Special locations: Filling stations

Further to the Earthing article in the Autumn issue of Wiring Matters, we thought we would develop a more detailed article on a 'special location', in this case Filling Stations.

Gareth Bourhill IEng MIET MEI GCGI and John Dallimore BTech CEng FIET FCIBSE MEI

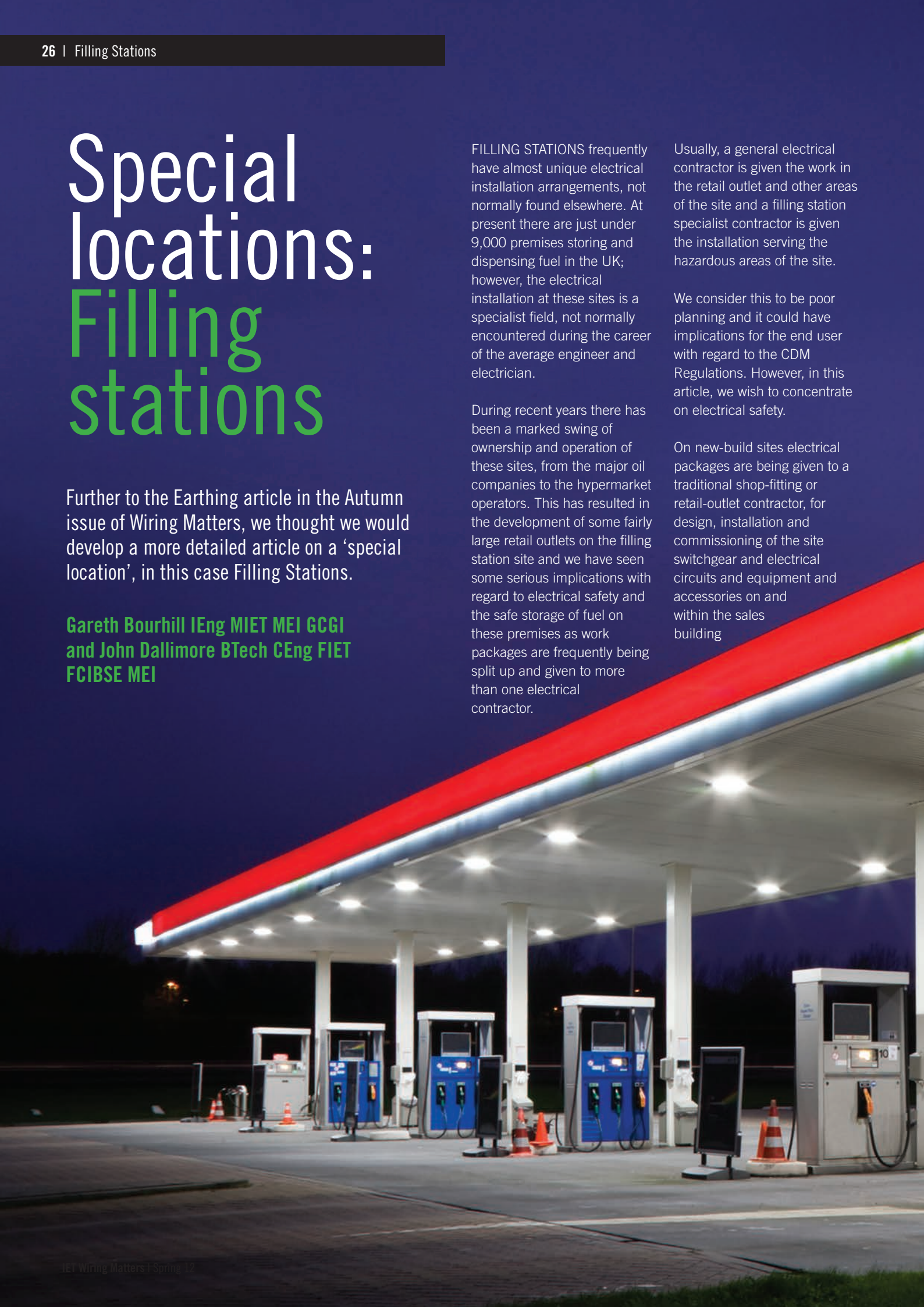
FILLING STATIONS frequently have almost unique electrical installation arrangements, not normally found elsewhere. At present there are just under 9,000 premises storing and dispensing fuel in the UK; however, the electrical installation at these sites is a specialist field, not normally encountered during the career of the average engineer and electrician.

During recent years there has been a marked swing of ownership and operation of these sites, from the major oil companies to the hypermarket operators. This has resulted in the development of some fairly large retail outlets on the filling station site and we have seen some serious implications with regard to electrical safety and the safe storage of fuel on these premises as work packages are frequently being split up and given to more than one electrical contractor.

