Amendment No 1 2002 to BS 7671 and ring circuits

Background

Consultants raised concerns that ring circuits protected by 32 amp circuit breakers and wired in 2.5 mm^2 twin with earth cable installed in conduit in a thermally insulated wall might not meet the specific requirements of BS 7671 : 2001. The old Regulation 433-02-04 required that the

> "minimum current carrying capacity I_Z of the cable be not less than 0.67 x the rated current setting I_n of the protective device".

For 32 amp devices this would require a cable rating of 21.44 amps. Table 4D2A in Appendix 4 reference method 4 (enclosed in an insulated wall etc) provides a rating of 18.5 amps.

Now, as contractors will know, this practice has been carried out for some time and if allowance is made for ambient temperature and the close protection provided by circuit breakers problems would not be anticipated. However, the issue would not go way so the National Committee responsible for BS 7671 looked into the matter. The Electrical Research Association were asked to measure the rating of the standard UK flat twin with earth insulated and sheathed cables. The cable ratings given in BS 7671 were not derived from the direct measurement of this particular type of cable. The rating tables in the International and Cenelec and British Standard (7671) are based on typical type tests, and in the case of table 4D2A, on round cables. The results of the ERA's work are published in a new table 4D5A. The rating of 2.5 mm^2 flat twin with earth enclosed in conduit in an insulated wall (now installation method 6) was found to be 20 amps. The rating when installed directly into insulated wall (now installation method 15) is 21 amps.

The Wiring Regulations Committee looked again at Regulation 433-02-04 as to how the rating of the accessories, the likely loading and the distribution of the load can be related to the rating of the conductor. The old Regulation 433-02-04 relaxed the overload requirements of Regulation 433-02-01 by requiring cables to have a rating of 0.67 x the rated current setting I_n of the protective device. Clearly it is possible that for a badly distributed load a current of exceeding 30 amps could flow in one leg of the ring without operating a 30 or a 32 amp device.

After some debate the National Committee, being keen to maintain the use of the UK ring circuit, amended the basic requirement for the rating of the current carrying capacity of the cable to be no less than 20 amps. This aligns with the total current rating of the wiring accessories. However, they added a further phrase which imposes an additional requirement on the designer of the installation and that is that under the intended conditions of use the load current in any part of the ring circuit should be unlikely to exceed for long periods the current carrying capacity of the cable.

