

## Autumn 2015



## Fire performance of cable supports

Recently, BRE undertook research concerning the fire integrity of cable supports and fixings. The aim of the experimental programme was to assess the ability of a selection of commercially available cable supports for electrical installations to maintain their integrity and hold electrical cables in place when exposed to temperatures typically encountered in compartment fires. A second scoping study was carried out to assess the performance of a range of commercially available fixings for cable supports in concrete substrates when exposed to elevated temperatures.

With the permission of BRE Global Limited (BRE), Wiring Matters provides you with that report here.

Gary Gundry, electrical safety specialist, technical consultant, and prospective owner of [Redford Charles Training Centre](#) takes us through the report and provides a summary of what the findings mean.

*The research on which this article is based was commissioned by the Department for Communities and Local Government (DCLG) and carried out by BRE. Any views expressed are not necessarily those of DCLG, with whose permission the article is published.*

In recent years, some firefighters have tragically lost their lives as a result of becoming trapped in 'collapsed' cables within burning buildings — but a new regulation, introduced by Amendment No. 3 into BS 7671:2008, seeks to address that. The regulation came in to effect on 1 July 2015.



The regulation — which now requires all new cables installed in escape routes to be supported in such a way that prevents them from collapse in the event of a fire — follows the deaths of two firefighters at Harrow Court, Hertfordshire, in 2005; four firefighters at a highly insulated warehouse at Atherstone-on-Stour, Warwickshire, in 2007; and another two firefighters at Shirley Towers, Hampshire, in 2010.

In each incident, being trapped in fallen cables was reported as a contributing factor in the deaths in at least two of these incidents where the firefighters became entangled in cables that had fallen across doorways, in and along corridors of escape routes. This was most likely due to the failure of the supports used to secure the cables, such as non-metallic cable trunking, conduit, and/or plastic clips, when exposed to heat or direct flame.

Consequently, post-incident investigations left coroners with no choice but to make recommendations to a number of individuals, authorities, and UK government for safety improvements, stating that “*action had be taken to prevent the recurrence of fatalities*”. One such recommendation was for BS 7671 to be amended so that ‘**all** *[emphasis editor's own] cables, not just fire alarm cables, are supported by fire resistant cable supports*’. Hence, Regulation 521.11.201 was introduced:

*‘Wiring systems in escape routes shall be supported such that they will not be liable to premature collapse in the event of fire. The requirements of Regulation 422.2.1 shall also apply, irrespective of the classification of the conditions for evacuation in an emergency.*

*NOTE 1: Non-metallic cable trunking or other non-metallic means of support can fail when subject to either direct flame or hot products of combustion. This may lead to wiring systems hanging across access or egress routes such that they hinder evacuation and firefighting activities.*

*NOTE 2: This precludes the use of non-metallic cable clips, cable ties or cable trunking as the sole means of support. For example, where non-metallic trunking is used, a suitable fire-resistant means of support/retention must be provided to prevent cables falling out in the event of fire.’*

## What does all of that mean in practical terms?

In 2012, the Department of Communities and Local Government (DCLG) commissioned the Building Research Establishment (BRE) to do some experimental work in this area as part of the Investigation of Real Fires project, and to report on that work to the fire community and other stakeholders, as appropriate.