Usually, a general electrical contractor is given the work in the retail outlet and other areas of the site and a filling station specialist contractor is given the installation serving the hazardous areas of the site.

We consider this to be poor planning and it could have implications for the end user with regard to the CDM Regulations. However, in this article, we wish to concentrate on electrical safety.

On new-build sites electrical packages are being given to a traditional shop-fitting or retail-outlet contractor, for design, installation and commissioning of the site switchgear and electrical circuits and equipment and accessories on and within the sales building



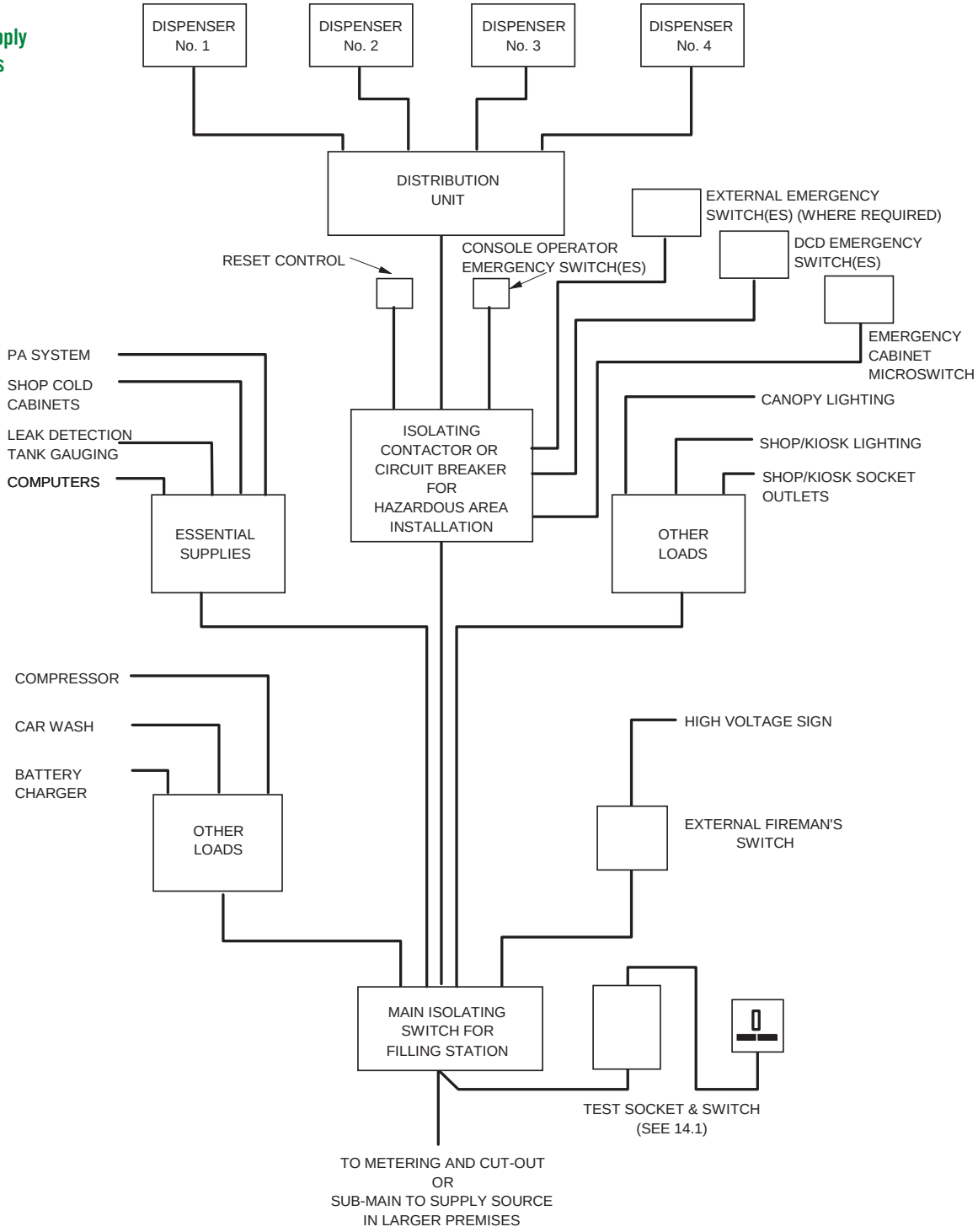
and peripheral areas of the site. A specialist electrical contractor, with experience in electrical systems and equipment for potentially explosive atmospheres is then employed to carry out the design, installation and commissioning of those circuits supplying the fuel system and associated specialist systems and equipment.