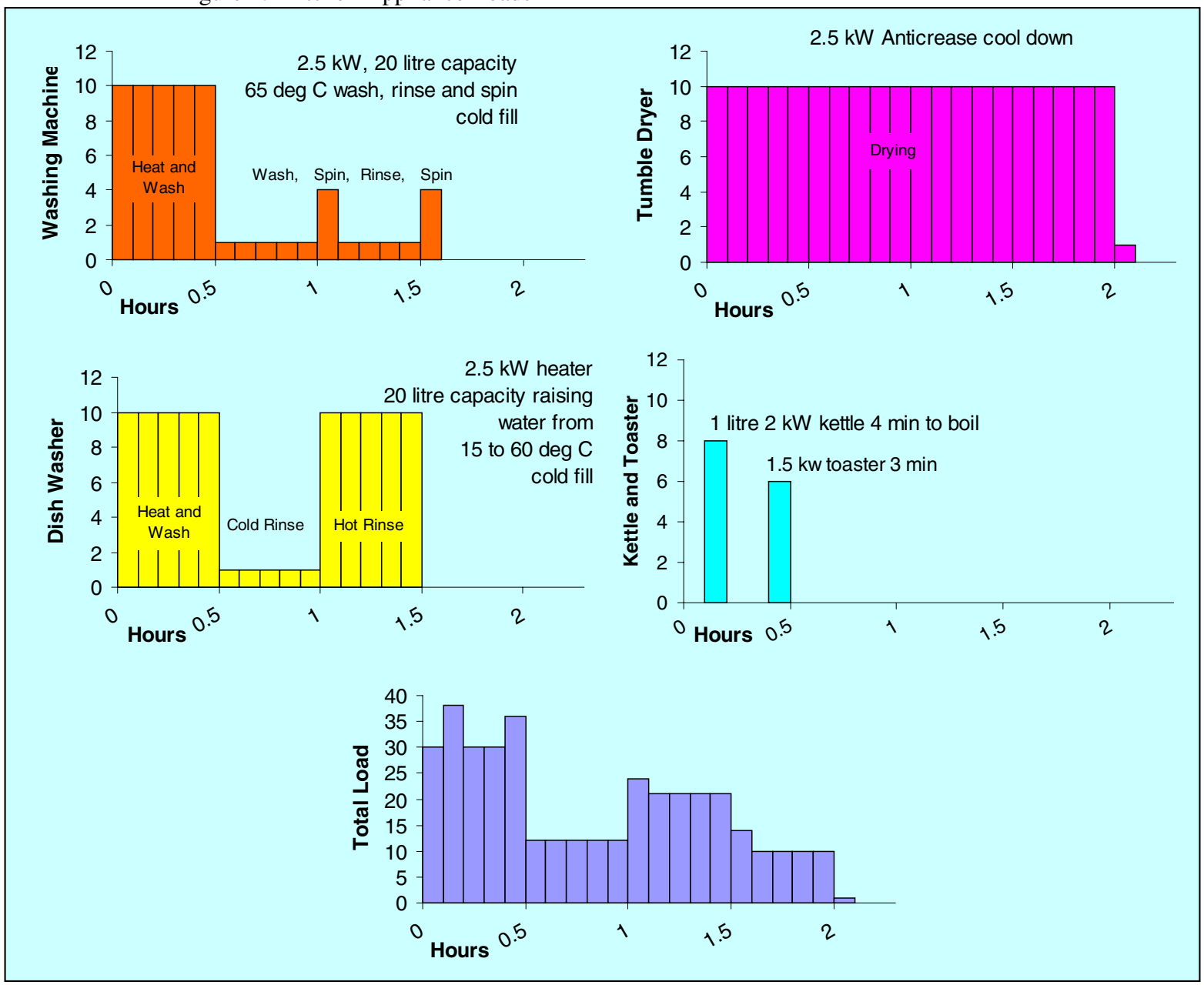
Assuming the cable under the intended conditions of use has a rating of 20 amps the designer needs to be able to demonstrate that this current will not be exceeded for long periods. " Long periods" is not defined but it needs to be considered in terms of the ageing of cable (see 6.1.3 of the Commentary) and perhaps the conventional fusing time of over-current devices (see table 6A of the Commentary). In this context a long time would be of the order of say 1 hour.

In domestic premises, it is preferable if water heaters and permanently connected heating appliances that are part of a comprehensive electric space heating installation, are not supplied from the ring circuit supplying kitchen appliances. Importantly the distribution of the kitchen load around the ring needs consideration.

Kitchen Appliance Loads

The load profiles of typical kitchen appliances are given in figure 1 and it is presumed that they are all switched on at the same time.

Figure 1: Kitchen Appliance Loads



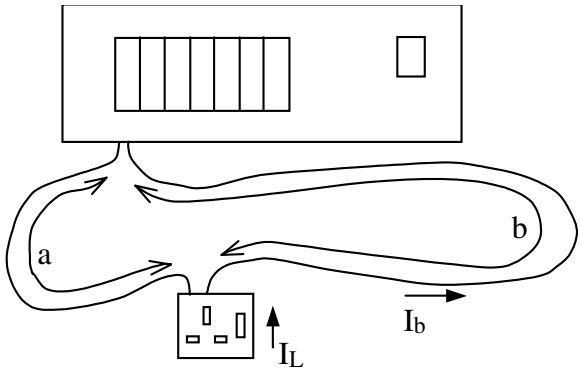
In the example (figure 1) the current in the first half hour is 31.5A and in the second half hour 10A and the third 20A. The rating of the cable would be exceeded in the first half hour if the mid point of the kitchen load was connected to the ring at a loop distance from the consumer unit of less than one third of the total ring loop length. However, even in the extreme case with all the load at the end of the ring close to the consumer unit the 30 or 32 A over-current device would not operate. This is an unsatisfactory arrangement.

