Module 24: The electrical installation

Module Objectives

By the end of this session, participants will understand:

1. The home inspector’s limited but important role in checking electrical installations
2. The basics of electrical installations
3. What the home inspector should look out for in the different areas of the house and garden

Module at a glance:

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<td>- What the law says&lt;br&gt;- About the limited but important inspection role of the home inspector.</td>
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The electrical installation

Home inspectors do not test the electrical installation of a house – because the home inspector is not a licensed electrician. Likewise the home inspector does not issue a certificate of compliance (CoC) for the installation. This is a document which is required by law in South Africa, every time a property is sold (transferred) and every time an electrical installation is altered. In South Africa the seller normally takes responsibility for the issue of the CoC. The home inspector, on the other hand, usually works for the buyer.

The Occupational Safety Act (85) of 1993 (updated 2008) requires that all house electrical installations must be installed and repaired under control of a registered electrician. The Act also stipulates that the property owner must be in possession of a certificate of compliance for any changes to the wiring of the property.

The information in this SAHITA module is designed to give the home inspector a basic understanding of the electrical installation and also equip the inspector to report to the client on observable defects such as:

- Loose, exposed or dangerous wiring
- Dangerous, broken or illegal electrical distribution boards – including the board at the swimming pool.
- Dangerous and illegal hot water geyser connections and earthing.
- Illegal live points in too close proximity to water in the bathroom or kitchen.

However, it is still necessary for the professional property inspector (and useful for the property owner) to have a basic knowledge of electrical wiring and installations. This knowledge will enable the inspector to identify obvious existing problems and potential problems and advise the client accordingly.
Electricity basics

Electric current is a movement or flow of electrically charged particles (electrons). In a typical modern house wiring system, electricity from a municipal supply enters the house via an underground cable; in older houses electricity is often supplied via overhead wiring from a municipal street pole.

The power is distributed through the house via a distribution board (DB), which is equipped with circuit breakers (switches), to the various lighting and power circuits. The wiring system is earthed via an earth spike which is placed deep into the ground in accordance with the relevant regulations.

The supply of electricity to South African houses is a nominal 230 volts of alternating current (AC). The supply to all circuits in the house is also the nominal 230V, but the amp rating of the circuits will vary according to the amount of power each circuit is required to deliver.

Most South African houses are supplied with single phase power. Three-phase electrical generation is common in industry and is also installed in homes which have a high electricity consumption requirement. A three-phase system is generally more economical, because it uses less conductor material than single phase, to transmit an equivalent amount of power.

An electrical installation

The DB board (distribution board) is the point of entry of electricity into the house. In older homes, the DB board is often still a surface-mounted cast iron box containing a number of ceramic or porcelain fuses linked to each circuit. Circuits are loops of conductor material (wiring) which supplies electricity to different areas of the house.

With these old DB boards, the function of the fuses is to prevent circuit overload – the fuse is the “weakest” point and the fuse wire/metal strip is designed to “fail” when the amperage over the circuit is exceeded. When the circuit is overloaded, the fuse wire/metal strip heats up and fails, thereby breaking the circuit. The “blown” fuse needs to be replaced with one of the same amperage.
If the cause of the problem is a power surge, replacing the fuse should sort out the problem. However, if there is a fault in the circuit, or the circuit continues to be overloaded, then the fuse will continue to blow until the problem is corrected.

*In more modern houses the old porcelain/ceramic push in fuses have been replaced with circuit breakers - which work on the same principle - i.e. the circuit breaker is rated for a particular amperage and is designed to “trip” (switch off) when the circuit is overloaded.*

New installations of a DB or a sub-DB in the garage (for example) must be installed in compliance with SANS 10142 which specifies appropriate circuit breakers, together with an earth leakage unit.

A DB must be located between 1.2m and 2.2m from the floor. Like most electrical regulations this height regulation is simple common sense as regards safety: The DB should not be too low (within reach of a small child) and neither should it is located too high (making it difficult for the average adult to easily reach in the event of an emergency).

A modern DB board contains a sensitive earth leakage unit that trips the entire system immediately a fault develops between the neutral and the earth.

The various circuits in a house have different amp ratings according to the amount of power they are required to deliver. Light circuit breakers should be 10 amps, while plug point circuit breakers will generally be 20 amps.

