NZS 3000 and local supply authority requirements.** | Termination of subcircuit cabling at switchboards and connection to components. |

**EPC 47 - Switchboard connections from subcircuits**

1. Is it necessary to mark the electrical components on a switchboard to indicate their relationship to each other? - Rule No. -

2. List five of the electrical accessories that would be found on the switchboard for a typical single phase single domestic installation which had at least two lighting circuits and two power circuits. Rule No. -

3. If two or more circuit breakers are mounted in the same row on a switchboard, is it necessary to orient the operating mechanism of each circuit breaker in the same general direction? – Rule No. -

4. What is the maximum permissible mounting height for a main switch above the ground, floor or platform? – Rule No. -

5. How can all protective earthing conductors be joined together if an earth link is not provided at the main switchboard? – Rule No. -

**Work Sheet -**

**EPC 48**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 48 | **Connect consumers mains to an installation, in accordance with AS/NZS 3000 and local supply authority requirements.** | Installation of consumer‟s mains in buildings and underground. Termination at pillars, pits and mains connection boxes. Bonding of metallic meter enclosures. |

## EPC 48 - Installation and connection of consumers mains

1. What is the minimum permissible current carrying capacity of the consumer's mains in a single phase single domestic installation?

2. What is the minimum permissible current carrying capacity of the consumer's mains in a three phase single domestic installation?

3. Which Clause in the WA Electrical Requirements specifies the general requirements for the installation of consumer's mains and sub-mains?

4. What is the minimum permissible depth of underground residential consumer's mains? State AS/NZS 3000 Clause No

5. Where do the consumer's mains begin in a domestic installation in which the consumer's mains are installed underground?

6. Is it permissible to use heavy duty corrugated PVC conduit to enclose underground residential consumer's mains? State AS/NZS 3000 Clause No

7. If a supply authority's 2 core parallel-webbed aerial SERVICE LINE has one ribbed conductor, should it be the active or the neutral? State AS/NZS 3000 Clause No

**EPC 51**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 51 | **Demonstrate ability to read, sketch and interpret electrical diagrams.** | Purpose and characteristics of schematic, block and wiring diagrams, typical symbols used. |

## EPC 51 - Read, sketch and interpret electrical diagrams

1. What is the MOST important convention which must be known when reading an electrical circuit (schematic) diagram?

2. Which type of electrical drawing shows the OUTLINE operation of a circuit?

3. If a particular electrical circuit diagram shows some conductors as thick lines and others as thin lines, what do the THICK lines represent?

4. Which type of electrical drawing shows the actual connections between individual terminals?

**Work Sheet -**

5. What type of electrical drawing usually shows connections in CONDUCTORS rather than at the actual terminals of the components?

6. What type of electrical drawing is usually most suitable for checking the existing wiring in a control circuit?

7. What is the most suitable type of electrical diagram to use when determining the sequence of operation of an electrical control circuit?

8. Draw the correct Australian Standard symbol for each of the following as they would appear on a circuit (schematic) diagram:

   a. circuit breaker
   b. stop button
   c. fuse
   d. relay contact - normally open
   e. contactor coil
   f. resistor
   g. thermal overload heater element

9. Draw the correct Australian Standard symbol for each of the following as they would appear on an architectural drawing such as a floor plan of a domestic residence:

   a. single pole light switch b a typical luminaire (lighting fitting) c a two-way light switch
   d a 10 amp general purpose socket outlet (single)
   e a 10 amp general purpose socket outlet (double)
   f a twin 36 watt fluorescent lighting fitting

**EPC 53**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 53 | **Describe basic statutory occupational safety and health responsibilities for employers and employees, including supervisory requirements and employees' own "duty of care".** | Occupational Safety and Health regulations and electrical safety regulations - legal requirements, safety committees and duty of care. |

**EPC 53 - Basic OSH and supervision responsibilities**

1. How does the Occupational Safety and Health Act benefit you as an employee?

2. What is meant by the term 'duty of care' in relation to Occupational Safety and Health?

3. List FOUR 'duties of care' which are the responsibility of the employer in relation to Occupational Safety and Health?

**Work Sheet -**

4. List FOUR 'duties of care" which are the responsibility of the employee in relation to Occupational Safety and Health?

5. What qualifications and experience must an applicant for the position of OSH Safety Representative have? Give three factors.

6. What is the general penalty if an individual employee commits an offence against the Occupational Safety and Health Act?

7. What two actions must an employee take if he or she becomes aware of a situation which is hazardous?

8. Which two areas of industry are exempt from the requirements of the Occupational Safety and Health Act 1984? Why?

**EPC 54**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 54 | **Demonstrate understanding of the requirements for personal safety in the workplace including safe isolation and application of safety practices.** | Adoption of safe working practices, incident reporting process and responsibility to co-workers. Reference to safe electrical work guidelines issued by regulators, including supervision requirements applying to apprentices and trainees. |

**EPC 54 - Requirements for personal safety in the workplace**

1. What are the three major principles for the prevention or control of hazards in the workplace?

2. Which clause in the Wiring Rules specifies the requirements for devices which can be used as a point of isolation for a typical isolation procedure?

3. Who is directly responsible for the way you act at your workplace?

4. What is the general meaning of the term „risk assessment" when applied to OS&H?

5. What are the two main CAUSES of industrial accidents?

6. List FOUR examples of unsafe acts in an industrial situation.

7. List FOUR examples of unsafe conditions in the workplace.

8. List FOUR general guidelines for safe behaviour in the work area.

9. What is the purpose of BLUE lines marked on a floor in a workshop?

10. List ONE items of safety equipment which can be used to protect each of the following:

| | | | |
|---|---|---|---|
| a. | The Head | e) | The Lungs |
| b. | The Eyes | f) | The Ears |
| c. | The Face | g) | The Hands |
| d. | The Feet | h) | The Body |

11. Which two items of approved safety equipment MUST be worn on ALL construction sites?

**Work Sheet -**

12. What procedure should be followed if a worker finds a 240 volt electric power drill which has a damaged casing, brush cap, switch, lead or plug, or which overheats and smells burnt?

13. What important safety precaution should always be taken when lifting any object?

14. What MAIN precaution must be taken before touching the terminals of any fixed 240/415 volt device?

15. What additional precaution must be taken before touching the terminals of any fixed 240/415 volt device AFTER you have tested the terminals for zero volts?

**EPC 57**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 57 | **Describe the method of rescuing a person in contact with live electrical conductors or equipment.** | Fundamental principles of emergency procedures. |

**EPC 57 - Electrical rescue procedures**

1. What is the first consideration when you discover a person receiving an electric shock?

2. How would you remove a victim receiving an electric shock if the power could not be isolated?

3. What are the six steps that should be followed if you discover a person suffering from electric shock?

4. What is the procedure if you discover a person in contact with High Voltage wiring?

5. To whom should all electric shocks be reported?

**Work Sheet -**

**EPC 58**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 58 | **Describe the emergency first aid requirements for an electric shock victim and demonstrate the knowledge and application skill of EAR and CPR.** | Application and learning of EAR and CPR procedures to resuscitate and stabilise a victim. Use of fire extinguishers to control electrical fire at accident site. |

## EPC 58 - First aid and CPR for electric shock

1. What six words are known as the D-R-S-A-B-C when administering immediate first aid to a person who has just received an electric shock?

