Issue No. 01
May 2001

electrician's newsletter

A newsletter for electricians...

Welcome to this first edition of the "Electrician's Newsletter".

The Electrician's Newsletter is an initiative of the Office of Energy and the Electrical Licensing Board. This newsletter and future editions will be used to inform electricians about important safety and technical issues.

In this first edition, we focus on two important technical issues:

1. The Multiple Earthed Neutral (MEN) system of earthing
2. Final sub-circuit design using the new Australian/New Zealand Standard AS/NZS 3000:2000 Wiring Rules and the new (August 2000) edition of the WA Electrical Requirements

We recommend you keep this newsletter, together with subsequent editions (which will also contain worked examples), to form a useful technical reference for your day-to-day work.

Future editions of this newsletter will be available from the Office of Energy's website and will be transmitted to electricians who have registered their email address details with the Office of Energy. Please refer to page 5 for details of how to register your email address.

Electricians whose email addresses are received at the Office of Energy by 30 June 2001 will be eligible to enter a draw for one of three prizes of trade tool vouchers, each valued at $100.00. Further information on this offer is also on page 5.

This first issue of the newsletter is also available on the Office of Energy's website at:

http://www.energy.wa.gov.au/html/body_7.13.html

in this issue...

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The MEN System of Earthing

The MEN (Multiple Earthed Neutral) system of earthing is an arrangement that uses the network neutral conductor as the conductive path for installation earth fault currents. These fault currents need to be large enough to cause the protective devices (such as circuit breakers or fuses) to operate. For example, when an ACTIVE to EARTH fault occurs, the fault path is the low impedance circuit via the MEN link, to the source of supply (eg. distribution transformer or generator – see diagram below).

In the diagram, the NEUTRAL conductor of the electrical distribution system provides the low impedance return path for the fault current (we call it the "earth fault current" because it goes to the earthed frame of a faulty appliance or piece of equipment). If the MEN link was not in place, the return fault current path would be from E2 to E1 via the ground. The impedance of the ground is generally much higher than the MEN/NEUTRAL conductor path. This would limit the magnitude of the fault current to a value which may be insufficient to cause the protective device to operate.

If the protective device does not operate, a life-threatening voltage may remain on the metallic enclosure of the appliance or equipment.

The installation of the MEN link is therefore crucial to the safety of an electrical installation.