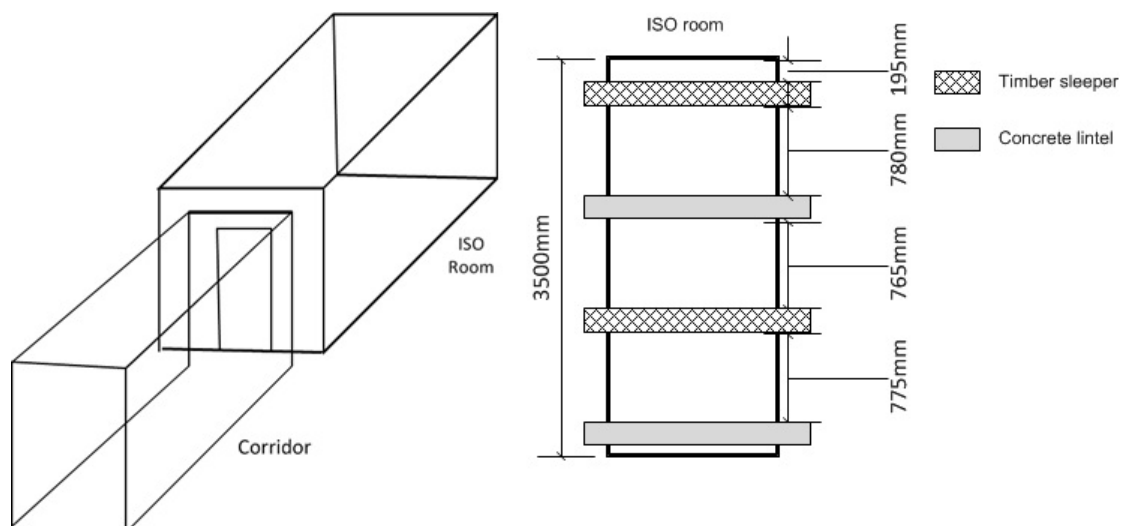
That work has since been completed and the report is now available. BRE advises that the work was never supposed to be a comprehensive testing programme of individual components or products, but more a ‘proof of concept’. So, the findings from the research could be used to demonstrate a possible simple solution to the issues that have raised concerns.

As the 12-page report is too comprehensive to reproduce in this article, the detail and findings have been summarised below.

## Cable support experiments

Stage one of the research was to design and construct a fire test room (ISO room), sized 3.6 m x 2.4 m x 2.4 m, with an attached timber-framed and plasterboard (single layer 12.5 mm Type F) lined corridor of dimensions 3.5 m x 1.5 m x 2.4 m (see Figure 1). The walls, floor and ceiling of the ISO room were lined with two layers of 12.5 mm Type F plasterboard to contain the crib fire and, with the structure being on wheels, it was slightly raised from the ground; hence the corridor was not in line with the top of the ISO room (see Figures 1 and 2).

Figure 1 ISO room and attached corridor, showing timber sleepers and concrete lintels above corridor construction



The test rig was then completed by positioning two timber sleepers and two concrete lintels above the corridor, spaced approximately 750 mm apart, and alternate to each other, to which the cables and supports were then secured. For ease of reporting, BRE numbered the lintels from 1 to 4, where lintel 1 was closest to the ISO room, and therefore closest to the fires.

Figure 2 Real world set-up

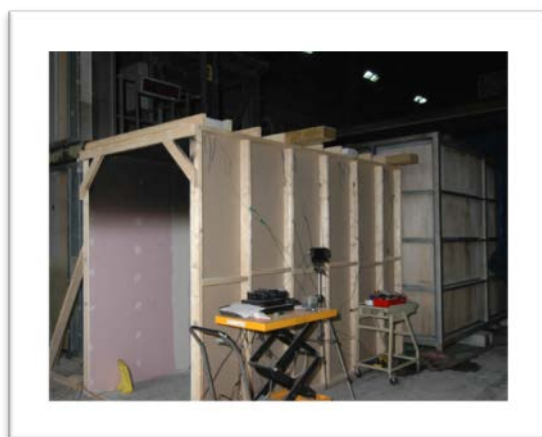
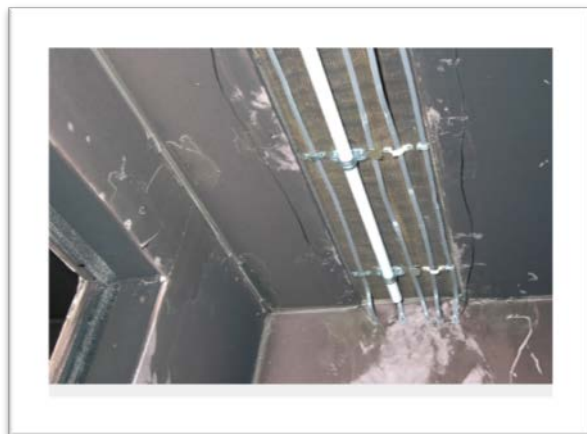


