Electrical Installation Planning

Learner Workbook

Version 1

Training and Education Support
Industry Skills Unit
Meadowbank

Product code: 5681
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Section 1 - Performance Requirements
Design and Safety

Topics

• Protection against harmful effects
• Correct functioning
• Supply characteristics
• Determining maximum demand
• Voltage drop limitations
• Arrangement into circuits
• External factors
• Protection against:
  • Direct contact
  • Indirect contact
  • Thermal effects
  • Over current
  • Earth fault current
  • Abnormal voltages
  • Mechanical movement
• Integrity of fire rated construction.

Aim

Learners will be introduced to basic electrical design considerations when selecting electrical equipment to meet safety and performance standards.
**Learning Objectives**

Learners should be able to meet the following learning objectives:

- Outline the harmful effects against which the design of an electrical installation must provide protection.
- Outline the acceptable performance standards of a correctly functioning electrical installation.
- Explain each of the supply characteristics that shall be considered when designing an electrical installation.
- Describe the acceptable methods for determining the maximum demand in consumer's mains and sub-mains.
- State the AS/NZS 3000 requirements limiting voltage drop in an installation.
- State the reason for dividing electrical installations into circuits and the factors that shall determine their number and type.
- List typical external factors that may damage an electrical installation and that shall be considered in the installation design.
- Describe the methods for protecting persons and livestock against direct contact with conductive parts.
- Describe the methods for protecting persons and livestock against indirect contact and the typical application of each.
- Describe acceptable methods of protection against the risks of ignition of flammable materials and injury by burns from the thermal effects of current, in normal service.
- Describe the acceptable methods for protecting persons and livestock against injury and property against damage from the effects of over current.
- Outline the requirement for protection against earth fault current.
- Describe the likely sources of abnormal voltages and the methods for dealing with this potential hazard.
- Outline the requirement for protection against the harmful effects of faults between live parts of circuits supplied at different voltages.
- Explain the need for protection against injury from mechanical movement and how this may be achieved.
- Describe the features of 'fire rated construction' and how the integrity of the fire rating can be maintained in relation to electrical installations.

**Introduction**

As an electrician, especially in the contracting industry, you will be required to make design decisions about various parts of an installation. This may be as simple as selecting the correct current rating of a circuit breaker to protect the circuit for a piece of equipment, or as complex as the complete design of an installation.
**Topic 1 - Protection Against Harmful Effects**

Risk management has three parts.
- Identification, what is the risk?
- Assessment, what danger and how often the risk will occur?
- Mitigation, what actions and processes can be used to eliminate or control the risk?

Now the risks have been identified, it is obvious that assessment will show the dangers are catastrophic and frequent. Designing an electrical installation to the appropriate Australian standards will mitigate the risks to an acceptable level.

### Activity 1 - Protection Against Dangers and Damage

Read AS/NZS 3000 clause 1.5.1

1. What 3 items require protection?
   a) ___________________________
   b) ___________________________
   c) ___________________________

2. What are the 3 major risks?
   a) ___________________________
   b) ___________________________
   c) ___________________________
Topic 2 - A Correctly Functioning Electrical Installation

So how do we select the correct equipment so that we do not cause electric shock and/or potentially burn the installation to the ground? Section 1.6 of AS3000 (2007) gives guidance.

Activity 2 - Design of an Electrical Installation

Read AS/NZS 3000 clause 1.6.1

1. List 5 functions that an electrical installation must be able to perform.

   a) ____________________________________________

   b) ____________________________________________

   c) ____________________________________________

   d) ____________________________________________

   e) ____________________________________________

   f) ____________________________________________
**Topic 3 - Supply Characteristics**

The electrical equipment and the wiring systems installed must be compatible with the characteristics of the supply. Most installations are supplied by large electrical distributors, however it is not uncommon for private supply sources to be in use. In remote areas solar, wind and small internal combustion generators are common. Larger factories may have their own steam turbines as a source of supply.

Overseas countries such as the United States use a 110 V, 60 Hz system. Equipment to suit the American supply will not be compatible with Australia’s 230 V, 50 Hz system.

**Activity 3 - Design of an Electrical Installation.**

Read AS/NZS 3000 clause 1.6.2

1. List 9 characteristics of the supply system that must be compatible with the electrical installation connected to it.

   a) ____________________________
   b) ____________________________
   c) ____________________________
   d) ____________________________
   e) ____________________________
   f) ____________________________
   g) ____________________________
   h) ____________________________
   i) ____________________________

(a) Generally the supply in Australia is alternating current.
(b) If an installation’s maximum demand is greater than that of the supply available it is normal for the supply distributor to ask for a financial contribution to any upgrades in infrastructure.

The number of supply phases will depend on the maximum demand and load types. Small installations up to 100 A will generally be connected only to 1 phase and a neutral. If the load exceeds 100 A or a 3 phase motor is installed 3 phases and a neutral will be connected. Known as a 4 wire 3 phase supply it is shown in Figure 1.

The Service and Installation Rules of New South Wales gives guidance on the number of phases connected to an installation.

Outside metropolitan areas 3 phase supply is not always available. Many rural distributors use a 3 wire 2 phase supply as shown in Figure 2. Heavy loads are wired across A and B phases but are connect to 480 volts single phase, not 415 volts. A 3 phase 415 V motor would not be compatible with the 2 phase 480 volt supply.

(c) The nominal supply voltage is 230 volts for single phase supply and 400 volts for three phase supply, not 240/415 Volts. All calculations for this subject are to be performed at 230/400 V.

It is important to ensure the supply voltage is within tolerance. If the voltage is either too high or too low, damage to electrical wiring and equipment will occur.
(d) The standard frequency in Australia is 50 Hz. Operation at any other frequency will cause three phase induction motors to run at speeds different to rated values and cause changes in characteristics of other inductive devices.

(e) The maximum current that is supplied to the installation can be limited at the electricity distributor’s discretion. Maximum demand will be covered in the next topic.

(f) The prospective short circuit current is the maximum possible current that could flow under short circuit conditions. Protection devices must be capable of interrupting this current without damage.

Activity 4 - Supply Characteristics

Use AS/NZS 3000 clause 1.6.2 (c) to Complete the following activities:

1. Calculate the **maximum** permissible **supply** voltage for a single phase 230 V installation.

2. Calculate the **minimum** permissible **supply** voltage for a single phase 230 V installation.

3. Calculate the **maximum** permissible **supply** voltage for a three phase 400 V installation.

4. Calculate the **minimum** permissible **supply** voltage for a three phase 400 V installation.