2. What condition is indicated if an accident victim has pale and clammy skin together with a feeble and rapid pulse?

3. What is the most common method of keeping a victim's air passage open during emergency mouth to mouth resuscitation?

4. Is it always necessary to apply mouth to mouth resuscitation AND external heart compression to an electric shock victim?

5. If mouth to mouth resuscitation and external cardiac compression are being administered to an adult by ONE operator, what is the recommended ratio of lung inflations to chest compressions?

6. How far should an adult's chest be compressed when administering external heart compression?

7. When administering External Cardiac Compressions where should the administers hands be place?

8. At what point on the body can an electric shock victim‟s circulation be checked before administering CPR?

9. When should the process of administering mouth to mouth resuscitation be discontinued?

10. What is the recommended first aid treatment for burns?

11. What is the general first aid treatment required to stop bleeding from an open wound?

12. What general type of fire extinguisher must **never** be used to combat an electrical fire?

13. What additional risk exists when combating an electrical fire with a carbon dioxide ($CO_2$) type fire extinguisher in a confined space (apart from the fire itself)?

**EPC 59**

| # | Essential Performance Capability | Comment |
|---|---|---|

**Work Sheet -**

| | | |
|---|---|---|
| 59 | **Demonstrate knowledge and understanding of the significant dangers of High Voltage equipment and distribution systems.** | Step and touch voltages, induced voltages, creepage and clearance requirements. Stored energy and earthing requirements. The use of safe working procedures. |

**EPC 59 - Dangers of high voltage equipment**

1. What is the main safety precaution an electrician must observe when carrying out authorised work in the vicinity of live high voltage equipment?

2. What publication can be used to obtain guidelines relating to the minimum safe working distance from high voltage equipment in WA?

3. How is „high voltage" defined according to AS/NZS 3000 (Wiring Rules)?

4. Explain in your own words what is meant by the term „Touch Current". State the AS/NZS 3000 Clause number (if applicable).

5. Explain in your own words what is meant by the term „Touch Voltage". State the AS/NZS 3000 Clause number (if applicable).

6. Explain in your own words what is meant by the term „Step Voltage". State the AS/NZS 3000 Clause number (if applicable).

7. Explain in your own words what is meant by the term „Induced Voltage".

**EPC 62**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 62 | **Describe methods of commissioning and/or decommissioning electrical equipment or an installation, using a systems approach.** | Commissioning: Circuit voltage testing, phase rotation checks, systematic loading up, correct installation functioning and instrumentation/control parameter checks. Decommissioning: Identification of all circuits, impact on other equipment, isolation, tagging, testing, securing and earthing where required, safe removal of equipment/ conductors. |

**EPC 62 - Commissioning and decommissioning**

1. Who is responsible for ensuring that commissioning has been carried out on an installation?

2. What is the general distinction between commissioning and testing an installation?

3. List four aspects which must be considered when commissioning a new factory installation, after all regulatory requirements have been satisfied?

4. What effect does „phase rotation" have on the operation of a three phase induction motor?

**Work Sheet -**

5. How should disconnected conductors be treated after they have been temporarily removed from an electrical device so that the device can be taken away for testing?

6. What is meant by the term „decommissioning" an electrical installation?

**EPC 66**

| # | Essential Performance Capability | Comment |
|---|---|---|
| 66 | **Demonstrate the knowledge and skills for diagnosing and rectifying faults in electrical apparatus and associated circuits.** | Required for safe working practices with electrical systems and installations. All repairs must be compliant with the relevant standards. This item is crucial as all previous skills are utilised to effectively perform a fault find function. |

**EPC 66 - Diagnosis and rectification of circuit faults**

1. What is the basic item of information which must be available before an electrical fault can be diagnosed and rectified?

2. What is the first check which should be carried out if an electrical device or circuit does not function as intended?

3. What basic precaution must be taken if zero volts is measured at the terminals of a connected electrical device?

4. What Clause in AS/NZS 3000 gives a checklist for the visual inspection of a completed installation?

5. What are the six mandatory tests which must be carried out on any low voltage installation?

**Typical Answers to 32 Work Sheets**

**References and Texts**

The following references and texts.

**Current editions** of the following Standards, Regulations and texts may be required to answer some of the questions

| |
|---|
| AS/NZS 3000 - Wiring Rules. Standards Australia. |
| AS/NZS 3001 - Electrical installations – Relocatable premises (including caravans and tents) and their site installations. |
| |
| AS/NZS 3008.1.1 - Electrical installations. Selection of cables. |
| AS/NZS 3012 - Electrical installations - Construction and demolition sites. |
| |
| Electrical Trade Principles - A Practical Approach. J. Hampson |
| Electrotechnology Practice, J. Hampson |
| |
| Electrical Wiring Practice - Volumes 1&2, Pethebridge & Neeson. |
| |
| AS/NZS 3017 - Electrical Installations - Testing guidelines. |
| AS/NZS 3018 - Electrical Installations - Domestic Installations. |
| AS 3760 - In-service safety inspection and testing of electrical equipment. |
| WA Electrical Requirements: Energy Safety WA, 2008. |
| AS/NZS 4836 - Safe working practice on low-voltage electrical installations. |
| Code of Practice. Safe electrical work on low voltage electrical installations. Energy Safety WA. |
| |
| Checking and Testing Electrical Installation Work, WA Office of Energy Safety. |
| Safety Guidelines for Electrical Workers, WA Office of Energy Safety. |
| WA Electricity (Licensing) Regulations 1991. (2008 reprint) |
| The Occupational Safety and Health Regulations 1996 (WA). |
| AS/NZS 2381.1 - Electrical equipment for explosive gas atmospheres - Selection, installation and maintenance. Part 1: General requirements. |
| |

November 2010

Electrical Trades

**Index - Check Book 32 Answers**

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The answers in the following section are provided as a guide

**EPC 02 - Effects of current flow**

1. Batteries or cells – Electroplating, Electrolytic refining.
2. Electromagnetic devices – Measuring instruments, Motors generators, Relays, Transformers, Contractors
3. Magnetic stresses – Magnetic interference, Hysteresis loss, Eddy current loss
4. Heating elements
5. Power losses in machines – Heating of cables
6. An electrolyte is a conducting liquid
7. Dissimilar metals joined in the presence of an electrolyte (electrolytic corrosion)
8. Electrocution; breathing can stop; the heart can stop; ventricular fibrillation, Severe burns
9. Approximately 20-30 milliamps
10. Voltage value – Current value. Path of current through the body, Duration of contact, Body resistance, The individual, Point on cardiac cycle
11. The heart

**EPC 05 - Operation of practical circuits**

1. A basic circuit consists of a voltage source; conductors and a device for using the electricity (a load).
2. The two additional components are a means of controlling the circuit (e.g. a switch) and a protective device (e.g. a fuse)
3. The purpose of a fuse is to automatically disconnect the supply in the event of a short circuit to earth.
4. A 10 amp circuit breaker should trip at 14.5 amps (1.45 x rating B3.2.1).
5. Isolate the supply.
6. An HRC (high rupturing capacity) fuse.
7. Switching circuit diagram - 3-way circuit