Figure 3 Close up of cable set fixed to timber sleeper with different supports



## Cables and cable supports

In each experiment, five standard 1.5 mm<sup>2</sup> flat twin and earth PVC sheathed cables were fixed to the lintels by means of commercially available ‘fit for purpose’ cable supports (see Figure 3), the detail of each is shown in Table 1 of this article. However, for ease of reference, four were of metal construction, with one type used to secure a cable oversleeved with a length 20 mm heavy gauge PVC conduit, and the fifth was moulded plastic cable clips. To help simplify things going forward, wherever the term ‘support(s)’ is used, it refers to metal cable supports; ‘clip(s)’ refers to plastic cable clips; and ‘fixed’ or ‘fixing(s)’ refers to the means of securing the cable supports and clips to the structure.

All of the supports, except for clip 5 (as it was fixed using its own pin) were fixed to the lintels by means of zinc plated hardened steel 7 x 1¼ inch screws, but in the case of the concrete lintels, standard plastic wall plugs were also used.

**Table 1 Cable supports used in the experiments**

Number	Detail
Support 1	Zinc plated saddle support. These supports are used in the automotive industry for fixing cables.
Support 2	Galvanised steel spacer bar saddle for use with conduit.
Support 3	Passivated stainless steel cable support with fold over fastening tabs for use with 2 core 1.5 mm <sup>2</sup> fire alarm cables. The support meets the requirements of BS 5839-1.
Support 4	Double cable saddle support for 2 core 1.5 mm <sup>2</sup> fire alarm cable. This support was made of copper and coated with a polymeric coating. The support is understood to comply with BS 476 Part

	6, BS 476 Part 7, UL 94 and meets the cable support requirements of BS 5839 1:2013.
Clip 5	Moulded plastic flat 1.5 mm <sup>2</sup> clip with pre-fitted zinc-plated carbon steel pin.

## Bench-scale experiments on fixings

A series of bench-scale experiments were also carried out using a range of commercially available fixings for cable supports for use in concrete substrates. Including screws with plastic plugs and self-tapping screws, the fixings were installed into standard aerated 3.6N concrete blocks of dimensions 440 mm by 215 mm by 100 mm deep. Each block was exposed to one set temperature - from the range 100 °C, 200 °C, 300 °C and 400 °C - for one hour.

## Cable Supports – Fire 1 results

The first fire burned for approximately 34 minutes and throughout that period temperatures were monitored at various points across the rig (using instrumentation and thermocouples that are not discussed in this article). The maximum recorded temperatures at ceiling height in the ISO room and the corridor were 397 °C and 302 °C, respectively.

To visualise those measured temperatures, especially at each lintel, and see how each support performed, refer to Table 2 as it clearly shows which supports remained intact and those that did not.

After the fire, the rig was allowed to cool down before the condition of the cable supports were examined and documented.

**Table 2 Summary of condition of cable supports after the first experiment with the average maximum temperatures recorded at each lintel**

Lintel	Type	Average maximum temperature at lintel (°C)	Average temperature when cable observed to drop (°C)	Support 1	Support 2	Support 3	Support 4	Clip 5
1	Timber	264	258	All intact	All intact	All intact	All intact	Four failed
2	Concrete	294	286	All intact	All intact	All intact	All intact	All failed
3	Timber	255	243	All intact	All intact	All intact	All intact	All failed
4	Concrete	204	No drop	All intact	All intact	All intact	All intact	Four failed

NOTE: The average maximum temperature was determined by averaging the values recorded by each pair of thermocouples located at the lintels.

