Guidance Notes

Installation & Inspection of Fuel Cells
May 2011

This document has been prepared by Energy Safe Victoria to provide guidance for electrical contractors and licensed electrical inspectors for the installation and inspection of grid-connected fuel cell systems; this document contains extracts from the relevant Regulations, Standards and Victorian Electricity Distributors Service and Installation rules.

What is a fuel cell?

A fuel cell is a device that very efficiently generates Direct Current (DC) electricity from hydrogen rich fuels through an electrochemical reaction.

Similar to a battery, a fuel cell provides continuous DC electricity from a chemical reaction, and they contain an anode, a cathode and an electrolyte. Unlike batteries, they cannot store electrical energy, do not go flat, or require electricity to charge them again. Fuel cells will continuously generate electricity as long as they have a supply of fuel and air. An operational fuel cell is called a fuel cell system.

Fuel cells do not burn fuel; they use an electrochemical reaction to convert the chemical energy in the fuel into electricity, heat and water. Therefore they can be used to co-generate electricity which can be used in the installation or fed into the grid, and also heat, for space heating and hot water.

There are numerous types of fuel cells, generally grouped into high and low temperature units. Units currently being installed in Victoria for grid connection are supplied using natural gas. Units contain an inverter integral with the unit, and output 230V AC ±10% 50Hz.

Other types of fuel cells, using other fuels such as methane or LPG are currently available for back-up generation, but not for grid connection. An LPG unit is expected on the market for grid connection in 2012. The unit will have a 12 or 24V DC output, and will therefore have a DC cable to an external inverter. In this case all requirements currently used with solar systems will apply.

Standards and regulations for installation

The following standards and regulations **shall** be complied with where applicable.

Electrical Safety Act 1998

Electricity Safety (Installations) Regulations 2009

Victorian Distributors Service and Installation Rules 2011

AS/NZS 3000:2007 Wiring Rules

AS/NZS 3008.1.1:2009 Electrical Installations-Selection of cables

AS/NZS 4777.1:2005 Grid connection of energy systems via Inverters –Installation requirements

AS/NZS 4777.2:2005 Grid connection of energy systems via Inverters –Inverter requirements

AS/NZS 4777.3:2005 Grid connection of energy systems via Inverters –Grid protection requirements

What part of the Grid connected Fuel Cell System is considered to be prescribed electrical installation work?

Those parts of the generation system operating at or above 120 Volt dc, or 50 Volt ac, and the ac cables installed between the fuel cell system and the switchboard to which the generation system is connected along with all the required isolation and protection devices, are prescribed electrical installation work.

For the purpose of section 45 of the Electricity Safety Act 1998, *prescribed electrical Installation work* means work on all or any part of the following electrical installations if they ordinarily operate at low voltage or a voltage exceeding low voltage.

> (f) Wiring systems, switchgear, control gear and accessories installed to provide control and protection of generation systems (excluding stand alone power systems with a power rating that is less than 500 volt-amperes)

Voltage

Differences in potential normally existing between conductors and conductors and earth as follows:

Extra Low Voltage: not exceeding 50 V ac or 120 V ripple-free dc

Low voltage: Exceeding extra-low voltage, but not exceeding 1000 V ac or 1500 V dc

High Voltage: Exceeding Low-voltage.
Reference - AS/NZS 3000:2007 Amd1 Clause 1.4.98 Voltage

Do the exposed metallic parts of the fuel cell system require be earthed?

Yes, the fuel cell system would require earthing.

The earthing conductor shall be regarded as a protective earthing conductor, and shall be selected in accordance with Clause 5.3.3.1 and Table 5.1 of AS/NZS3000. The earthing conductor shall be arranged in accordance with Clause 5.5.2.1 of AS/NZS 3000.
Reference - AS/NZS 3000:2007 Clause 5.3.3.1 & 5.5.2.1

Where appropriate, gas and water piping should also be equipotential bonded.

Reference - AS/NZS 3000:2007 Clause 5.6.2.2 & 5.6.2.3

Are the conductors installed between the fuel cell system and the main switchboard classified as consumer's mains?

Yes – the conductors between the output terminals of an electricity generating system that provides another source of electrical energy within the installation and the switchboard where they are connected are consumer's mains.

Consumer's mains **-** those conductors between the point of supply and the main switchboard.
Reference – AS/NZS 3000:2007 Clause 1.4.33

Point of supply - the junction of the consumer's mains with—

(a) conductors of an electricity distribution system; or

(b) output terminals of an electricity generating system within the premises.
Reference – AS/NZS 3000:2007 Clause 1.4.75

What considerations need apply to the fuel cell system consumer's mains?

The fuel cell system cable between the cell and the switchboard are deemed to be consumer's mains.

The consumer's mains installed between the fuel cell system and the switchboard are considered to be electrically protected when an appropriate sized ac circuit-breaker is installed as the fuel cell system main switch.

Do I need to provide isolation for the fuel cell system at or near the fuel cell unit?