**EPC 06 - Series, parallel and series/parallel circuits**

1. The line current
2. The voltage across each component.
3. The sum of the potential differences in a series circuit must be equal to the voltage applied to the series circuit.
4. R Total = 20 ohms; I = 1.2 amps; $R_1$=2.4 volts;$R_2$=4.8 volts; $R_3$=7.2 volts and $R_4$=9.6 volts 5. 2 ohms
6. The sum of the individual currents in a parallel circuit must be equal to the total or line current.
7. In a d.c. circuit the current is inversely proportional to the resistance of the circuit. I = V/R.
8. 24 ohms
9. The line current would decrease

**EPC 11 - AC generation and phase relationships**

1. There must be relative movement between them. The relative movement must be such that the conductor CROSSES the associated flux lines.
2. Zero. A voltage is only induced when a conductor cuts a magnetic field or visa versa
3. When the conductor is cutting the flux lines at right angles (twice per complete revolution in a two pole field)
4. The peak value; The root mean square (rms) or effective value; the average (avg) value; the instantaneous value; the peak to peak value.
5. 70.7 volts DC approximately. (Vac = Vdc/1.414
6. Most measuring instruments are calibrated to indicate rms values.
7. A sinusoidal waveform.
8. 120 degrees electrical.
9. Circuit diagram - ammeter, voltmeter, wattmeter on single phase a.c.
10. 0.8 lagging. Power Factor = W/VA = 1920/(240 x 10)
11. 6110 watts (approximately). P = 1.7321 x 415 x 10 x 0.85

**EPC 13 - Safety principles of AS/NZS 3000**

1. AS/NZS 3000:2007 Clause 1.4.34 and Figure 1.2
2. AS/NZS 3000 Clause 1.4.35 and Figure 1.3
3. Insulation; barriers; enclosures; obstacles; out of reach. AS/NZS 3000 Clause 1.5.4.2

4. a. Automatic disconnection of the supply on the occurrence of a designed fault current.
b. Preventing a fault current from passing through the body.
c. Limiting the fault current which can pass through the body to a lower value than the shock current.
(see AS/NZS 3000 Clause 1.5.5.2):
5. Protection of persons, property and livestock from harmful effects.
Correct functioning for the use intended, Compatibility with the electrical distribution system. AS/NZS 3000 Clause 1.6.1.
6. Protect persons, livestock and property Function as intended,
Be compatible with supply system, Minimise inconvenience in case of faults
Safe operation, inspection, testing and maintenance. AS/NZS 3000 Clause 1.7.1 7.
Not exceeding 50 V a.c. or 120 V d.c. AS/NZS 3000 Clause 1.4.98.
8 AS/NZS 3000 Clause 1.6.2.
9 An RCD See AS/NZS 3000 Clause 1.5.5.3(a)(ii)
10 It is deemed to be a new installation. AS/NZS 3000 Clause 1.9.3

**EPC 16 - Motor starting, connection and protection**

1. Primary resistance Star-delta Autotransformer Electronic Secondary resistance
2. Overloading. Frequent starting. Blocked ventilation passages.
3. Overload relay.
4. Electric motors with a high inrush starting current
5. Undervoltage protection
6. Three line cables. An earth is usually required
7. A direct-on-line (DOL) starter.
8. Diagram of the motor connected in delta to the three terminals of the starter
9. By reversing any two of the three incoming line leads
10. The Full Load Current (current rating on the name plate) of the motor

.

**EPC 21 - Earthing systems and fault loop impedance**

1. No. AS/NZS 3000 Clause 5.4.1.1 1.4.53
2. No. AS/NZS 3000 Clause 5.4.3.
3. No. AS/NZS 3000 Clause 5.4.1.1(i)
4. 8. One square inside another
5. It must be protected, secured or insulated so that it (or its single insulation) cannot come in contact with accessible metal. Clause AS/NZS 3000 5.4.1.1.
6. No. AS/NZS 3000 Clause 5.4.1.1
7. No. AS/NZS 3000 Clause 5.5.1.1
8. Yes. AS/NZS 3000 Clause 5.5.2.1(b) and 3.7.2
9. No. AS/NZS 3000 clause 5.5.2.1(c)
10. The minimum permissible size of main earthing conductor is 4 square mm AS/NZS 3000 Clause 5.3.3.2
11. It must be earthed at the end adjacent to the switchboard or at which the cable originates. AS/NZS 3000 Clause 5.5.3.2(b)
12. The metallic enclosure and associated fittings must be electrically and mechanically continuous. AS/NZS 3000 Clause 5.5.4.2
13. No. AS/NZS 3000 Clause 5.5.6.2

14. Exposed to the weather; outside the building; separated from metallic enclosures of other buried surfaces. AS/NZS 3000 Clause 5.3.6.4(a)
15. The electrical connection of non-electrical metallic piping to the main earth in an installation. AS/NZS 3000 Clause 1.4.52 and 5.6
16. 4 square mm. AS/NZS 3000 Clause 5.6.3.2
17. 2.5 AS/NZS 3000 Clause 1.4.44
18. Joints must be mechanically and electrically sound. AS/NZS 3000 Clause 3.7.1
19. Yes. AS/NZS 3000 Clause 5.4.6.2.
20. To provide a mechanism for automatically disconnecting the supply in the case of a short circuit to earth.
21. Exposed metal AS/NZS 3000 Clause 1.4.44
22. AS/NZS 3000 Table 8.1 and 8.2
23. No. 1.99 Ω is too high. AS/NZS 3000 Tables 8.1 an 8.2
24. Protective earth. Neutral-return path. Transformer neutral. Associated active to fault. AS/NZS 3000 Clause B4.4.

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**EPC 22 - The MEN system of earthing**

1. At one extremity of the bar or link (usually the left). The main neutral should occupy the next adjacent terminal. AS/NZS 3000 Clause 2.9.5.4.2.
2. A connection or link between the main earthing terminal/connection or bar to the earthing terminal on the neutral link. AS/NZS 3000 Clause 5.3.5 It is located on the main switchboard
3. Green/yellow. AS/NZS 3000 Clause 5.3.5.3
4. The same size as the main neutral conductor AS/NZS 3000 Clause.5.3.5.2
5. Yes AS/NZS 3000 Clause.5.5.3.
6. a. The resistance of the fault current path may be too high to allow the circuit protection device to operate correctly.
   b. An unexpected voltage may occur at a device under fault conditions.
7. An open circuit or high resistance in the main neutral conductor.
8. Clause B4.4 and Figure B5

**EPC 26 - Applications for transformers**

1. An autotransformer.
2. An Autotransformer.
3. An open circuited secondary winding.
4. Because the power factor of the load can vary.
5. A supply authority distribution transformer.
6. Turns ratio 10:1 (Same as the voltage ratio).Current ratio 1:10 (The inverse of the voltage ratio).
7. Using a multimeter on ohms scale: if the reading is low Ω"s there is a possibility of shorted turns
8. Megger on megohms set at 500 volts with a minimal value of ≥ than 1MΩ
9. Megger on megohms set at 500 volts and test between primary to secondary and all windings of a three phase transformer 10. 1.0Ω AS/NZS 3760

**EPC 27 - Circuit protection requirements**

1. Overheating, Damage cause by arcing, Damaging effect of magnetic stresses. Physical damage to cables and components
2. AS/NZS 3000 Clauses 2.4.3.2 and B3.2
3. The supply voltage and the circuit fault loop impedance. I = V/Zs
4. 2000 amps. $I_{SC}$ = 100 x 100/5.

