

Renewable sources of electricity – a brief overview

How to ensure the safe connection of low-voltage generating sets including small scale embedded generators and solar photovoltaic (PV). This article is repeated from a previous edition of *Wiring Matters*, and clarifies important issues.

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THE SCOPE of the 17th Edition is wider and contains many new requirements, including additional requirements to ensure the safe connection of low-voltage generating sets including small-scale embedded generators and solar photovoltaic (PV) power supply systems. In this article we look at the new Regulations in Section 551 and Section 712.

Chapter 55 – Other Equipment. Regulation 551 – Low Voltage Generation Sets

This set of Regulations now includes additional requirements contained in Regulation 551.2 to ensure the safe connection of low-voltage generating sets including small-scale embedded generators.

A new Regulation, 551.4.2, ▶



A wind generator

◀ regarding the use of RCDs, has been added. Regulation 551.4.2 states:

"The generating set shall be connected so that any provision within the installation for protection by RCDs in accordance with Chapter 41 remains effective for every intended combination of sources of supply."

Notes have been added including one to Regulation

551.1 stating that the procedure for connecting generating sets up to 16 A in parallel with the public supply is given in 'The Electricity Safety, Quality and Continuity (Amendment) Regulations 2006'. For sets above 16 A the requirements of the distributor must be ascertained. The 17th Edition recognises that there are two connection options:

(i) Connection into a separate dedicated circuit

(ii) Connection into an existing final circuit

Connection into a dedicated circuit is preferred. Regulation 551.7.2 sets out the requirements for the two options. The Regulation requires that a generating set used as an additional source of supply in parallel with another source shall either be installed on the supply side of all protective devices for the final circuits of the installation

(connection into a separate dedicated circuit) or if connected on the load side of all protective devices for the final circuits must fulfil a number of additional requirements.

These additional requirements are:

(i) the current carrying capacity of the final circuit conductors shall be greater than or equal to the rated



current of the protective device plus the rated output of the generating set, and

(ii) A generating set shall not be connected to a final circuit by a plug and socket, and

(iii) A residual current device providing additional protection of the final circuit in accordance with Regulation 415.1 shall disconnect all live conductors including the neutral conductor, and

(iv) The line and neutral conductors of the final circuit and of the generating set shall not be connected to earth, and

(v) Unless the device providing automatic disconnection of the final circuit in accordance with Regulation 411.3.2 disconnects the line and neutral conductors, it shall be verified that the combination of the disconnection time of the protective device for the final circuit and the time taken for

the output voltage of the generating set to reduce to 50 V or less is not greater than the disconnection time required by Regulation 411.3.2 for a final circuit.

PV Installation

Section 712 of BS 7671:2008 is concerned with the safe installation of solar photovoltaic (PV) power supply systems. A PV system is a collection of interconnected PV cells that

turn sunlight directly into electrical energy.

The risks

Modules produce electricity when exposed to daylight. This needs to be taken into account during design, installation, use and maintenance. Also, the electrical installation which incorporates a PV system has a second source of energy which needs to be isolated before starting work. A further risk involves working at height ►



◀ on a roof, for example together with the manual handling associated with a PV installation. Finally, PV installations require expertise in dc wiring and fault protection for d.c. side of the installation.

Scope

Section 712 of BS 7671:2008 applies to the electrical installations of PV power supply systems including systems with a.c. modules. Section 712 does not apply to PV power supply systems which are intended for standalone operation.

The Electricity Safety, Quality and Continuity (Amendment) Regulations 2006

Solar photovoltaic (PV) power supply systems are required to meet the Electricity Safety, Quality and Continuity (Amendment) Regulations 2006 (ESQCR) as they are embedded generators. These are mandatory requirements.

However, where the output does not exceed 16 A per line they are small-scale embedded generators (SSEG) and are exempted from certain of the requirements provided that:

- (i) the equipment should be type tested and approved by a recognised body,
- (ii) the consumer's installation should comply with the requirements of BS 7671,
- (iii) the equipment must disconnect itself from the distributor's network in the event of a network fault, and
- (iv) the distributor must be advised of the installation before or at the time of commissioning.

See 'Engineering Recommendations G83/1, for PV systems up to 16A (5kw) and G59/1', published by the Energy Networks Association (ENA) for larger systems and generators, etc. Further information can be obtained at: www.ena-eng.org.

Protection for safety

General requirements

Regulation 712.410.3 requires that PV equipment on the dc side must be considered to be energised, even when the system is disconnected from the a.c. side. This is because modules produce electricity when exposed to daylight. Regulation 712.410.3.6 states that the protective measures of non-conducting location and earth-free local equipotential bonding are not permitted on the d.c. side.