The end result of this is that the two installations are not properly coordinated; for example, the design of the site main switchgear often falls short of the specialist requirements for filling stations and in particular the supplies to hazardous area equipment. The specialist contractor will often not commission his own work and this can lead to contractual disagreements between parties, delays to the project and an increase in cost for the client.

This could all so easily be avoided if contractors, clients, duty holders and project management companies remembered that everything within the legal boundary of the site is subject to the granting of a petroleum licence by the local Petroleum Authority and is covered by numerous pieces of legislation, e.g.: Petroleum Consolidation Act 1928, DSEAR 2002, Health and Safety at Work Act 1974 and Electricity at Work Regulations 1989.

So what should the competent electrical ▶

Figure 14.1 Simplified supply arrangements



◀ contractor use as guidance and best practice?

BS7671:2008, Amendment No1 2011, will be useful in parts, but more so will be the BSEN 60079 series of standards for electrical installations in potentially explosive atmospheres.

However, unlike oil rigs, refineries and other process applications, where BSEN 60079 plays a principal role, at filling stations the 'risk' of hazards caused by the electrical installation and/or equipment is seen as greater for the simple reason that these premises have uncontrolled and unlimited access to the public and are not under the supervision of a technical team or operator; often a site may have just one retail member of staff responsible for the entire operation. Over the last few years numerous unmanned sites have been constructed, where there are no staff present during normal use.

A number of years ago when the HSE decided to withdraw its guidance document HS(G)41, it approached the Association for Petroleum and Explosive Administration (APEA) and the then Institute

of Petroleum (now the Energy Institute (EI)) to suggest that they should jointly publish a technical document to replace HS(G)41 and provide the retail petroleum industry with more comprehensive technical standards and guidance needed for modern filling stations.

This challenge was accepted by the APEA/EI and, since the late 1990s, both organisations have been involved in producing a best working practice guidance document 'Design, Construction, Modification, Maintenance and Decommissioning of Filling Stations', the first edition of which was published in 1999. The document is now not only seen as best practice here in the UK but is sold and used in many countries.

The most recent 3rd Edition of the 'Design, Construction, Modification, Maintenance and Decommissioning of Filling Stations' was published in June 2011 by the APEA/EI. Given the length of the title it is more commonly known in the filling station industry as "the Blue Book".

The document provides guidance on both new and existing sites and in particular, Chapter 14 includes comprehensive guidance on the electrical installation; from initial concept and planning with the client and end user, through design matters, installation detail, commissioning and test and inspection regimes and the maintenance regime.

The Blue Book does not extract detail from other standard electrical documents, it provides specific guidance on installations at filling stations, which generally require higher technical requirements to ensure electrical safety and the safe storage and dispensing of petrol.

One of the classic mistakes made when a general electrical contractor designs the switchgear arrangement for the site is that he bases the requirements simply on the latest BS7671 requirements, without knowledge or thought for requirements for potentially explosive atmospheres. The Blue Book indicates that a TT earthing system or a guaranteed TN-S system from a dedicated on site transformer is preferred for the filling station supply. It also warns that a TN-S earthing system from the public supply should not be used, since there is no guarantee that there is a dedicated Earth conductor from the site back to the supply transformer. Clause 14.3.5 of the Blue Book refers.

The use of TN-C-S (more commonly know as PME) systems have been prohibited on UK filling stations since the introduction of the now obsolete HS(G)41 back in 1989. The reason is the risk of a spark occurring in hazardous areas as a result of Diverted Neutral Currents (neutral current flowing back to the supply transformer via the site earthing system and any metalwork bonded to the earthing system). Unfortunately, today we still see contractors using TN-C-S systems or worse, installing a TN-C-S system for the shop building and installing a TT system for the hazardous area circuits.

The Blue Book includes two useful diagrams (see below): a suggested arrangement for the switchgear for the site (Fig 14.3) and details of the preferred supply arrangement, showing the test socket and the TT earthing system (Fig 14.1) Such an arrangement will not normally be seen by non-filling station contractors.

The publication also gives detailed advice on cable types and termination arrangements (Clause 14.9). Inspection and Testing is covered in Clause 14.10 and there are a number of requirements not generally found in other installations; for example, Clause 14.10.2.1 states that the minimum insulation resistance for cables passing through or to the hazardous areas should not be less than 10 MΩ. The same clause states that where a TT earthing system is installed the aggregate earth electrode resistance must not exceed 20 Ω and the product of this resistance, multiplied by the rated residual tripping current in Amperes of the upstream RCD must not exceed 25.