5. 721.69 amps. $I_{FL}$ = 500 x 1000/√3 x 400.
6. 14433.76 amps. $I_{sc} = I_{fl}$ x 100/5
7. 0.4 seconds (400 ms). AS/NZS 3000 Clause 1.5.5.3(d)(i)
8. 5 seconds . AS/NZS 3000 Clause 1.5.5.3(d)(ii).
9. $Z_{INT}$ = 1.6 ohms. 240/(16 x 7.5) = 2 ohms. 0.8 of 2 = 1.6 ohms.
10. Protective earth. Neutral-return path. Transformer neutral Associated active to fault. AS/NZS 3000 Clause B4.4.

**EPC 28 - SELV, PELV and earth leakage protection**

1. 1. Electrically separated from earth. AS/NZS 3000 Clause 1.4.83 1.4.76
2. No. AS/NZS 3000 Clause 7.4.3.3.
3. AS/NZS 3000 Clause 3.9.8.3.
4. No. AS/NZS 3000 Clause 7.5.10.
5. Protection in the case of a phase to earth fault.
6. Most RCD's are set to 30 mA (Type II) 7. Crossed neutrals. Low insulation resistance 8. No.

9. Fixed electric cooking appliances. AS/NZS 3000 Clause 2.6.3.1 10.
Yes. AS/NZS 3000 Clause 2.6.3.2.

11. Two AS/NZS 3000 Clause 2.6.2.4.12.
12. Thee AS/NZS 3000 Clause 2.6.2.4 (b)

**EPC 29 - Cable selection for mains and submains**

Approximate max demand answers

1. Maximum Demand: 71 amps
2. 16mm$^2$ AS/NZS 3008 Table 10 Col 25
3. Maximum Demand: 76.5 amps
4. 16mm$^2$ AS/NZS 3000 Table C5
5. Maximum Demand: 40 amps
6. 6mm$^2$ WAER Section 12.2
7. 11 amps. AS/NZS 3008.1.1 Table 10 Col 15
8. 13 amps AS/NZS 3008.1.1 Table 3(2) T.13 Col 11 20 amps Derate Table 22 Col 7 = 4 Circuits 0.65 20 x 0.65 = 13 amps
9. 20 amps AS/NZS 3008.1.1 Table10 and AS/NZS 3000 Table C5 20 amps **EPC 30 - Cable selection for final subcircuits**

1. 6 amps. Maximum demand is limited by the current rating of the circuit protection AS/NZS 3000 Clause C2.5.
2. 25 amps. AS/NZS 3000 Table C4
3. a. Partially surrounded in thermal insulation. WAER:2008 Clause 12.3. AS/3008.1.1 Clause 3.4.3(d)(iii)

b. 1.5 mm$^2$ twin and earth TPS. AS/NZS 3000 Table C5. in thermal insulation

c. 2.5 mm$^2$ twin and earth TPS. Vc = 24.7 AS/NZS 3008.1.1 Table 42.

4. The voltage drop is 3.68 volts. Vc=2.55 x 1.155 AS/NZS 3008.1.1 Table 42 and Clause 4.2 5. Table 50.
6. 394.25 volts. 5% of the supply voltage is 20.75 V AS/NZS 3000 Clauses 3.6.2
7. 218.5 volts. 5% of the supply voltage is 11.5 V AS/NZS 3000 Clause 3.6.2
8. Length = (1000.Vd)/(Vc x I) 19.8 metres. AS/NZS 3008.1.1 Table 42
9. 1.5mm$^2$ AS/NZS 3000 C7 Am = 6 x 30 = 180 / 3% = 60
10. Half the current rating of the protective device may be used. AS/NZS 3000 Clause 3.6.2 (Exceptions 1).

11. Vd = (Vc x L x I)/1000 for each cable. $VD_1$=4.92v $VD_2$ = 5.57 $VD_3$ = 2.83 Volt at load = 217 V
12. Vd = (Vc x L x I)/1000 for each cable. $VD_1$=3.08 (400 - 3.08 = 396.92/√3 = 229.16)
    $VD_2$ = 3.57 $VD_3$ = 3.36 Volt at load = 222 V
13. 383 amps AS/NZS 3008.1.1 Table 7 Column 5.
14. Reduce circuit resistance. Reduce line current. Reduce the length of cable. Increase the size of cable.
15. $Z_{INT}$ = 1.53 ohms. 230/(16 x 7.5) = 1.92 ohms. 0.8 of 1.92 = 1.53 ohms. AS/NZS 3000 Clause B4.5

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**EPC 31 - Control and protection requirements**

1. Maximum operating voltage; Full load or continuous current rating; rupturing capacity.
2. The current rating of the circuit breaker is equal to or greater than the load but equal or less than the conductor current rating. Clause 2.5.3.1 or Appendix B
3. Overheating of the wiring and magnetic stress.
4. Higher the fault current the quicker the response time to operate.
5. The impedance of the circuit wiring.
6. A circuit breaker automatically operates under fault conditions where as a switch is manually operated
7. Switchboard wiring diagram including circuit breakers earthing arrangements RCDs etc.

**EPC 33 - Installation in damp situations**

1. Table 6.1.
2. 0.45 m above ground and 1.5 m from the rim; or beneath a barrier(0.5m from the edge). AS/NZS 3000 Clause 6.3.4.3.
3. 12 V a.c. from a double wound transformer. AS/NZS 3000 Clause 6.3.4.5.
4. Within arms reach of the edge of the pool. AS/NZS 3000 Clause 5.6.2.6.
5. No - unless enclosed in a cupboard and protected by RCD. AS/NZS 3000 Clause 6.2.4.2.
6. 0.15 metres (150 mm) AS/NZS Clause 3000 6.2.2.2 Figure 6.10.
7. IP X4 AS/NZS 3000 Clause 6.2.4.1.
8. No. AS/NZS 3000 Clause 6.5.4.4.

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**EPC 34 Construction and demolition sites (AS/NZS 3012)**

1. No - they must be on separate circuits. AS/NZS 3012:2003 Clause 2.1.6
2. 40 metres AS/NZS 3012 Clause 2.6.7 Table 1.
3. 15 metres AS/NZS 3012 Clause 2.9(d).
4. AS/NZS 3012 Clause 3.2 Table 2.
5. 2.5 metres AS/NZS 3012 Clause 2.7.6.2
6. Yes. AS/NZS 3012 Clause 3.9

**EPC 35 - Aerial and underground wiring requirements**

1. 6 sq mm. AS/NZS 3000 Clause 3.12.3.1(a)
2. 128 amps. AS/NZS 3008.1.1 Table 21
3. Category A. AS/NZS 3000 Table 3.5
4. 100 mm from other services AS/NZS 3000 Clause 3.11.5
5. 0.5 metres. AS/NZS 3000 Table 3.6
6. 0.95. AS/NZS 3008.1.1 Table 28 Column 2.