Yes – the fuel cell systems require regular maintenance by a person with a Type B Gas Appliance licence. Therefore an isolator, switching all live conductors (both active and neutral), intended for mechanical maintenance should be installed in close proximity to the equipment, and be easily accessible at all times. The isolator should have means to be locked in the open position. The exception under this clause regarding locking facilities not being required if the isolator is under the control of the person performing the maintenance does not apply in this case, due to the long cool down and start up times of these units.

Reference AS/NZS 3000- 2007 Clause 2.3.6.1

Where should the fuel cell systems be installed?

Current units are suitably IP rated (IPX4D) for outdoor installation. Installation instructions state that units installed outdoors should be protected from the elements and above freezing temperature. Units may also be installed indoors, excluding living areas.

As other units come onto the market, individual specifications should be checked.

How should I connect the fuel cell system (generator) to the installation?

The fuel cell system shall be connected by fixed wiring to a dedicated circuit on a switchboard. It is not permitted to connect the fuel cell system via a removable plug arrangement.

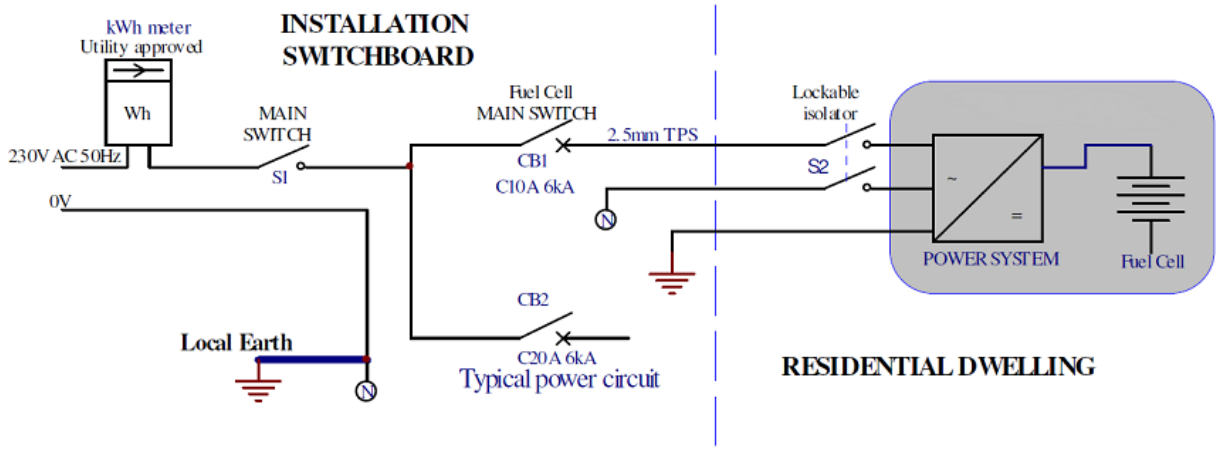
The fuel cell system should be connected directly to the main switchboard. In installations where this is not possible or not desirable, the inverter energy system should be connected to the distribution board located physically nearest to the fuel cell system, and the main switchboard.

All intermediate distribution boards shall be appropriately labelled in accordance with Clause 5.5 of AS/NZS 4777.1.

Reference AS/NZS 4777.1 -2005 Clause 5.3.1

All the cables between the fuel cell system and any switchboard and all the cables between any distribution boards and a main switchboard which carry current from the fuel cell system shall be rated for at least the full output current and voltage of the fuel cell system.

Reference AS/NZS 4777.1 -2005 Clause 5.3.2



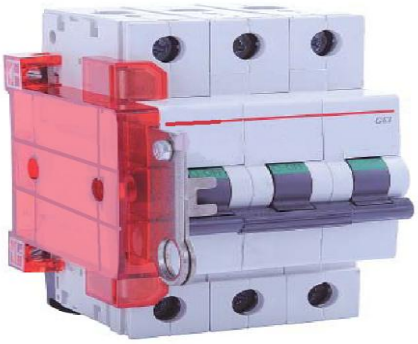
Does the fuel cell system main switch need locking facilities?

Yes, the main switch shall be provided with a permanent locking facility so it can be the locked in the OFF position. This cannot be achieved using a plug in circuit breaker in a semi enclosed rewirable fuse base.

The fuel cell system main switch for the switchboard to which the fuel cell system is connected, shall be a lockable switch.

An appropriately labelled lockable isolation switch or circuit breaker, which is lockable in the OFF position and operates in all active conductors, shall be provided on the switchboard to which the fuel cell system is directly connected.

This switch shall be capable of breaking the full output current of the fuel cell system. Operation of this switch shall isolate the fuel cell system from that switchboard. This isolation switch shall be installed to the requirements for main switches, as specified in AS/NZS 3000.



NOTE: This switch is to provide isolation of the fuel cell system for persons working on other parts of the electrical installation.

Reference AS/NZS 4777.1 -2005 Clause 5.3.3

Common requirements for isolating devices

Provision shall be made to enable isolation of electrical equipment and to prevent electrical equipment from being inadvertently energized. The means of isolation shall be such that a deliberate action in addition to the normal method of operation is required to energize the circuit.
NOTE: Such precautions may include one or more of the following measures:
(a) Provision for the fitting of a padlock.
(b) Location within a lockable space or enclosure.