### Cable supports – Fire 2 results

The second fire was more intense than the first, and lasted approximately 20 minutes. The maximum temperature recorded in the ISO room, 0.5 m from the ceiling, was 820 °C, and in the corridor, approximately 1.8 m from the ISO room, the maximum temperature recorded at the ceiling was 690 °C.

To visualise those measured temperatures, especially at each lintel, and to see how each support performed in the second fire, refer to Table 3, where, just like in the first fire, all of the plastic clips failed again but something else was observed too. All types of supports fixed at lintel 2 also failed, but, on closer inspection, it was not the supports that had failed, but rather the plastic wall plug(s) used to fix the supports that had melted, so they ‘fell’ from the ceiling.

Once the fire had cooled, all of the metal supports from lintel 2 were recovered and were found to be intact.

**Table 3 Summary of condition of cable supports after the second experiment**

Lintel	Type	Average maximum temperature at lintel (°C)	Average temperature when cable observed to drop (°C)	Support 1	Support 2	Support 3	Support 4	Clip 5
1	Timber	578	481	All intact	All intact	All intact	All intact	All failed
2	Concrete	557	212 (Clip 5) and 221 (Clip 2)	Three failed*	Three failed*	Three failed*	Three failed*	All failed
3	Timber	570	486	All intact	All intact	All intact	All intact	All failed
4	Concrete	388	310	All intact	All intact	All intact	All intact	All failed

NOTE: The average maximum temperature was determined by averaging the values recorded by each pair of thermocouples located at the lintels.

\* Each fixing failed rather than the support because the plastic wall plugs melted.

### Bench scale experimental results

The findings from the bench-scale fixings study showed that combustible wall plugs in concrete substrates demonstrated signs of weakening of mechanical strength from 300 °C and above. Additionally, these fixings can fail at 400 °C after up to a one hour exposure in controlled conditions.



Non-combustible wall anchors and concrete screws were capable of retaining mechanical strength after exposure to 400 °C for one hour in the same controlled conditions. This allowed the conclusion that there are commercially available products which can maintain their mechanical strength at that temperature.

## Conclusions

In this article we have tried to summarise the findings of BRE's experiments, to demonstrate the effects of fire on a selection of cable supports and fixings. However, it seems only right to report that the actual performance of any support and its fixing in a fire will always be dependent on a number of factors, including the combination of the cable supports or clips, their fixings, the weight of the cable, the distance from the fire and the duration of exposure.

BRE's experimental work does, however, indicate that selecting and erecting supports that are capable of maintaining their mechanical strength when exposed to temperatures of, at least, 600 °C should prevent cables from falling, when exposed to typical compartment fires.

Looking now at the new requirement introduced into BS 7671, which calls for all cables within escape routes to be supported such that they will not be liable to premature collapse, whether they are fixed to a wall, or to the underside of a ceiling regardless of being clipped direct to the structure, or enclosed within or on a wiring system, does literally mean all cables. So, anyone who installs cables for door entry systems, digital TV and data-cables, for example, must comply with this new requirement. Installers of such cables may however contain them within a non-metallic conduit or cable management system provided either is fixed to the building structure with non-combustible supports that would maintain mechanical strength when exposed to temperatures greater than, say, 600 °C, to prevent any of the cables from falling out and/or dropping.

Following BRE's results that demonstrated failure of fixings can result in failure of the support, it would follow that consideration should also be given to the fixings used for the supports. With their research showing that there are simple non-combustible commercially available fixings that can maintain their mechanical strength up to 400 °C.

Finally, if there is only one thing that you should take away this, it is this: the new requirement in Regulation 521.11.201 precludes the use of non-metallic cable clips, cable ties, and conduit or cable trunking as the sole means of support for cables in escape routes.

A full copy of the report can be downloaded [here](#).



## Importance of electrical safety management

During 2013/14, 674 cases of safety non-compliance were prosecuted by the Health and Safety Executive, an Environmental Health Officer or Procurator Fiscal, with a 94 % success rate. As of March 2015, 186 individuals had received immediate or suspended prison sentences for Health and Safety at Work offences since 1975. Of those, 137 occurred since May 2008.