**EPC 36 - Hazardous area installation requirements**

1. Dust Hazardous Areas. AS/NZS 3000 Clause 7.7.2.2(b)
2. Gas Hazardous Areas. AS/NZS 3000 Clause 7.7.2.2
3. AS 2430 Part 1 Explosive gas atmospheres. Part 2 Combustible dust.
4. See AS/NZS 3000 Appendix A - page 327.4.
5. The occupier. AS/NZS 3000 Clause 7.7.2.1.6.
6. The AS 2381 series See AS/NZS 3000 Clause 7.7.2.4.1 and Appendix A
7. IP56 5 - limited ingress of dust permitted. 6 - protected against strong jets of water.

**EPC 38 - Installation testing**

1. Wiring Rules and WA Electrical Requirements.
2. The licensed electrical worker.
3. a. earth resistance. b. insulation resistance.
   c. polarity. d. correct circuit connections.
   e. Verification of impedance f. Operation of RCDs AS/NZS 3000 Clause 8.3.3
4. AS/NZS 3017:2007 Electrical installations - Verification guidelines 5. AS/NZS 3012:2003.
6. 0.5 ohms. AS/NZS 3000 Clause 8.3.5.2
7. To avoid parallel connections through water pipes.
8. 1 megohm. AS/NZS 3000 Clause 8.3.6.2
9. 0.01 megohms. AS/NZS 3000 Clause 8.3.6.1. See AS/NZS 3017 Clause 3.2
10. All switches must be operated during the tests to ensure that all switchwires are tested. 11. Earth active neutral in a clockwise direction. AS/NZS 3000 Clause 4.4.5
12. There is a short circuit somewhere in the installation.
13. 11.02 ohms. $230^2$ / 4800 = 11Ω or 4800/230=20.86 amps. 230/20.86 = 11.02 ohms.
14. Between all actives and the earth Clause 8.3.6.1
15. 500 volts. AS/NZS 3000 Clause 8.3.6.1 The normal operating voltage between any active and EARTH is 240 volts in a three phase domestic installation.
16. All switches must be on - otherwise the switchwires would not be included in the test.

-

**EPC 40 - Safe isolation and tagging procedures**

1. A circuit breaker is usually ON in the UP position; or a circuit breaker operates automatically.
2. Red and black.
3. Yellow and Black.
4. Test for zero volts.
5. Test the testing device.
6. The person who placed it there.
7. Identify. Switch off. Isolate. Tag. Test.

**EPC 44 - Installation of cables and final subcircuits**

1. Protection against shock. Protection against external influences.Mutual detrimental influences. Cable selection. Reliability of terminations. Identification of conductors. Protection against fire.
2. TPS, PVC conduit, Steel conduit, Underground, Catenary, Aerial, Ducting, Cable tray, Busway, Armoured, MIMS.
3. 16 points AS/NZS 3000 Table C8.
4. No. AS/NZS 3000 Clause 3.9.3.3(c)
5. No. AS/NZS 3000 Clause 3.9.4.3
6. 25mm$^2$ 3.9.9.3 (ii)
7. No 3.9.8.2(a)
8. Cat A, Cat B, Cat C 3.11.2
9. 300mm T3.6
10. 50% of the cover 3.11.4.5

**EPC 46 - Circuit tests in installations**

1. Resistance of main earth. Resistance of circuit earths. Insulation resistance consumers" mains. Insulation resistance overall. Polarity of mains. Active/neutral shorts. Polarity of switches. Polarity of socket outlets. Polarity of light switches. Correct circuit connections. Verification of earth fault loop impedance.Operation of RCDs
2. AS/NZS 3000 Table 8.1.
3. AS/NZS 3000 Clause 8.3.9.3.
4. AS/NZS 3000 Clause 8.3.3

.

**EPC 47 - Switchboard connections from subcircuits**

1. Yes. AS/NZS 3000 Clauses 2.9.4 and 2.8.3.3.3.
2. Main switch. Circuit breakers. RCDs, Main neutral link, RCD neutral link.
3. Yes. AS/NZS 3000 Clause 2.9.3.4.
4. 2 metres. AS/NZS 3000 Clause 2.3.3.3(a)

5. By twisting together and soft soldering. AS/NZS 3000 Clause 5.3.4 and 3.7.2.11

**EPC 48 Installation and connection of consumers mains**

1. 63 amps. WAER Clause 12.2
2. 32 amps. WAER Clause 12.2 3. WAER Section 5 - Underground supply.
4. 500 mm.
5. At the supply authority termination pillar. WAER: Section 5.
6. Yes.
7. The neutral.

**EPC 51 - Read, sketch and interpret electrical diagrams**

1. All components are shown in the unoperated condition.
2. A block diagram.
3. Usually higher current circuits.
4. A wiring diagram.
5. A circuit diagram.
6. A wiring diagram.
7. A circuit diagram.
8. Appropriate symbols for components on a circuit diagrams
9. Appropriate symbols for components on an architectural drawing

**EPC 53 - Basic OSH and supervision responsibilities**

1. It is intended to ensure that you can work without being exposed to hazards.
2. It means that a person or employer has a legal responsibility to take reasonable care in matters relating to health and safety
3. Workplace without hazards; provide information and training; consult safety representatives; provide protective materials; use safe processes. Clause19.
4. Comply with instructions; Use protective equipment; Do not damage safety equipment; Report unsafe conditions; Report injuries. Clause 20.
5. Must work at the workplace; been employed for 2 years; have 2 years experience in similar work; had adequate training. Clause 31(8).
6. For an employee: A fine of $5000. Clause 54.
7. Attempt to remove the hazard – if possible and report the hazard
8. The mining industry and the petroleum industry are exempt because they are covered by other special legislation. Clause 4(2).

**EPC 54 - Requirements for personal safety in the workplace**

1. Eliminate the hazard. Substitute the hazard. Control the hazard.
2. AS/NZS 3000 Clause 2.3.2.2.
3. Yourself
4. Deliberate consideration of the possible safety risks and their controls.
5. Unsafe acts/conditions
6. Unsafe Acts
    a. Lifting incorrectly.
    b. Using a ladder without adequate support.

-

c. Using metal removing machinery without eye protection
d. Drilling without adequate support for the work piece
e. Handling chemicals without personal protection
f. Skylarking in a workshop
g. Failing to correct or report an unsafe condition
h. Using hand tools incorrectly
i. Using machinery without proper authorisation
j. Performing a task without using all proper safety equipment and precautions

**EPC 54 - Requirements for personal safety in the workplace (continued)**

7. Unsafe Conditions
   a. Untidy workshops.
   b. Unguarded machinery.
   c. Wet or slippery floors.
   d. Inadequate lighting for a particular task.
   e. Badly maintained hand tools.
   f. Incorrect storage of flammable liquids.
   g. Electrical equipment with damaged insulation or cords.
   h. Incorrectly stacked materials.