**Electricity is measured in various units**

- **Amperes (A).** The number of amps defines the “volume” of electrical current flowing through a circuit. A usual house DB will have a rated main circuit breaker (“main switch”) of 60A. Light circuits are normally 10A, geyser circuits 15/20A, plug circuits 15/20A, stove circuits 35A. The rating of the circuit breakers (including the mains switch) is designed to prevent overload, and the consequent overheating and fire risk which is likely to occur if too much power is drawn through the system.
- **Milliamp (mA)** is 1000\(^{th}\) of an amp. An earth leakage unit normally has a sensitivity of 30mA. The earth leakage will trip if the leakage of power from the neutral to the earth is greater than 30mA. This is especially designed to prevent people getting lethal shocks. (A shock occurs when a person becomes part of the earthing system and current flows from the live wire, through the person and into the ground.)

- **Resistance (R)** is measured in ohms and is a measure of the opposition to electrical flow – for instance from the conductor wire itself, and mainly from the light bulb or appliance.

- **Volt (V)** is a measure of the electrical potential between two points. An electrical potential of 1V will push 1A of current through a 1 ohm resistance load. An analogy: Voltage is similar to water pressure and amperes measures the actual flow (units flowing through the system). The electrical supply to a South African home is 230V (nominally 220V).

- **Watt (W)** is the standard measurement for the consumption of electrical power by an appliance or a light: 1W = 1A of current flowing at 1V. Therefore W = V x A. For instance a 100W light bulb draws approximately 0.4A (100=230 X 0.4 – approx.).

- **Kilowatt (kW)** is 1000W. The connected load of an electrical installation is reckoned in kW. Stove: 8kW; geyser: 3kW; 12 plug sockets: 6kW; 20 lights: 1.2kW.

- **Kilowatt-hours (kWh)** is the measurement of electrical consumption. For example if you leave five 100W lights on for 10 hours you will use: 5 X 100 X 10 = 5 000 watt hours or 2.4kWh. A 2000W electrical motor running for 1 hour would use: 1X2000 = 2kWh.

The regulations governing electrical installations (SANS 10142) specifies the cross-section of the connecting and circuit conductors (“wires”). To prevent overheating and failure, the correct thickness of conductor wire must be used for wiring circuits. The thickness required depends on the connected load to be carried by the conductor (wire).

The wire thickness used for connections must be correct for the power supplied. As a rule of thumb: If the cross section of the wire to too small to carry the load the circuit requires, then the wire is likely to overheat.
Usual wire thicknesses and DB circuit breakers for house installations are:

- Lighting circuits (10 lights per circuit): wire cross-section: 1 mm$^2$; circuit breaker on DB board 5A.

- Plug circuits (3 sockets per circuit) wire cross-section: 1.5mm$^2$; circuit breaker on DB board 15A.

- Stove: wire cross-section: 6 mm$^2$; circuit breaker on DB board 35A

- Geyser: wire cross-section: 1.5mm$^2$ circuit breaker on DB board 15A

### Colour codes of wiring

Conductors (wires) of single phase and three phase systems are identified by colour coded insulation:

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<tr>
<th></th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>Neutral</th>
<th>Earth</th>
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<tbody>
<tr>
<td>Single Phase</td>
<td>Brown (Red pre 2004)</td>
<td></td>
<td></td>
<td>Blue (Black pre 2004)</td>
<td>Green/Yellow striped</td>
</tr>
<tr>
<td>Three phase</td>
<td>Red</td>
<td>Yellow</td>
<td>Blue</td>
<td>Black</td>
<td>Green/Yellow striped</td>
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Single phase has two insulated wires – one blue (black pre 2004) neutral and one brown (red pre 2004) positive/live. Three phase has four insulated wires – one black (neutral) and three live (red, yellow and blue). The neutral wire for three phase is usually connected on the house side to the copper earth spike, which is driven into the ground, and also to the cold water plumbing pipes.

### Inspection checklist for electrical installation

The checks described below should be performed by home inspectors using visual observation only. These checks are not a substitute for the legally required Certificate of Compliance (CoC) which must be issued by a licensed electrician before transfer, or any time that the house’s electrical installation is altered. The licensed electrician, before issuing a CoC, will check and test the entire electrical installation and perform remedial work on any aspects of the installation which do not comply.
The purpose of the home inspector’s check of observable defects is to raise a “red flag” regarding any obvious defects. This can be important because South African electrical CoC’s are sometimes issued fraudulently when installations have not been properly and personally inspected by licensed electricians.

