

Standards & Related Documents Committee

TECHNICAL BULLETIN - SEPTEMBER 2005

301. Overcurrent Protection on Generator Supplies

Page 1 of 4

On 24 June 2005 we received, from the Health and Safety Executive, a copy of an explanatory paper on this subject prepared by John M Madden, CEng, FIEE - HM Principal Inspector (Electrical / Control Engineering).

The need for the paper followed from the HSE's recent experience that there was some degree of misunderstanding by dutyholders in relation to the rating of overcurrent protection devices on generators. The full text of the paper is appended.

We note that, at present, inspection bodies are not directly involved in this matter since generators supplying amusement devices are not part of the ADIPS system.

OVERCURRENT PROTECTION ON GENERATOR SUPPLIES

During our tour of rides inspected at Newcastle Town Moor fair, the need for HSE to take action in relation to the rating of overcurrent protection devices on generators was raised and there was some concern that we may be 'nit picking' on this issue. This is a topic that has caused concern and confusion at other shows so it may help to outline the requirements in some detail.

The legal requirement for overcurrent protection is set out in the Electricity at Work Regulations 1989, where Regulation 11 requires that 'Efficient means, suitably located, shall be provided for protecting from excess of current every part of a system as may be necessary to prevent danger'. The term 'excess of current' refers to current that flows as a result of a fault, most commonly a short circuit fault, or as a result of an overload in a system caused by features such as excessive loading of circuits and motors with locked rotors. The protection against such excess current is usually a fuse or a circuit breaker.

The Memorandum of Guidance to the Electricity at Work Regulations, published as guidance note HS(R)25, provides some limited advice on how to interpret Regulation 11, but the main source for detailed advice on low voltage power generation and distribution systems such as those used at fairgrounds is British Standard 7671 *Requirements for electrical installations*. Compliance with BS 7671 is not a statutory requirement under health and safety legislation, but it is a code of practice that is widely recognised and accepted in the UK and compliance with it is likely to achieve compliance with the relevant aspects of the Electricity at Work Regulations. Our views on the requirements for excess current protection on fairground generators are therefore based on the standards set out in BS 7671.

It may help understanding to relate the issues in the context of a particular supply configuration that is representative of the type of system commonly seen on fairgrounds. The example is a 50kVA 3-phase 415 volt synchronous diesel generator with a 100 amp Type C miniature circuit breaker (MCB) to BS EN 60898; the generator supplies a distribution board on a ride through 10 metres of 5-core 70°C PVC insulated and sheathed cable with copper conductors with a cross sectional area of 10mm². It is assumed that the ride is taking a balanced load of 30 amps per phase. The essential electrical features of this system are as follows:

- The generator is rated to supply 70 amps per phase, which is large enough to cover the normal load of 30 amps per phase. Its sub-transient short circuit current can be assumed to be 700 amps, using the 'ten times' rule of thumb in the absence of any detailed knowledge on its internal impedances, particularly its sub-transient and transient reactances.
- The cable is rated to carry 57 amps. This is the continuous full thermal current rating of the cable –if it were to carry higher current for sustained periods the insulation may be seriously damaged and the cable's service life may be significantly reduced.
- The MCB is rated at 100 amps, meaning that it will pass this current without tripping. It requires 1000 amps to trip within 0.1 seconds and 5 seconds. With a current of 700 amps,

301. Overcurrent Protection on Generator Supplies

equivalent to the sub-transient short circuit current from the generator, the MCB will take approximately 10 seconds to trip; it may trip faster if there were to be a fault current contribution from motors connected and running at the time of the short circuit fault.

BS 7671 stipulates that the live conductors of the 5-core cable must be protected for automatic interruption in the event of overload current and fault current, which is the purpose of the MCB in the example system. The standard also specifies that the MCB must satisfy the following conditions:

- its nominal current (100 amps in this case) must be not less than the design current of the circuit; and
- its nominal current must not exceed the lowest of the current-carrying capacities of any of the conductors of the circuit (57 amps in this case, assuming that circuits from the distribution board are adequately protected against overcurrent); and
- the current causing effective operation of the MCB must not exceed 1.45 times the lowest of the current-carrying capacities of any of the conductors of the circuit.

The first of these conditions is satisfied in my example system because the MCB rating of 100 amps exceeds the 30 amp design current of the system by a comfortable margin. However, the second and third conditions are not met because, firstly, the MCB's 100 amp rating is considerably greater than the 57 amp thermal rating of the cable; and, secondly, the current causing effective operation of the MCB (about 150 amps) does exceed 1.45 times 57 amps (83 amps). This means that the cable is inadequately protected against overload and that, should an overload occur, the cable could suffer serious damage with a consequential risk of injury to the owner/operator of the ride and members of the public.

In addition to the problems with overload protection, the fact that a short circuit fault on the cable or on the load side of the MCB terminals may not be cleared within 5 seconds would be a matter of some concern. It would be imperative in this case for protection against indirect contact electric shock to be provided using an RCD with a rated residual operating current not exceeding 30 milliamps but this would not provide protection against the thermal effects of, for example, a phase-to-phase short circuit fault.

It would be our conclusion that the design of this example system is not compliant with BS 7671 and is not safe so far as reasonably practicable. In order to make the system compliant, a competent person would need to consider coordinating the characteristics of the generator, the connecting cables, the load, and the protective devices, but our main suggestion would be to reduce the rating of the MCB from 100 amps to 40 amps. This would ensure that the MCB rating exceeded the design current, that it did not exceed the current carrying capacity of the cable, and that it did not exceed 1.45 times 57 amps. Moreover, the current required to trip the MCB within 5 seconds would be 400 amps, which would mean that a short circuit fault would trip it within the required 5 second period.

301. Overcurrent Protection on Generator Supplies

Page 4 of 4

Our experience is that the type of configuration described is very common on fairground generators, especially where multiple rides and stalls are supplied from a single generator.

John M Madden CEng FIEE

HM Principal Inspector (Electrical/Control Engineering)