8. Safe Behaviour
   a. Do not skylark in the work area.
   b. Do not operate switches without proper authority.
   c. Do not tamper with safety equipment such as fire extinguishers,
   d. warning signs, emergency stop buttons and machinery guards.
   e. Take care when handling cotton waste.
   f. Concentrate on the job in hand.
   g. Take notice of safety signs.
   h. Always use the correct danger tag procedures.
   i. Do not run in workshops - particularly in confined spaces such as
   j. in corridors or on stairways.
   k. Be conscious of the need for safety at all times.
   l. Always use the appropriate personal safety equipment.
   m. Do not interfere with electrical equipment without authority.
9. Blue lines indicate areas in which protective equipment MUST be worn.
10.

| | |
|---|---|
| Head Protection: | Helmets caps |
| Eye Protection | Safety glasses, face shields or goggles |
| Face Protection | Transparent face shields |
| Foot Protection | Safety shoes or boots |
| Ear Protection | Ear muffs, approved ear plugs |
| Lung Protection | Respirators, masks |
| Hand Protection | Gloves, barrier cream |
| Body Protection | Overalls, aprons |

11. A helmet and safety footwear.
12. Label it. Don't use it. Report it.
13. Keep your back straight. Lift with the legs - not with the back.
14. Test for zero volts.
15. Test the testing device.

**EPC 57 - Electrical rescue procedures**

1. Danger to yourself and others

2. Using non conductive material
3. Danger Response Send Airways Breathing Circulation
4. Isolate the power. (Do Not attempt to touch)
5. The relevant network operator (Western Power etc ) or the Director (Energy Safety) Electricity Licensing Regulations

**EPC 58 - First aid and CPR for electric shock**

1. Danger. Response. Send Airway. Breathing. Circulation. See AS/NZS 3000 Appendix L.
2. Traumatic shock (shock to the nervous system).
3. Tilt the head back 4. No
5. 2 lung inflations to 30 chest compressions.
6. 40 - 50 mm.

**EPC 58 First aid and CPR for electric shock (continued)**

7. In the centre of the chest
8. The carotid pulse position on the neck
9. When the victim recovers or when medical help takes over the responsibility.
10. Hold the burn under clean cold running water.
11. Applying pressure to the wound
12. An extinguisher which contains water or water-based foam.
13. The risk of asphyxiation (lack of oxygen) to the user.

**EPC 59 - Dangers of high voltage equipment**

1. Maintain a safe distance from the high voltage equipment.
2. Guidelines for Electrical Distribution and Transmission Work. Energy Safety
3. Any voltage above 1000 volts. See AS/NZS 3000 Clause 1.4.98
4. Electric current which passes through a body when that body touches
5. A voltage appearing between simultaneously accessible live parts under indirect contact fault conditions. (see AS 2067 Clause 3.9.6 and AS/NZS 3000 Clause 1.4.95).
6. Step voltage. The voltage gradient between a person‟s feet when approaching a live conductor lying on the ground.
7. A voltage which occurs in a conductive component as a result of adjacent magnetic fields without a specific electrical connection to any live part (No AS/NZS 3000 reference)

**EPC 62 - Commissioning and decommissioning**

1. The electrical contractor.
2. Commissioning involves ensuring correct operation. Testing involves using instruments to ensure that mandatory and specified technical requirements have been met before power is applied.
3. Voltage. Phase rotations. Loading up, correct functioning. RCD checks. Voltage drop. Isolation checks, Motor directions. Safety interlocks. Emergency systems checks,
4. Phase rotation determines the direction of rotation of the three phase motor.
5. Label the conductors. Tape all bare conductors. Leave cable tidy and secure.
6. Systematically isolating and removing electrical devices in a planned sequence so that the installation or part thereof can be taken out of service and left in a safe and tidy condition with documentation in the main switchboard updated.

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**EPC 66 - Diagnosis and rectification of circuit faults**

1. What the circuit is meant to do.
2. Ensure that the electrical supply is available.
3. Test the tester on a known voltage source.
4. AS/NZS 3000 Clause 8.2.2
5. Continuity of earthing system
   Insulation resistance
   Polarities
   Correct circuit connections
   Verification of earth fault-loop impedance
   Operation of RCDs AS/NZS 3000 Clause 8.3.3

# Equipment Testing

**General**

Equipment testing requires you to examine and test a portable or disconnected electrical device to determine whether or not the device is safe to connect to the electrical supply.

**Instructions**

All relevant tools and measuring instruments are to be available from the tool store on request. A commercial appliance tester such as a Safe-T-Tester is not available unless otherwise advised.

Record the results on the Test Sheets provided where applicable.

If electrical measuring instruments are used, the type of instrument and the actual reading must be shown on the inspection sheet.

The equipment is NOT to be dismantled except for terminal box or inspection covers if applicable.

All faults are to be reported, but not repaired.

The equipment is NOT to be connected to the 240 volt supply.

The Test and Inspection Sheets are provided as a general guide. It may contain aspects which are not applicable to a particular piece of equipment, and it may not include all essential safety checks or tests applicable to a particular item of equipment.

You may supply and refer to AS/NZS 3000 and AS/NZS 3760.

All aspects of safety must be observed at all times.

## Summary of Tasks

| # | Testing Tasks | |
|---|---|---|
| Task 1 | Portable single insulated appliance | |
| Task 2 | Single phase 240 volt single insulated squirrel cage induction (SCI) motor | |
| Task 3 | Three phase 415 volt single insulated squirrel cage induction (SCI) motor | |
| Task 4 | Single phase double wound step down transformer | |
| Task 5 | Three phase double wound step down transformer | |
| | | |

# Portable Appliance

## Task 1

Check and test a 230/240 volt single insulated portable appliance and determine whether it complies with all relevant requirements, and is safe to connect to the supply.

**DO NOT ENERGISE APPLIANCE**

| **Equipment ID** | | | | | | |
|---|---|---|---|---|---|---|
| ***Visual Inspection*** | | | | | | |
| Inspected and report | Item | | | | Good | Bad |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| ***Continuity of earth conductor*** | | | | | | |
| Test Equipment | | | | | | |
| Test Result | | | | | | |
| ***Continuity of windings/element*** | | | | | | |
| Test Equipment | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| ***Insulation resistance*** | | | | | | |
| Test Equipment | | | | | | |
| Test Points and Test Results | | | | | | |
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|---|---|---|---|---|---|---|
| | | | | | | |
| Is this equipment safe to use | Yes ☐<br>No ☐ | | | | | |
| *Description of any fault(s) found* | | | | | | |
| | | | | | | |
| | | | | | | |
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**Single Phase Motor Task 2**