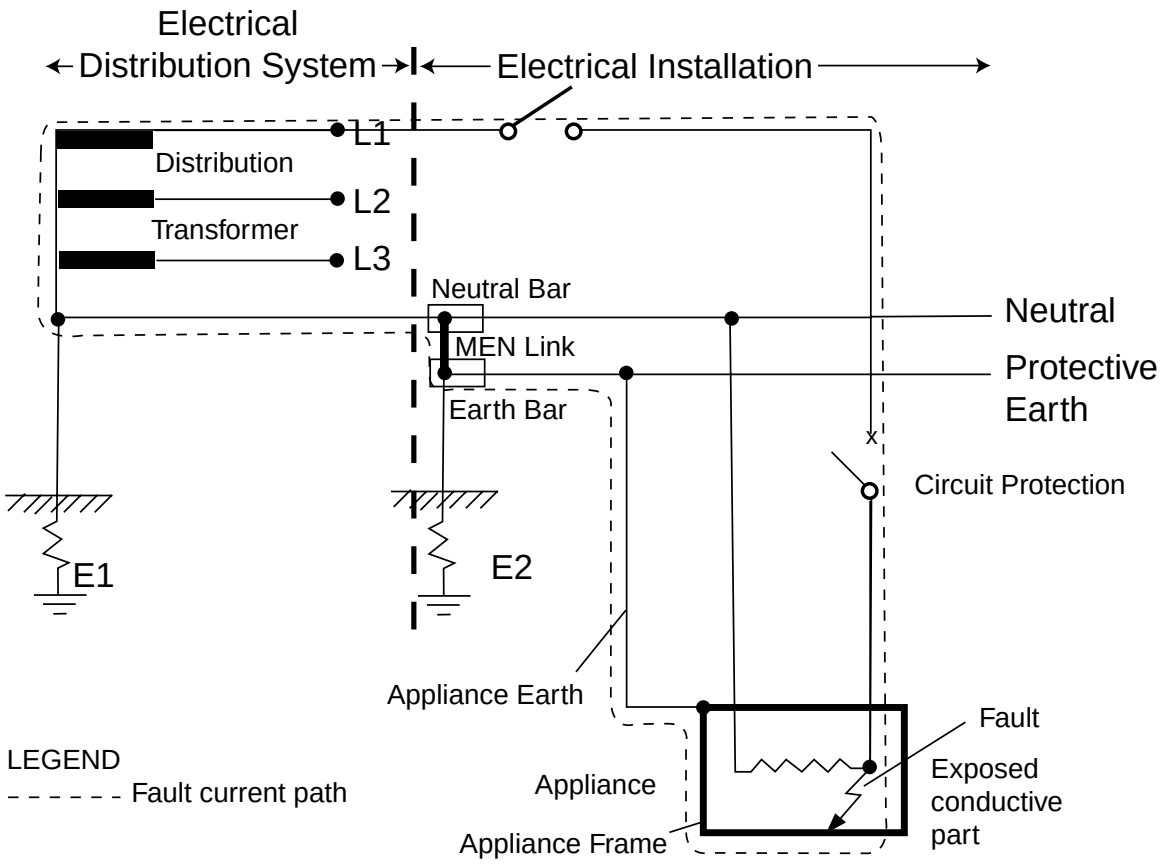
How to Make the MEN Connection

The MEN connection is a link between the main EARTH bar (or earth terminal/connection) and the main NEUTRAL bar and should be made at the main switchboard. The MEN link needs to comply with Clause 5.6 of the Wiring Rules.

Where to Make the MEN Connection

Generally, the MEN connection needs to be made at the main switchboard. Where a switchboard is installed at a separate installation (ie. outbuildings and detached portions of an installation), particular attention must be given to the method of earthing and the MEN connection (refer to Clause 5.6.6 of the Wiring Rules).

Once the installation has been tested, the MEN connection needs to be rechecked as a "last task" item. There have been several electrocutions and many serious electrical accidents where the MEN link was missing, and subsequent faults occurred in the installation.



Final Sub-Circuit Design

This article describes how to safely design and install a final sub-circuit, using the Wiring Rules (AS/NZS 3000:2000) and the recently updated "WA Electrical Requirements".

Where the automatic disconnection of a supply is by an over current device, the Wiring Rules requires calculation of the installation earth impedance values, termed "fault-loop impedance". The impedance measurement (in ohms) of the low voltage distribution system (loop) involving the active conductors from the distribution transformer to the consumer's appliance, the return path of the earth cable, MEN link and neutral cable back to the distribution transformer is the "fault-loop impedance". If an active to earth fault occurs at the consumer's appliance, a high fault current should flow in the above path, as depicted in the previous diagram.

Protective devices are placed in the above circuit to operate when fault currents flow, for a variety of reasons. There needs to be very careful selection of the protective device tripping/fusing characteristics. Why? The most important reason is to protect a person who may be touching an appliance at the time a fault occurs (termed "indirect contact").

The effect of electricity on the human body depends on the magnitude of touch voltage and the amount of time for which current flows. The fault current must be large enough to cause the protective devices to operate before the combination of touch voltage and time duration exceed safe limits for a human body.

An RCD will provide superior "earth fault current" sensing and response time, compared to a conventional fuse or circuit breaker. Hence a circuit protected by an RCD device during a fault provides suitable touch voltage protection.

Note: Voltage drop limitations and current carrying capacity must be considered for all circuits.

For 230/240V final sub circuits supplying socket outlets, single insulated appliances (Class I) and portable (in use) equipment, the maximum disconnect time must not exceed 0.4 seconds. For fixed and stationary equipment and other circuits, the maximum disconnect time must not exceed 5 seconds.

A method is required to determine the fault-loop impedance so that the installed cables satisfy the impedance limits. Also, the tripping current and times of the circuit protective devices need to be considered.

The Wiring Rules provides this information in an easy-to-read tabular format in Appendix B5.

Table B5.1 (page 239) of the Wiring Rules lists both the minimum conductor size and the maximum circuit length limits which will ensure operation of the protective device, providing safety against indirect contact.

To use the table, determine the required cable size and protective device rating and type. At the intersection of these values on the table, the maximum circuit length (metres) is shown. If the planned circuit distance is greater, then the cable size or circuit protective equipment will need to be reassessed.