The Calculation

The load in each leg of the ring can be estimated as the current will divide in the ratio:

$$I_a = I_L \, b/(a+b)$$

Where
I_L is the load of the socket,
I_a is the load in leg a
a and b are the cable lengths to the fuseboard or consumer unit



This in practice is a much easier calculation than it looks. If a load is connected 1/3 of the way round a ring, 2/3 of the current will flow in the short leg. If a load is connected 1/5 of the way round a ring 4/5 of the current will flow in the short leg.

Consider a washing machine 1/5 around the ring, a dishwasher a 1/4 around and a tumble dryer 1/3 way round. The load would divide as follows:

Appliance	leg a	leg b
Washing machine	8	2
Dishwasher	7.5	2.5
Tumble dryer	6.6	3.3
Total	21.1	7.8

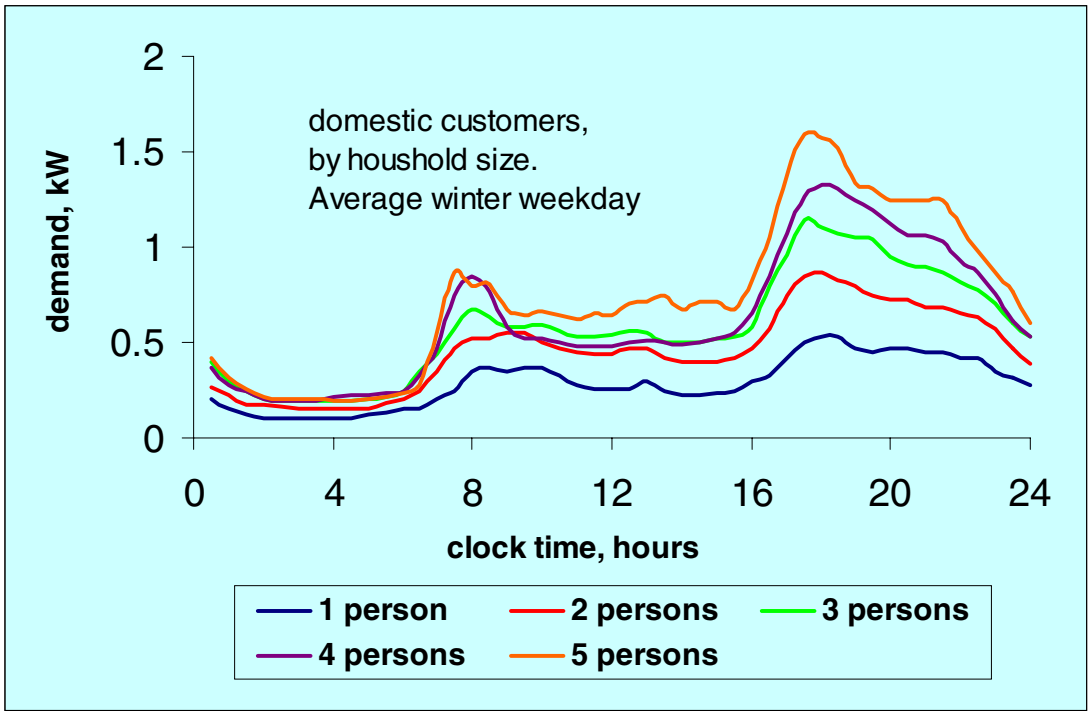
As this is a small overload persisting for say 30 minutes this would meet the requirements of regulation 433-02-04 .

A 30 A radial circuit is an alternate solution for kitchen sockets.

Total Domestic Electricity Demand

The half hourly customer demands of domestic customers by household size published by the Electricity Association are shown in Fig 2. The demands shown are average winter week day which means that from time to time they would be somewhat higher than this, they are total demands including cooking and water heating if any. They do however give an insight to the likely half hour demands of ring circuits.

Figure 2: Half Hour Domestic Demands



With respect to installations in an office, as long as known fixed loads such as water heating and space heating are wired with their own circuits, designs based on the load per desk or per square foot will not present problems. In industrial installations specific consideration of the likely loading must be made. Socket-outlet circuits are sometimes used in industrial locations to supply known loads and when this is the case calculations need to be made apportioning the load as described above.

This article is based on advice given in the new edition of the Commentary on BS 7671. The drawing of half our customer demands is provided with the kind permission of the Electricity Association.

