Semi-enclosed fuses

by Mark Coles

"I'm working on an older installation and there are rewirable fuses in older consumer units. Can I continue to use them?"

The IET's technical helpline is asked this question frequently. The answer is "Yes" but there are, of course, conditions for continued use. This article looks at semi-enclosed fuses and where they can be used.

THE IET publication *Guidance Note 1 - Selection and Erection*, due for imminent publication, contains further information on this subject.

Terminology
Those fuses referred to as "rewirable fuses" are correctly termed semi-enclosed fuses as they are *partially* enclosed within the fuse-carrier.

Semi-enclosed fuses are manufactured to BS 3036, the latest version is:

BS 3036:1958
Incorporating Amendment Nos. 1, 2, 3, 4 and 5 (Confirmed December 2007) Specification Semi-enclosed Electric fuses - Ratings up to 100 amperes and 240 volts to earth

The definition of a semi-enclosed fuse, given here, is extracted from BS 3036:

semi-enclosed fuse
a fuse in which the fuse element is neither in free air (other than the air in any external containing case not forming part of the fuse) nor totally enclosed

Originally issued on 23 October 1958, BS 3036:1958 has just celebrated 50 years in existence. The standard has been amended on a number of occasions, namely, December 1959, March 1963, February 1964, February 1978, January 1991 and recently confirmed in December 2007. It is unusual for a standard to survive for such a long time but this obviously reflects how simple and efficient such devices are.

Applications of semi-enclosed fuses
Semi-enclosed fuses have been used extensively on industrial, commercial and domestic installations over the years. They have given satisfactory service on systems not exceeding 240 volts to earth but installed only at points where the breaking-capacity severity is limited. Such fuses are usually installed either with switches in composite units or with distribution boards/consumer units, used on single- or multi-phase circuits, the fuses being enclosed within a single case.

Rated breaking capacity

BS 3036 defines breaking capacity as:
breaking-capacity rating
a prospective current stated by the manufacturer to be the greatest

Device type	Device designation	Rated short-circuit capacity kA
Semi-enclosed fuse to BS 3036 with category of duty	S1A S2A S3A	1 2 4
Cartridge fuse to BS 1361 type I type II		16.5 33.0
General purpose fuse to BS 88-2.2		16.5 at 240 V 80 at 415V

Table 1: Rated short-circuit capacities of fuses

Category of duty	Number of sizes	Standard sizes (Maximum current)
S1A	6	5, 15, 20, 30, 45, 60
S2A	7	5, 15, 20, 30, 45, 60, 100
S4A	4	30, 45, 60, 100

Table 2: Sizes for each category of duty

prospective current to which a fuse may be subjected under prescribed conditions of voltage and of power factor

All protective devices, e.g. circuit-breakers, fuses, etc., have a rated short-circuit or breaking capacity, see Table 1. Suitable devices are selected such that their rating is not exceeded by the prospective fault current at the point of installation, hence, semi-enclosed fuses to BS 3036 are suitable in certain applications only.

BS 3036 semi-enclosed fuses cannot be relied upon to operate within 4 hours at 1.45 times the nominal current of the fuse element.

Correct protection can be obtained by modifying the normal condition In ≤ Iz such that the fuse rating does not exceed 1.45/2 = 0.725 times the rating of the circuit conductor. For this reason, larger cables may need to be selected where overload protection is provided by semi-enclosed fuses than when it is provided by a cartridge fuse or fuses or circuit-breaker (Appendix 4 of BS 7671 and Guidance Note 6 give further guidance).

Note should be taken of the warning regarding the possible inadvertent replacement of a fuse link by one of a higher nominal current rating.

Note that the devices are available in three types relating to short-circuit capacity, i.e. 1, 2 & 4 kA. The category of duty is denoted by numerals prefixed by the letter "S" indicating that the fuse is semi-enclosed.
The category of duty to which any fuse is assigned shall be one having a distinguishing value of prospective current not greater than the breaking-capacity rating of the fuse. A fuse having a breaking-capacity rating greater than 2 000 amperes but less than 4 000 amperes, is, for example, placed in category of duty S2A.

A fuse having a breaking-capacity rating less than 1 000 amperes is outside the scope of BS 3036.

Fuses within the scope of this standard are not sensitive to normal electromagnetic disturbances and therefore no immunity tests are required. Significant electromagnetic disturbance generated by a fuse is limited to the instant of its operation. Provided that the maximum arc voltages during operation in the type test comply with the requirements of the clause in this standard specifying maximum arc voltage, the requirements for electromagnetic compatibility are deemed to be satisfied.

Availability

Beyond the three categories of duty, fuses to BS 3036 are available in a number of different sizes for each category of duty; see Table 2.

The requirements of BS 7671

Regulation 533.1.1.3 of BS 7671:2008 states that a fuse shall preferably be of the cartridge type but this does not preclude the use and installation of semi-enclosed fuses. Where a semi-enclosed fuse is selected, the carrier shall be fitted with an element in accordance with the manufacturer's instructions, if any. If manufacturers do specify a particular type/size of fuse element it is likely that the sizes of table 3 will be quoted; this is also to ensure that the incorrect size is not fitted inadvertently. Where such instructions are absent, Regulation 533.1.1.3 permits the fitting of a single element of tinned copper wire of the

Rated current of fuse elements (A)	Nominal diameter of wire (mm)
3	0.15
5	0.2
10	0.35
15	0.5
20	0.6
25	0.75
30	0.85
45	1.25
60	1.53
80	1.8
100	2.0

Table 3: Sizes of tinned copper wire for use in semi-enclosed fuse carriers

appropriate diameter specified in Table 53.1 of BS 7671, reproduced in Table 3.

Regulation 536 .1 requires that the rated breaking capacity of a protective device shall be not less than the maximum prospective short-circuit or earth fault current at the point at which the device is installed unless back-up protection is provided. A lower breaking capacity is permitted if another protective device (a back-up protective device) having the necessary breaking capacity is installed on the supply side and the characteristics of the devices are suitably co-ordinated such that the energy let-through of the upstream device does not exceed that which can be withstood without damage by the downstream device. Back-up protection on the load side of a protective device is acceptable only if the risk of a fault in the circuit between the two protective devices in series is negligible.

Practicalities

Beyond the requirements for breaking capacity there are the practicalities of installation to consider. Although the fuse-elements of semi-enclosed fuses are very cheap to replace should the fuse have blown, it may be hard to justify the continued use of such devices in, for example, a domestic installation.

Further, some older consumer units were installed with open-backs, often on wooden templates. Such consumer units may not comply with Regulation 526.5 of BS 7671 which requires that an enclosure partially formed with building material is to be non-combustible.

Conversely, semi-enclosed fuses used to protect circuits in a commercial or industrial setting may be perfectly suited for that installation and environment.

Conclusion

Semi-enclosed fuses are suitable for the protection of new installations or for continued used in existing installations provided the prospective fault current at the point of installation does not exceed the category of duty of the device and all other pertinent requirements of BS 7671:2008 are met.

Thanks

Thanks to TLC-Direct for the images used www.tlc-direct.co.uk