Important Point: Earth Resistance

The new Wiring Rules states that for all installations, the resistance of the protective earthing conductors **must be low enough** to permit the passage of current necessary to **operate the protective device.** (Clause 1.5.3.3 of the superseded 1991 Wiring Rules Clause permitted 2 Ohms. **This no longer applies).**

Table B4.1 of the Wiring Rules provides the **maximum** values of fault-loop impedance allowed for various circuit protection devices. The impedance values listed are for the entire fault-loop including the earth cable segment (refer to the definition at the start of this article).

Fault-loop impedance should be measured (using a suitable instrument) when:

- the installation work is completed;
- checking and testing has been carried out; and
- power has been applied.

Meter being used to measure fault-loop impedance

Worked Example

The following is a worked example of final sub-circuit design.

The Wiring Rules uses 230V for all calculations and data tables, in keeping with the international standard of 230V. For this reason, the calculations are also based on 230V, enabling direct tabular readings without applying correction factors.

The Western Power supply voltage will remain at 240V (nominal) until advised otherwise. Cables designed (in terms of cable sizes) to work at 230V will operate satisfactorily at 240V.

A commercial installation with a maximum demand (load) of 50A is to be supplied by a single-phase underground supply from the street mains.

A socket outlet circuit with a route length of 55m is to be installed in the commercial building that uses V-75 insulated copper cable clipped to the timber joists in the insulated ceiling space.

The following steps may be taken to determine cable size and circuit protective device type and size.

Step 1: Calculate maximum allowable voltage drop.

The nominal voltage is 230V. The maximum voltage drop from the "point of supply" (where the consumers mains joins to the distribution cables) to any part of the installation must not be more than 5%. This is to ensure that appliances will operate as intended.

5% Voltage Drop = 11.5V. This is the maximum allowable voltage drop.

Step 2: Determine the cable sizes which satisfy volt drop requirements.

(a) Consumers Mains Voltage Drop

The consumers mains cable length is 15m underground in PVC conduit with a load of 50A.

Note: The WA Electrical Requirements states the maximum demand current value can be used to determine the voltage drop in consumers mains.

From the "Selection of Cables" Standard AS/NZS 3008.1.1: 1998 (Table 9 Column 16), a 10mm^2 V75 cable has a current rating of 68A. The volt drop calculations (ensure you use the single phase mV/Am value of 3.86 x 1.155 from Table 42 of AS 3008, current = 50A and length = 15m) yields 3.3V. The maximum voltage drop allowable for the final sub-circuit is therefore 11.5-3.3 = 8.2V.

(b) Sub-Circuit Voltage Drop

Cable length is 55m. From AS 3008 (Table 9 Column 10 "partially surrounded by insulation"), 2.5mm^2 cable has a rating of 18A. For cable overload protection, select a 16A MCB as the first choice. The current value to be used in volt drop calculations for final sub-circuits may be HALF of the protective device current rating (see Clause 3.6.2 of the Wiring Rules), therefore 16A/2=8A. Volt drop calculations (15.6 x 1.155 = 18.02mV/Am, 8A and 55m) yield 7.9V, which is within the 8.2V limit. Hence the 2.5mm^2 cable with a 16A MCB is suitable for volt drop considerations.

Notes:

1. If 1.5mm^2 cable was used for the final sub-circuit, the resultant voltage drop would be 9.1V and, when added to the consumers mains cable voltage drop of 3.3V, would yield a total voltage drop of 12.4V (5.4%) for a 10A MCB. This is too high.
2. If 6mm^2 cable was used for the consumers mains, then the higher volt drop (5.6V) at the switchboard would require the installation of 4mm^2 cable for the socket outlets, to comply with the installation voltage drop requirements.

Step 3: Check earth loop impedance for compliance.

Check that the circuit protective device (16A Type C) and the length of the sub-circuit (55m) satisfy the maximum earth-loop impedance value.

From Table B5.1 of the Wiring Rules, the above power circuit protected by a Type C circuit breaker is suitable for a circuit length of up to 85m with a 16A protective device.

Note that a 16A Type D circuit breaker with a 2.5mm^2 conductor has a maximum circuit length of only 51m and would present a substantial safety hazard if used for the above example.

How can you receive future copies of this Electrician's Newsletter?

This first issue of the Electrician's Newsletter has been mailed to all electricians. It is also available from the Office of Energy website at:

http://www.energy.wa.gov.au/html/body_7.13.html.

Future issues of the newsletter will be emailed to electricians who have registered their email address details with the Office of Energy. To register, simply:

1. register your email address on the web page http://www.energy.wa.gov.au/html/operatives/information.html; or
2. email your email details to register@energy.wa.gov.au .