Bill Bates is an electrical engineer with over 40 years of experience including many years as an HSE inspector – so who better to give us some pointers on electrical safety management? Amy Walker interviews Bill for an overview of what you should look out for when it comes to managing the electrical safety of your workplace.

### **Tell me about your experience and background, and what interests you about electrical safety management?**

After 40 years associated with the electrotechnical industry, and 21 years involved with inspection and investigation of incidents, I have profound feelings of frustration at foreseeable issues leading to incidents, and sympathy for those suffering as a result of incidents. All incidents can be upsetting, some with life-changing injuries. Every injury causes suffering. It is so often the case that simple steps would have prevented the incidents. Giving evidence at inquests, you see the emotional suffering of family, friends and fellow workers.

### **Has any incident been particularly costly?**

All incidents have costs, whether it is the [Buncefield explosion](#) or a flashover at a low voltage panel. To an individual these costs can be greater than a larger penalty to a big organisation. The financial costs can be paid off quickly, but the most telling costs are more often the longer term reputational and emotional costs to all those involved. Some people never recover.

### **Can incidents lead to prosecution?**

Many incidents result in some form of penalty. These can be prosecutions with fines, costs and terms of imprisonment. I have been involved in cases where a company had fines and costs of over £500,000 or where an individual was sentenced to a year in prison.

There are also other forms of enforcement of the law. These range from written advice and guidance, through Improvement or Prosecution Notices, to prosecution. All of these have significant financial costs for non-compliance with the Regulations.

### **Can you tell us about some common elements you see, that lead to injury?**

The most common incidents involving low voltage installations that I saw resulted from:

- (a) Poor design – this may be the wrong cable or equipment in a wet, dusty, hot or otherwise adverse environment, or an overloaded circuit etc.

- (b) Poor installation – there were many complex installations that had problems, such as damaged cables or equipment, but something as simple as wiring up a plug wrongly can be fatal.
- (c) Poor operational procedures – the most frustrating incidents often resulted from work where the circuit had not been switched off and securely isolated. This could be because of incorrect identification due to poor labelling, or perhaps because someone thought they did not have to isolate. One third of the incidents I investigated involved flashovers on low voltage equipment or switchgear, where electrically experienced workers used inappropriate procedures or tools adjacent to exposed live conductors or terminals. Workers are also exposed to other risks such as asbestos, working at height, or flammable or corrosive materials.
- (d) Poor maintenance – basic poor work like taped joints, broken plugs, socket-outlets and switchgear, loose connections, poor earthing, incorrect fusing, damaged or unsupported cables, poor asset records or lack of testing are all signs of poor maintenance that can have serious consequences.

## **What are the consequences involved with such incidents?**

There are significant consequences for business if there is a serious mistake or incident. For example, disruption to work with productivity loss and unpredictable affect to business continuity. In addition, costs arise for the business from the injured person, the additional work and consequential costs for the company, for the community and prevention of further incidents. Ignoring these consequences and hoping they will not happen can be an expensive mistake.

## **Who is ultimately responsible?**

The owner of the installation is ultimately responsible. However, managers and technical personnel are responsible for managing the risks, and the control of the electrical installation and the activities affected by it. The health and safety of an organisation's workers, contractors and others potentially at risk has to be managed. There have to be policies, procedures and competent people in place for that system. It is necessary to ensure that persons working at that installation are capable and have their limitations recognised and formally managed.

Often clients and managers lack the competence and confidence to improve their safety management. Safety management has to be made accessible to technical and non-technical people so that risks to people and their business are safely reduced.

There are serious effects of an incident on the company, injured person, other workers, families and members of public, and so on. Directors and managers can be jailed, while large fines and costs can adversely affect the organisation. That's before we start on the other consequential costs and psychological damage.