The requirements for shock protection call for circuits on the filling station forecourt to ▶

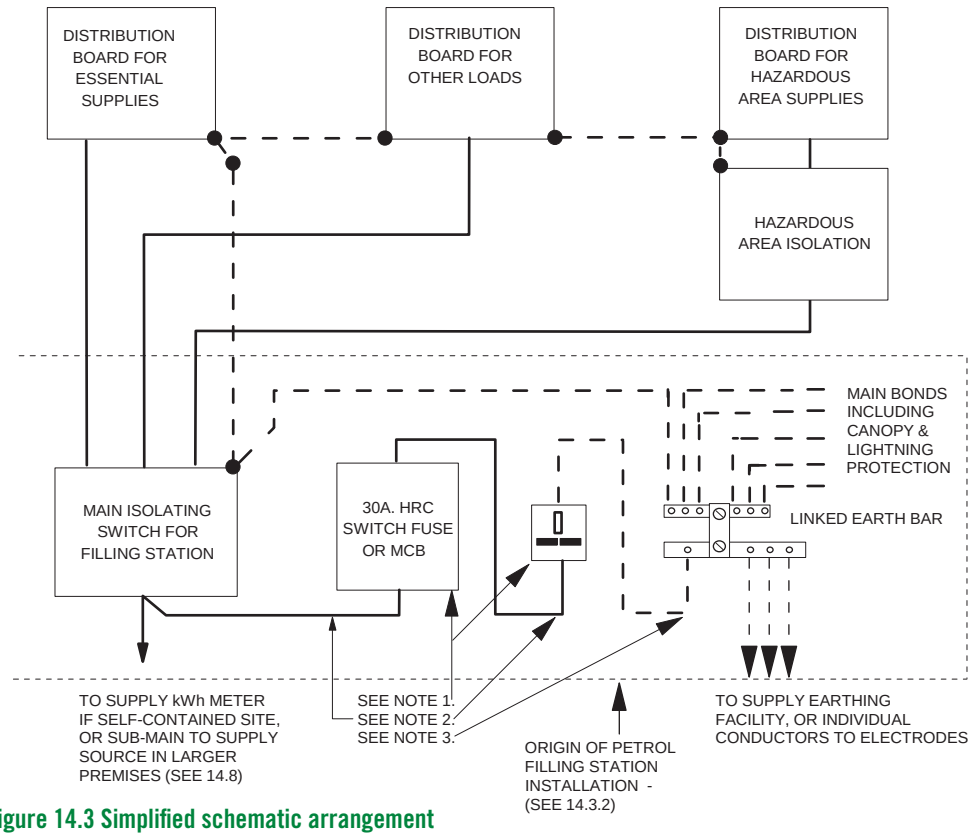


Figure 14.3 Simplified schematic arrangement

◀ have a maximum disconnection time of 100 mS, therefore, with a TT earthing system the correct supply and design of the RCD time/current cascading is very important. Typical examples would be a main protective device having a tripping current of 1 A and a time delay of 1 second, the sub-main devices perhaps being 300 mA tripping current and a time delay of 100 or 300 mS and final circuit devices 30 mA tripping current and instantaneous operation.

Another issue frequently overlooked is the requirement for RCD to break all live conductors; if this is not done the upstream devices may not be isolated from the fault and nuisance tripping may occur. This requirement is reinforced by the need to be able to isolate all live conductors on any circuits feeding into hazardous areas. With anything up to two hundred final circuits, it is easy to understand how things can go wrong at the planning stage if a inexperienced contractor prices and installs switchgear without these items.

The electrical contractor also needs to know about the different dispenser and hydraulic systems on site and requirements for these, including the tank details, types of pipework and drainage systems, including the oil/water separator.

In recent years, with the availability of plastic type materials, filling stations now have conductive pipework, non-conductive pipework and semi-conductive pipework, all of which require their own special earthing and bonding arrangements to minimise a build-up of electrostatic charge, especially during the delivery of fuel, which could create a spark in a hazardous area. Again, a general electrical contractor may not know of the precautions to be taken in this respect.

Filling stations are 'special locations' and require trained and 'competent' persons to design, install and maintain the electrical installation and equipment. It is often thought that the filling station shop is exactly that; however, it is not that simple; this 'shop' houses all the switchgear and the main earthing terminal for the licensed premises arrangements and apart from the statutory legislation of the Petroleum Licence, the appropriate parts of DSEAR 2002 and EAWR1989 state that equipment and systems located in a non-hazardous area must not have a detrimental effect on equipment in a area where a potentially explosive atmosphere exists. Contractors and persons wishing to do work on filling stations should be aware of and practise the guidance given in the Blue Book, which is readily available from the APEA (www.apea.org.uk) or the EI (www.energyinst.org), in hardback or electronic form.

Gareth Bourhill is Co-Chair of the full APEA/EI Technical Review committee for the Blue Book and works as a freelance electrical safety consultant, trainer assessor. ■

John Dallimore is Chair of WG6 Electrical Sub Committee for the Blue Book and proprietor of his own specialist consultancy practice John Dallimore and Partners.