It should be noted that South African house owners are legally responsible to ensure that they are in possession of a valid electrical certificate of compliance at all times. If in any doubt regarding the validity of an electrical CoC, because of the serious safety and legal implications, the home owner should engage an approved provincial electrical inspection authority to verify the integrity of the CoC which has been issued.

These approved authorities were empowered to investigate incidents and complaints in terms of the provisions of the Electrical Installation Regulations (2009). The AIA’s in the various provinces are officially authorised to help the public by uncovering dangerous and illegal electrical work. These authorities are also able to audit CoC’s and to verify compliance of new electrical installation work performed by electrical contractors.

While the initial investigation by the AIA is for the account of the home owner commissioning their services, if problems are discovered then the AIA can force the guilty electrical contractor to “make good” at his own cost. If fraudulently issued CoC’s are discovered, then criminal prosecution is on the cards for the offending electrician.

Only an AIA accredited by the Department of Labour should be used to verify any electrical installation work or to audit a suspect CoC.

Faulty electrical installations can be extremely dangerous and life-threatening. Most house fires are caused by faulty electrical installations.

The following are the areas of the electrical installation that the home inspector should observe and report on:

**General**

- Missing or broken sockets or light switch covers anywhere on the property.
- Missing cover plates for junction boxes in the roof cavity.
- Exposed wiring anywhere on the property
- Missing or broken lights or other electrical installations

**Distribution Boards**

- Gaps between the circuit breakers on the DB board which have not been blanked off.
- Absence of an earth leakage unit. The home inspector should operate the "Test Button" on the earth leakage unit. Reset by first pushing the lever further down and then re-setting upwards.
- Labelling: Permanent labelling must identify all circuit breakers (switches) on a distribution board (main DB and sub-DBs). The mains switch on the main DB board must be labelled as "main switch" and the mains switch on sub-DB boards must be labelled "sub-mains switch" or "mains switch" if the sub-board itself is labelled "sub board".
- Distribution boards must be protected against corrosion and should not be rusted. Swimming pool sub-boards are sometimes found to be badly rusted and this fact should be noted in the SAHITA report.
- Location of the DB board:
  - No part of the board which has to be reached should be more than 2.2m from floor level. Unless the board is enclosed and cannot be reached by an infant, no part of an indoor board shall be less than 1.2m above the floor level and no part of an outdoor distribution board should be less than 200mm above the ground.
  - No board should be mounted above a cooking appliance unless suitably enclosed.
• No board shall be mounted within a radius of 1m of a water tap or valve (in the same room) unless the board is suitably enclosed.

Water heaters (geysers and other water heating devices)

• Dedicated circuits (clearly marked on the DB board) must be used for water heaters. More than one water heater is allowed on the same circuit.

• There must be an isolator switch within easy reach (1m) of the water heater.

• The cold and hot supply pipes must be bonded (joined with a perforated copper strap) for earthing.

Stoves and ovens

The circuit that supplies a cooking appliance through fixed wiring (this includes all appliances rated at more than 16A) must have a readily accessible switch dis-connector, clearly marked.

• The switch must be in the same room as the appliance (s) and must not be attached to the appliance.

• It must not be more than 2.2m or less than 500mm above floor level.

• It must not be more than 3m from the appliance it serves and must be clearly marked, unless it is within 500mm of the appliance.

• The switch should preferably not be located above the cooking appliance

• If the cooking appliance is connected by means of a stove coupler, then the open end of the connector tube or socket outlet must point downwards.

The cooking appliance circuit may supply more than one appliance so long as the appliances are in the same room.
Bathroom & Indoor Spas

Zones in the bathroom:

No electrical equipment or appliances are allowed to be installed in the various zones of a bathroom, except as indicated below. (Note that the volume under the bath or spa which is covered and cannot be accessed without the use of a tool is not considered part of the room - not a zone):

Zone 0: This is the interior of the bathtub or shower cubicle. No electrical installation.

Zone 1: This is the space 200mm from the inner edge of the bathtub, or 600mm from the shower rose and 2500mm above the bathtub or shower floor. No switches or plugs and no lights except for specially insulated lighting.