You may also like to include your employer's email address details (with his/her permission) to enable future newsletters to be sent to your workmates who may not have direct access to email facilities.

The newsletter will also be available from the Office of Energy's website.

Trainee Restricted Electrical Worker Electrocuted

The distressing electrocution of a National Restricted Electrical Licence (NREL) trainee highlights the importance of effective supervision of trainees. **All** NREL trainees require supervision by a person licensed in the principal work performed.

The supervisor is responsible for:

- providing the necessary on-the-job instructions
- monitoring the performance of the NREL trainee
- ensuring the primary duty of care to the NREL trainee.

The supervisor is responsible for the safety of the trainee as well as ensuring safe and satisfactory workmanship.

Change of Address

Electrical (and gas) workers can now advise the Office of Energy of their change of address or business details using the Internet.

Changed details can be notified on the website page:

http://www.energy.wa.gov.au/html/body_3.1.3.html

Electrical workers need to be aware that it is a requirement of the *Electricity (Licensing) Regulations 1991* that their change of address details are notified immediately to the Office of Energy.

How can you enter the draw for a "Trade Tool Voucher" prize?

Electricians who provide the Office of Energy with details of their email addresses will be entered into a draw to win one of three prizes of a "Trade Tool Voucher", each valued at $100.00, sponsored by the MM Electrical Merchandising company.

To be eligible to enter the draw, details of your email address must have reached the Office of Energy by 30 June 2001. Details provided by email or by registering on-line will be entered into the draw.

The results will be posted on the Office of Energy website and the three winners will be notified by email by 11 July 2001.

The "Conditions of Entry" to be eligible for this draw are:

- The prize must be redeemed before 31st August 2001.
- There can only be one entry per EW licence number.
- Employees of the Office of Energy are ineligible to enter the draw.

Did You Know?

- The Office of Energy is a Western Australian Government agency responsible for energy regulation, energy safety and energy policy development and coordination.
- The Office of Energy reports directly to the Minister for Energy and is independent of Western Power, AlintaGas and other electricity and gas suppliers.
- The Office of Energy has a Technical & Safety Division headed by the Director of Energy Safety and is located in West Leederville. The Technical & Safety Division comprises the Technical Services, Regulatory Services (which includes the Licensing Office), Electrical Inspection and Gas Inspection Branches.
- The Electrical Licensing Board:
  - comprises seven members appointed by the Minister for Energy. Each member of the Board is nominated by a significant sector of the electrical industry
  - is supported by the Office of Energy
  - ensures that applicants for and holders of electrical licences and permits issued under the *Electricity (Licensing) Regulations 1991* have acquired the relevant competencies
  - reviews matters relating to the safety of electrical workers and advises the Director of Energy Safety and the Minister for Energy accordingly
  - maintains standards of conduct of licence holders through investigations and, where appropriate, disciplinary action.

The WA Electrical Requirements (WAER) Document

The WA Electrical Requirements (WAER) is WA's electricity service rules document, setting out how electricity is to be supplied to and metered at consumers' residences.

Section 12 of the document, entitled "Special Requirements for Electrical Installations in WA", details specific requirements that apply in WA. Some of these over-ride requirements in the Wiring Rules (eg in respect of RCDs – see next item). In accordance with Regulation 49 of the *Electricity (Licensing) Regulations 1991,* the requirements of Sections 1 to 12 take precedence over those detailed in prescribed standards and must be complied with at all times.

The latest version of the WAER may be accessed on the Office of Energy website at:

http://www.energy.wa.gov.au/html/body_7.12.html

Specific Requirements for Residual Current Devices in WA

Section 12 of the WA Electrical Requirements "Special Requirements for Electrical Installations in WA" details important requirements for residual current devices (RCDs).

Two or more RCDs must be installed in new domestic and residential type electrical installations. The RCDs must be connected to protect all socket outlets and lighting circuits. The only exclusion may be dedicated circuits for fixed cooking appliances, such as ranges, ovens or hotplates.

The Office of Energy recommends each RCD protects half of the power and light circuits to provide some light and power in the event of one RCD tripping.

For more information on the RCD requirements in electrical installations, including retro fits to older installations, please refer to:

- Section 12 of the WA Electrical Requirements; or
- the Office of Energy website at:

http://www.energy.wa.gov.au/html/electrical_focus_18_supplement.pdf

Alternative formats of the Electrician's Newsletter may be available to meet the needs of people with disabilities.

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