Protective measures

Regulation 712.41 recognises three methods of protection. Regulation 712.411 gives requirements for the protective measure, automatic disconnection of supply. Where this method of protection is used on the a.c. side, the PV supply cable shall be connected to the supply side of the protective device for automatic disconnection of circuits supplying current using equipment.

Regulation 712.412 gives requirements for the protective measure, double or reinforced insulation and states that protection by Class II or equivalent insulation shall preferably be adopted on the d.c. side. Regulation 712.414 gives requirements for the protective measure, extra-low voltage provided by SELV or PELV. Where this method of

protection is used Uoc STC replaces Uo and must not exceed 120 v dc.

Protection against overcurrent and electromagnetic interference

Regulation 712.433 gives a relaxation, and allows overload protection on the d.c. side to be omitted when the current carrying capacity of the cable is equal to or greater than 1.25 times Isc STC (short-circuit current under standard test conditions) at any location.

Regulation 712.434 requires that the PV supply cable on the a.c. side shall be protected against fault current by an overcurrent protective device installed at the connection to the a.c. mains.

Regulation 712.444 deals with Protection against electromagnetic interference (EMI) in buildings. The Regulation recognises that in order to minimise voltages induced by lightning, the area of all wiring loops shall be as small as possible.

Selection and erection of equipment

Compliance with standards

Regulation 712.511 requires that PV modules shall comply with the requirements of the relevant equipment standard, e.g. BS EN 61215 for crystalline PV modules.

Operational conditions and external influences

Electrical equipment on the d.c. side must be suitable for direct voltage and direct current as required by Regulation 712.512. Equipment approved to normal a.c. standards may not be suitable, especially switchgear.

It is therefore essential that PV systems are installed by competent persons to an approved design. The designer must clarify the standards and performance requirements with the equipment manufacturers as part of the design process. It must also be remembered that as PV systems are often installed on a roof or other location external to the building they will be subject to external influences such as heavy rain, high winds, etc. and therefore need to be designed and installed to withstand such conditions. Also, it must also be remembered that planning and building regulations approval may be required.

Accessibility

Regulation 712.513 requires that the selection and erection of equipment shall facilitate safe repair and maintenance.

Wiring systems

Regulation 712.522 requires that PV string cables, PV array cables and PV d.c. main cables shall be selected and erected so as to minimise the risk of earth faults and short-circuits. Cables should be selected that are suitable for their environment and conditions of use and the expected equipment temperatures. The Regulations require that wiring systems must be able to withstand the expected external influences such as wind, ice formation, temperature and solar radiation.

Isolation, switching and control

Regulation 712.537.2.1.1 recognises the need for maintenance and requires that a means of isolating the a.c. and d.c. sides of the PV convertor needs to be provided.



WARNING - DUAL SUPPLY

ISOLATE BOTH MAINS AND ON-SITE GENERATION
BEFORE CARRYING OUT WORK

ISOLATE THE MAINS AT _____
ISOLATE THE GENERATOR AT _____

Regulation 712.537.2.2 has requirements for the selection and erection of isolation and switching devices. The Regulation states that the selection and erection of devices for isolation and switching to be installed between the PV installation and the public supply, the public supply shall be considered the source and the PV installation shall be considered the load.

Earthing arrangements and protective conductors

Regulation 712.54 requires that where protective bonding conductors are installed, they shall be parallel to and in as close

contact as possible with d.c. cables and a.c. cables and accessories.

Labelling

Labels are required at the:

- supply terminals (fused cut-out)
- meter position
- consumer unit, and at all the points of isolation to indicate the presence of the SSEG within the premises

The Health and Safety (Safety Signs and Signals) Regulations 1996 stipulate that the labels should display the prescribed triangular shape and size using black on yellow colouring. A typical label both for size and content is shown above.

Conclusion

There are a wide range of microgeneration technologies including: Solar photovoltaic (PV), wind turbines, Small scale hydro and Micro CHP (Combined heat and power). Microgeneration systems such as solar PV installations should always be carried out by a trained and experienced installer. For example, the roof must be strong enough to take their weight, especially if the panel is placed on top of existing tiles. It is also important to note that there are mandatory requirements concerning the parallel connection of generators with the supply network.

For further information refer to 'BS 7671:2008, Engineering Recommendations G83/1 and G59/1' published by the Energy Networks Association and the Department for Business, Enterprise & Regulatory Reform (BERR).

Further information

England and Wales – the Department of Communities and Local Government www.communities.gov.uk

Scotland – The Scottish Building Standards Agency www.sbsa.gov.uk

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