Zone 2: This is the space 600mm beyond Zone 1 and 2250mm above the floor. Same as Zone 2, except shaver plugs allowed – maximum 50V

Zone 3: This is the space 2400mm beyond Zone 2 and 2250mm above the floor. Normal rules apply – as per elsewhere in the house.
Figure 7.1.2 – Plan of zone dimensions for bathrooms
Earthing in bathrooms

All metallic bathroom appliances, such as metallic baths and basins, and metallic fittings in baths and shower trays, must be earthed unless they are electrically isolated from earth, in which case they need not be earthed. Such fittings are considered electrically isolated if the waste pipes are non-metallic and the taps are either wall-mounted, or fitted with non-metallic pipes (polycop).

Plug sockets

- A socket outlet must not be positioned within 2m of a water tap (in the same room) unless the socket has earth leakage protection.

- No sockets should be positioned so close to the floor to present a danger that live parts can come in contact with the floor, or that the socket may become wet during floor mopping.

- A socket which is exposed to the weather, or to condensation or dripping water, must be weather-proofed.

- A socket outlet should supply only one fixed appliance (such as air conditioners and gate motors) and the use of long cords (over 3m) is not recommended.

Heaters and appliances for space heating and cooling

- Heaters include towel rail and mirror heaters, hair and hand driers. The regulations for both bathrooms and plug sockets apply for these devices.

- Space heating and cooling devices include air conditioners and under-floor, under-tile and under-carpet heaters. If the rating of these devices is more than 16A then a separate dedicated circuit must be provided.

- While there may be more than one space heater/cooler on a circuit, a separate disconnected switch must be installed for each unit.
Swimming pool & outdoor spas

There are basically two areas of concern for home inspectors regarding electrical installations for, or near swimming pools, ponds or outdoor spas.

- No-one in contact with the water should physically be able to touch any electrical installation except for a suitably insulated 12V pool light.

- The sub-DB board for the pool should be in order (i.e. no exposed wiring or missing cover) and have the following features:
  
  a. Linked to the main board earth leakage unit.

  b. Separate weather-proof plugs for items such as salt-water chlorinators.

Motors

Motors include motors in automatic doors and gates, garbage disposal units and pumps (pool, ponds and spas).

All motors must have a manually operated disconnector, which is easily accessible, and mounted near or on the motor.

Electric Fences

Electrical fencing can be extremely dangerous if not properly installed by a qualified expert. Non-compliant electric fencing is now also illegal in South Africa and property owners – including home owners, body corporates and businesses – are at risk if someone gets hurt because their electric fence installation is faulty, or non-compliant.

From 1 December 2012 all new, upgraded and repaired electric fence installations in South Africa had to be compliant after the government established strict new regulations for this industry. From 1 October 2013, all electric fence installers had to be registered after first passing a tough exam.
The law now says that electric fences must be certified with an electric fence system certificate of compliance (EFC). This certificate is similar to the electrical compliance certificate which all property owners must have. However, electricians cannot issue this electric fence certification—unless the electrician is also qualified in terms of the new electric fence laws and has been registered with the Department of Labour.

In terms of this new law, all properties with an electric fence can only be transferred after 1 December 2012, if an EFC has been lodged with the conveyancing attorney.

All residential and commercial units, freehold and or sectional title, within town house complexes, housing estates, echo parks, business parks, also fall under this legislation. Although sectional title properties do not require an EFC to effect transfer, body corporates and business entities are still legally responsible for any electric fence installation on the property and can be sued and prosecuted for non-compliance—especially if someone gets hurt.

A certificate is also required when a change and or addition is made to an existing installation—such as restringing an electric fence, or any additions to an electric fence. A certificate is not required when repairing a broken wire; replacing a broken bobbin; repairing the energizer; replacing a lightning arrestor; or other repairs of a minor issue.

Should a fence found to be non-compliant, it will either have to be upgraded to compliance or the owner will be forced to remove it.

Some of the topics covered in the electric fence legislation include: Energizer and energizer placement specifications; energizer lightning arrestors which must be fitted to all energizers; fence and energizer earthing specifications (the energizer must have its own earthing spike); the placement and positioning of brackets; specifications regarding the joining of fence wiring/cabling; and warning signs.
Home inspectors should report on the observed condition of an electric fence – broken strands, insulators, posts and warning signs on portions of the fence which can be accessed by the public or neighbours.

_Before you take the online test, please……_
Make sure that you are thoroughly familiar with the material in this module before completing the online test. The more familiar you make yourself with the information presented in this Module the better you will be as a professional home inspector. Review thoroughly all areas of this module before and during the open book online test.