## **What would you tell business managers when it comes to avoiding workplace incidents?**

Risk awareness is important in preventing incidents. Often workers can be asked to go beyond their limitations of competence if those involved do not understand the risk. There are workers who appear to be unaware of the danger from electricity, experienced workers who

believe that a 230 V shock cannot kill you, that you cannot get a shock if there is an RCD, that you cannot get an explosion from a low voltage circuit, or that having no circuit or equipment records does not matter. Managers need to ensure that all workers, whether 'electrical' or not, who may be exposed to electrical risk are trained and suitably aware of the dangers.

Workers should have suitable and sufficient procedures and instructions to allow them to complete their tasks safely and not endanger those affected by their work. Rules to control risk are important.

Responsibilities and worker limitations should be clear. There should be adequate information, instruction and supervision. Failure to do this will lead to danger.

### **What more can business owners and managers do to avoid risks?**

Business owners and managers should be aware of the risks, responsibilities of their installations and consequences of failure to comply with standards and regulations. They must ensure that there are sufficient resources so that their installations are safely operated and maintained in a safe condition. They should follow good standards of safety, ensuring that bad habits and complacency do not undermine continuing improvements.

### **Do you have any advice for installers?**

Installers have a professional responsibility to ensure that design, operation and maintenance are carried out to a safe standard. They are often the only electrically competent persons involved on site and work should be undertaken in a safe way for the protection of themselves and others affected. No assumptions can be made that someone else will solve any deficiencies. For example, perhaps children, elderly or vulnerable people may be involved who may not react in an expected way.

If something is not right, make this clear to those responsible. The control of the installation can be complex, particularly for modification, refurbishing and handover. From the outset it is essential that the control of the installation is absolutely clear. Only one party can be in control of any part of the installation at any particular time. If necessary, special procedures to cover the work should be developed with all those responsible for, or involved in, the work. Live working has to be justified to comply with the regulations and should be very much the exception. Records are important.

### **Electrical incidents**

Here are some examples of incidents that could have been prevented if the company had had effective electrical safety management.



## Flashover

LV switchboard flashover causing serious burns.

Procedural, training and design issues.

## Busbar explosion



LV flashover causing serious burns.

Procedural, training and management issues.



## Damaged MCB

Leaky roof allowing water to damage installation causing electric shock

Maintenance and operational issues

## Accidents at work showing a downward trend – SELECT survey

SELECT have carried out a survey on accidents in the workplace, which shows a decrease in the number of incidents recorded in Scotland. Although this is good to see we must be aware that there are still a significant number of incidents occurring, therefore the risks must be effectively managed. There are also many mitigating factors involved that may have impacted the survey figures. As Jim Cornwall, Technical and Safety Adviser at SELECT, points out: "It is difficult to read concrete conclusions into the latest survey figures, since there have been so many reporting changes in the past few years.

"However, it is encouraging to see the number of companies who are again willingly responding to surveys such as this and the response is a credit to our survey team which compiles the statistics.

"It is reasonable to conclude from the figures, though, that members are aware of the importance of health and safety at work and are cascading the message down to their workforces."

By increasing the awareness of workplace incidents, and understanding the penalties that may come as a result of workplace incidents, we hope that the rate of incidents can continue to decline.

## How can you learn more about electrical safety management?

### IET Code of Practice for Electrical Safety Management

In 2013, the Institution of Engineering and Technology (IET) published the Code of Practice for Electrical Safety Management, as a tool to help organisations of all sizes to provide guidance on the process for managing electrical safety, and aiding responsible personnel to reach a certain level of knowledge and understanding to manage the risks associated with an electrical system.