Test a single phase 240 volt single insulated squirrel cage induction (SCI) motor and determine whether it complies with all relevant requirements, and is safe to connect to the supply. **DO NOT ENERGISE MOTOR**

| **Equipment ID** | | | | | | |
|---|---|---|---|---|---|---|
| ***Visual Inspection*** | | | | | | |
| Inspected and report | | | | | | |
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| | | | | | | |
| | | | | | | |
| | | | | | | |
| ***Continuity of earth conductor*** | | | | | | |
| Test Equipment | | | | | | |
| Test Result | | | | | | |
| ***Continuity of windings*** | | | | | | |
| Test Equipment | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| ***Insulation resistance*** | | | | | | |
| Test Equipment | | | | | | |
| Test Points and Test Results | | | | | | |
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| Is this equipment safe to use | Yes ☐ | | | No ☐ | | |
| **Faults Summary:** | | | | | | |
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**Three Phase Motor Task 3**

Check and test a disconnected 415 volt three phase single insulated six terminal **squirrel cage induction motor** and determine whether it complies with all relevant requirements, and is safe to connect to the supply. **DO NOT ENERGISE MOTOR**

| **Equipment ID** | | | | | | |
|---|---|---|---|---|---|---|
| ***Visual Inspection*** | | | | | | |
| Inspected and report | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| ***Continuity of earth conductor*** | | | | | | |
| Test Equipment | | | | | | |
| Test Result | | | | | | |
| ***Continuity of windings*** | | | | | | |
| Test Equipment | | | | | | |
| | | | | | | |
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| | | | | | | |
| | | | | | | |
| ***Insulation resistance*** | | | | | | |
| Test Equipment | | | | | | |
| Test Points and Test Results | | | | | | |
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| Is this equipment safe to use | | | Yes ☐ | | No ☐ | |
| **Faults Summary:** | | | | | | |
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**Single Phase Transformer Task 4**

Check and test a disconnected single phase double wound step down transformer and determine whether it complies with all relevant requirements, and is safe to connect to the supply. **DO NOT ENERGISE TRANSFORMER**

| **Equipment ID** | | | | | | |
|---|---|---|---|---|---|---|
| ***Visual Inspection*** | | | | | | |
| Inspected and report | | | | | | |
| | | | | | | |
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| | | | | | | |
| ***Continuity of earth conductor*** | | | | | | |
| Test Equipment | | | | | | |
| Test Result | | | | | | |
| ***Continuity of windings*** | | | | | | |
| Test Equipment | | | | | | |
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| ***Insulation resistance*** | | | | | | |
| Test Equipment | | | | | | |
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|---|---|---|---|---|---|---|
| Test Points and Test Results | | | | | | |
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| Is this equipment safe to use | | | Yes ☐ | | No ☐ | |
| **Faults Summary:** | | | | | | |
| | | | | | | |
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**Three Phase Transformer Task 5**

Check and test a disconnected 415 volt three phase double wound step down transformer and determine whether it complies with all relevant requirements, and is safe to connect to the supply. **DO NOT ENERGISE TRANSFORMER**

| | | | |
|---|---|---|---|
| **Equipment ID** | | | |
| ***Visual Inspection*** | | | |
| Inspected and report | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| ***Continuity of earth conductor*** | | | |
| Test Equipment | | | |
| Test Result | | | |
| ***Continuity of windings*** | | | |
| Test Equipment | | | |
| | | | |
| | | | |
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| | | | |
|---|---|---|---|
| | | | |
| ***Insulation resistance*** | | | |
| Test Equipment | | | |
| Test Points and Test Results | | | |
| Is this equipment safe to use | Yes ☐ | No ☐ | |
| **Faults Summary:** | | | |
| | | | |
| | | | |
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| | | | |

**General Inspection Sheet**

This inspection sheet could be used for any piece of equipment

| | Item | Good | Bad | Comment |
|---|---|---|---|---|
| 1. | Polarization of plug top | | | |
| 2. | Switch connected in active | | | |
| 3. | Continuity of active and neutral | | | |
| 4. | Continuity of earthing conductor | | | |
| 5. | Security of earthing connection | | | |
| 6. | Insulation resistance (show actual reading) | | | |
| 7. | Condition of flexible cord | | | |
| 8. | Condition of terminals | | | |
| 9. | Resistance of winding/element | | | |
| 10. | Condition of parts and safety covers | | | |
| 11. | Anchorage of flex | | | |
| 12. | Cleanliness of insulation between live parts | | | |
| 13. | Accumulation of dust/dirt | | | |
| 14. | Leads away from moving parts | | | |

| | | | | |
|---|---|---|---|---|
| 15. | Porcelain beads sound | | | |
| 16. | Condition of reflector | | | |
| 17. | Condition of contacts | | | |
| 18. | Operation of moving parts | | | |
| 19. | Legibility of labels | | | |
| 20. | Control knob alignment | | | |
| | | | | |
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The final questions to be asked after each time a piece of equipment is tested:-

| Final Results | Yes | No |
|---|---|---|
| Is the equipment safe to connect to the electrical supply? | | |
| Would this item of equipment operate correctly if connected to the electrical supply? | | |

## General Questions

Where applicable include AS/NZS Rule numbers

| | Question | Answer |
|---|---|---|
| 1. | What is the minimum permissible insulation resistance in a 415 volt three phase motor? | |
| 2. | What is the minimum permissible insulation resistance in a 240 volt heating appliance which contains a sheathed heating element? | |
| 3. | What type of measuring instrument must be used to measure insulation resistance to earth in a 240 volt electrical device? | |
| 4. | Which Australian/NZ Standard has the title „In-service safety inspection and testing of electrical equipment"? | |
| 5. | What resistance would you expect for the heating element in a 230 volt 920 watt domestic iron? | |
| 6. | Is it permissible to tie a knot in a flexible cord to prevent stress on its connections due to a pull on the cord? | |

| | | |
|---|---|---|
| 7. | Would 2 ohms be acceptable for the resistance of the earthing conductor in a 1.8 metre flexible cord to a 240 volt portable appliance? | |
| 8. | Why does a portable domestic appliance require a double-pole switch? | |
| 9. | Which winding in a 240:12 volt double wound transformer would have the lowest resistance? | |
| 10. | What resistance would you expect between the primary and secondary windings of a serviceable 240:24 volt double wound transformer? | |
| 11. | Which winding of a capacitor start motor has the lowest resistance (start or run)? | |
| 12. | Which part of a split phase will fail if the centrifugal switch fails to open? | |
| 13. | If an ohm meter is connected across the terminals of a motor start capacitor and the resultant reading remains at low ohms. Is the Capacitor faulty or serviceable? | |

## Isolation Procedure

**Isolation Procedure Task**

You are required to prepare a written isolation procedure for a 415 volt three phase installation based on the given scenario.

**Scenario**

You have been asked to disconnect and remove a 415 volt 3 kW three phase delta connected squirrel cage induction motor from a floor mounted woodworking machine in a joinery factory.

The motor is wired on its own final subcircuit and power is supplied from a circuit breaker on a sub distribution board in the same part of the factory. The sub distribution board is visible from the woodworking machine

A manually operated isolating switch is installed adjacent to the woodworking machine.

The cables to the motor are enclosed in a 300 mm length of flexible PVC conduit.

There are 10 other machines, 5 machine operators and 1 supervisor in the same general area.