What are the signage requirements?

The purpose is to clearly indicate that the installation has multiple supplies and to indicate which circuits are affected by these supplies.

This sign shall be placed on the switchboard where the fuel cell system is connected.

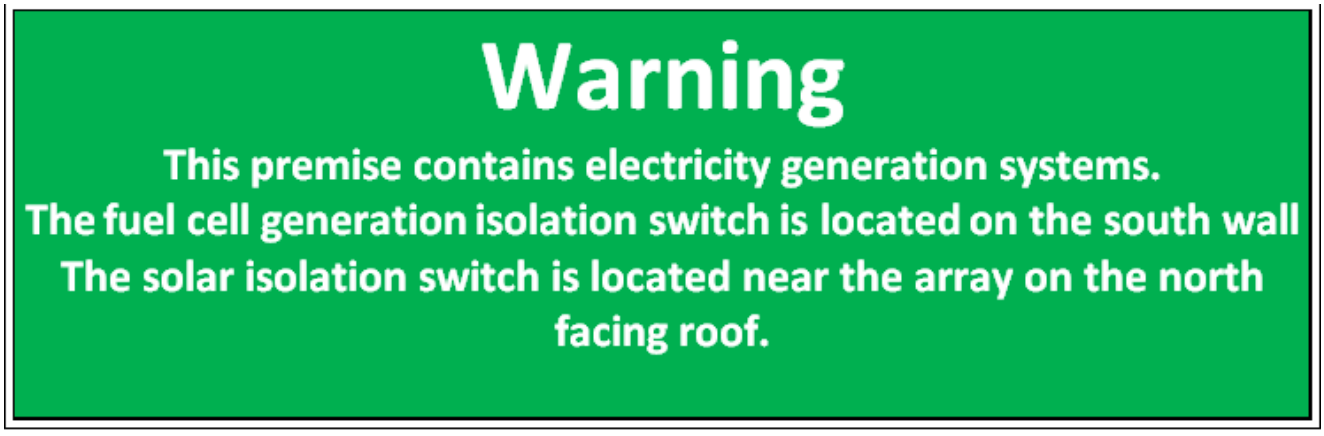
If the fuel cell system is connected to a sub-board signs shall also be placed on the main switchboard and all intermediate switchboards.

Reference AS/NZS 4777.1 -2005 Clause 5.3.1

If the system is installed within a multiple installation these labels should be placed on the switchboard of the installation containing the fuel cell system and on the distribution boards that supply that occupancy.

This sign shall be placed at the main switchboard and any fire indicator panel.

It must also indicate the LOCATION OF ISOLATION SWITCHES FOR EACH GENERATION SYSTEM.



The main switch should be identified in accordance with Clause 2.3.3.4(a) of AS/NZS3000:2007, and all main switches in the installation must be identified in accordance with Clause 2.3.3.4(b).

Reference: The Electricity Safety (Installations) Regulations 2009 Reg. 210.

Reference AS/NZS 3000:2007 Clause 2.3.3.4

Reference AS/NZS 4777.1 -2005 Clause 5.5

The Service and Installation Rules require marking on the meter panel where the meters are remote from the switchboard, and on the mains in the pit for underground supplies, or at the Point of Attachment, on or adjacent to the FOLCB for overhead supplies.

Reference – Victorian Distributors Service & Installation Rules

In addition, the manufacturer may require the shut down procedure to be marked on the fuel cell system.

Can I use the fuel cell system before it's inspected?

No, all prescribed electrical installation work must be inspected by licensed electrical inspector within 8 business days after the completion of the work.

Electricity distributors require that the fuel cell system remains disconnected until the correct metering is installed and associated tests are carried out by the distributor's representative.
Reference – Victorian Distributors Service & Installation Rules

What Information is required on the Certificate of Electrical Safety?

The Certificate of Electrical Safety should state:

- The location of the fuel cell system;
- The rating of the fuel cell system;
- The output voltage and current of the fuel cell system;

What part of the fuel cell system does an Electrical inspector need to Inspect?

Section 8 of AS/NZS 3000:2007 presents the minimum requirement of inspection and testing, it is expected the following additional items shall be inspected to satisfy the minimum safety principles of Part 1 of AS/NZS 3000:2007 and the Electricity Safety (Installations) Regulations 2009.

The inspection shall include but is not limited to the following;

- The fuel cell system wiring for location (IP rating) and fixing;
- The fuel cell system frame and supports for protective earthing;
- The isolator near the fuel cell system;
- The ac circuit wiring for polarity, current rating, mechanical protection;

The switchboard to which the fuel cell system is connected for circuit arrangement, main switch rating, and marking;

Ensure that there is no RCD installed between the fuel cell system and point of supply;

Ensure the fuel cell system neutral is identified as required.

The meter panel, pit or FOLCB for marking;

The installation of signage if the fuel cell system is connected to a sub-board;

The installation of signage if the fuel cell system is connected within a multiple installation.

We would like to thank all those who contributed to the development of this document.