## Isolation Procedure

| Action |
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## Typical Isolation Procedure

| # | Action |
|---|---|
| 1 | Advise the supervisor that power is to be disconnected and negotiate a convenient time. |
| 2 | Switch the machine off at the isolating switch adjacent to it. Attach a Danger Tag.<br>Write your name, the date and the time on the danger tag. |
| 3 | Identify the relevant circuit on the sub distribution board. |
| 4 | Isolate the supply by switching the circuit breaker to the off position. Lock it in the OFF position. |
| 5 | Attach a „Danger Do Not Operate" danger tag to the identified circuit breaker to warn others that the circuit must not be re-energised. Write your name, the date and the time on the danger tag. |
| 6 | Check the test instrument (a multimeter on volts scale) to see that it is working properly on a known voltage source usually. |
| 7 | Test for zero volts at the motor terminals. Test between all actives, from all actives to neutral, and from all actives to earth. |

| | |
|---|---|
| 8 | Re-check the test instrument (usually a multimeter on volts scale) to see that it is working properly on a known voltage source. |
| 9 | Double check all conductors using a phase pencil or voltage stick. |
| 10 | Disconnect and remove ALL cables from the motor terminals. |
| 11 | Insulate all disconnected cables with tape and leave them in a safe and tidy condition. |
| 12 | Remove the motor from its mounting. |
| 13 | If the task is not completed in the same shift them remove the Danger Tag and attach an Out of Service Tag |
| 14 | Advise the supervisor that the work is completed. |

**NOTE:** This procedure is **only a guide**
Each isolation procedure should be produced to suit each individual task

**Simulated Installation Testing**

## Installation Testing Task

You are required to inspect and test a simulated new electrical single domestic MEN installation using appropriate measuring instruments and equipment to ensure that it satisfies all relevant regulatory requirements for electrical safety. The installation involves 'notifiable work'.

You may supply and refer to the following publications during the test:

Current editions of:-

| |
|---|
| AS/NZS 3000 - Wiring Rules (with amendments). Standards Australia. |
| AS/NZS 3008.1.1 - Electrical installations. Selection of cables. |
| AS/NZS 3017 Electrical Installations - Testing guidelines. |
| Electricity (Licensing) Regulations 1991 |
| WA Electrical Requirements. |

### Equipment Required

Simulated electrical installation (no supply connected).
High voltage installation tester.
Multimeter with a low ohms range and long lead.
Hand tools as required.
Other test equipment as required.

## Visual Inspection

| Item | Comments & Details | Good | Bad |
|---|---|---|---|
| General | | | |
| Consumer"s Mains | | | |
| Switchboard | | | |
| Wiring Systems | | | |
| Electrical Equipment | | | |
| Earthing | | | |

## Continuity & Resistance of the Earthing System

| Circuit | Conductor Size | Rating Circuit Breaker | Measured Value | Maximum Value |
|---|---|---|---|---|
| Main Earth | | Not Applicable | | |
| | | | | |
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## Insulation Resistance

| Test | Measured Value | Minimum Permissible Value |
|---|---|---|

| | | |
|---|---|---|
| Mains Active to Neutral (PEN) | | |
| Active/Neutral to Earth | | |
| Active/Neutral to Earth | | |
| Active/Neutral to Earth | | |

## Polarity & Correct Circuit Connections -

| Circuit | Polarity | | Connections | |
|---|---|---|---|---|
| | Correct | Incorrect | Correct | Incorrect |
| Power-1 | | | | |
| Power-2 | | | | |
| Lighting 1 | | | | |
| Lighting 2 | | | | |
| Air Conditioner | | | | |
| Hot Plate | | | | |
| Oven | | | | |
| Hot Water System | | | | |

## Earth Fault-Loop Impedance

**Power Not Available**

| Circuit | Conductor Size | | Rating Circuit Breaker | Measured Value $R_{phe}$ | Maximum Permissible Value $R_{phe}$ |
|---|---|---|---|---|---|
| | Active | Earth | | | |
| Power-1 | | | | | |
| Power-2 | | | | | |

## Faults

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Complete a supply authority Electrical Safety Certificate as required by Regulation 52B of the Electricity (Licensing) Regulations 1991 for the installation, using fictitious data where appropriate.

## Typical Test Procedure - Before Connection of Supply

| Test | General Procedure | Notes |
|---|---|---|
| | | |
| **Isolation** | Ensure supply is isolated.<br>Test for zero volts. | |
| | | |
| **Visual Inspection** | Check that the installation complies with all appropriate requirements and specifications | AS/NZS 3000 Clause 8.2 |
| | | |
| **Main Earth Resistance** | Disconnect main earth, equipotential bond(s) and HWS earth, then measure main earthing conductor resistance with a low reading ohmmeter. | Must not exceed 0.5 ohms. |
| | | |
| **Protective Earth Continuity** | Check earthing conductor continuity from main earth to each remote point required to be earthed.<br>Check all equipotential bonding conductors for continuity from the main earth. | Resistance must be low enough to allow circuit protection device to operate.<br>AS/NZS 3000 Table 8.2 (Re)<br>Equipotential bonding conductors ≤0.5Ω |
| | | |
| **Insulation Resistance**<br><br>**Mains Cable** | Test between Active and Neutral (**P**rotective **E**arth **N**eutral)<br><br>Ensure that the cables are disconnected and separated at both ends | Must use a 500 V high voltage insulation tester.<br><br>Must be over 1 megohm, ≥50MΩ is expected |
| | | |
| **Insulation Resistance**<br><br>**Whole of Installation** | Switch all circuit breakers and appliances on.<br>Join main active and neutral at the switchboard.<br>Disconnect MEN link. Megger between joined active/neutral and the disconnected main earthing conductor. If a fault is indicated, turn off each circuit breaker in turn and re-check.<br>If fault persists disconnect active and neutral of each circuit until fault disappears.<br>Remove temporary active-neutral connection. | Must use a 500 V high voltage insulation tester.<br><br>Operate multi-way switches during testing.<br><br>Must be over 1 megohm, or over 0.01 megohms for sheathed heating elements.<br><br>Ideal reading is ≥200mΩ. |
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|---|---|---|
| **Polarity and Connections** | Socket-outlets: Check continuity from each power circuit breaker to each socket active.<br>Check neutrals to correct neutral link. | If infinity, check neutral and earth points for crossed wiring.<br><br>Active must be switched - not the neutral. |
| | Lighting: Check continuity from each lighting circuit breaker to each lampholder active.<br>Check neutrals to correct neutral link. | |
| | Appliances: Check continuity from each appliance circuit breaker to each appliance active.<br>Check neutrals to correct neutral link. | |
| | | |
| **Insulation Resistance** | Reconnect all disconnected wiring except the MEN link and re-check insulation resistance with a Megger.<br>If results are correct then reconnect MEN link | |
| | | |
| **Short Circuit Test** | Switch all switches and circuit breakers on. Check resistance between main active and neutral with an ohmmeter. | Must not be a short circuit. All circuit connections must be correct. |
| | | |
| **Visual Check** | Check installation for compliance.<br>Ready for the supply to be connected | ALL disconnected cables/equipment reconnected |
| | | |

**NOTE:** This procedure is a guide only