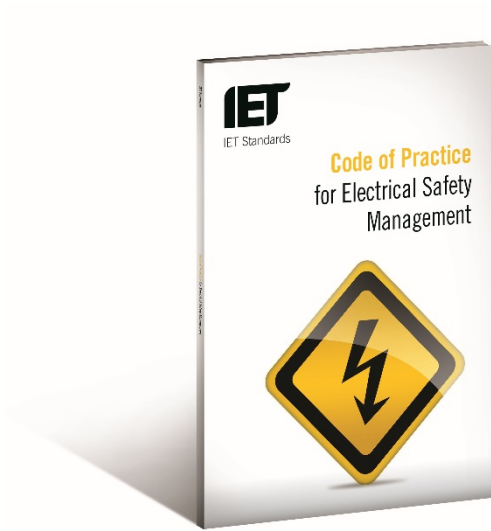
The CoP provides a comprehensive overview of the fundamentals of electrical safety in the workplace. It has a structured approach to managing electrical safety and the result of applying the guidance is confidence that risks associated with an electrical system are adequately covered.

The structured approach was seen as an important aspect of the project to avoid issues associated with a 'firefighting' or 'gap filling' approach often witnessed when dealing with a broad range of individuals within organisations. Another important aspect of this structured approach is to offer a way of involving people, gathering evidence and determining where improvements are needed.

The IET's 'Code of Practice for Electrical Safety Management' can be purchased for £130.00 (or £84.50 for IET Members) via the IET's website, at:  
<http://www.theiet.org/resources/standards/index.cfm>







The IET has now set up a group on [MyCommunity](#) for anyone interested in this topic and who would like to learn more. This was a very popular idea at the ESM events held earlier in the year and is a great way to engage and discuss with others.

### **Electrical Safety Management – A practical course for managing risks associated with an electrical system**

As this article conveys, many trained and untrained workers encounter electrical hazards in their workplace, some with disastrous results. If you have been asked to take responsibility for electrical safety matters make sure you are confident of tackling this thoroughly by attending this short but in-depth course.

**Date:** 4-5 November 2015

**Venue:** IET Birmingham, Austin Court

Find out more about the event at [www.theiet.org/electrical-safety](http://www.theiet.org/electrical-safety).

## Home automation

Where we once fantasised about appliances and home fittings making our lives easier, home automation is quickly becoming a reality. Worth around £65 million in 2011, it is estimated that the UK home automation market by 2016 will be worth a staggering £156 million. This growth is being driven by the rapid advance in technology, which is bringing intelligent automation systems to a growing number of homes and work places, allowing control of everything from lighting, heating, communications and entertainment. Marie Parry, group marketing manager at the [Scolmore Group](#), writes for Wiring Matters about this trend for smarter homes and some of the options available for wholesalers.

Home automation technology has been available for many years but demand for systems in the UK have, until recently, been largely limited to luxury homes and specialist projects. However, with declining costs and complexity, plus greater awareness of system benefits, industry experts predict that home automation is set to become one of the fastest growing markets in the UK.

Forecasts indicate that the pace of growth will increase over the next five years as the UK home automation market becomes more established. This can be partly attributed to growing concerns about energy efficiency and the environment and technological developments that will make home automation system products cheaper and easier to use.

Less than 0.1 % of UK homes currently have a home automation system installed (this compares to around 5 % of residential homes in the USA). Although small, the penetration of home automation in the UK is growing exponentially for both new and existing housing stock. In terms of importance, access and security control continues to be the most popular application area for home automation, followed by multi-room audio, home theatre, climate control and lighting control.

The further development of super-fast broadband services is likely to support demand for home automation, with new and improved products taking greater advantage of digital technology. These will deliver a better and more efficient service to the home owner.

Continued growth in this market sector will depend on the extent that home automation technology becomes affordable and accessible to the mainstream market. Declining prices and the increasing availability are likely to accelerate market demand for these systems.

By 2016, it is estimated that the UK home automation market will be worth some £156 million at DSP (Distributor Selling Price). In terms of volume, this equates to around 37,000 systems installed.

No longer the preserve of the rich and famous, the smart home is becoming accessible to us all and a raft of new products, specifically designed to enhance our lifestyles and save energy, is now available. Wholesalers and contractors are in a prime position to take a share of this growth by understanding the products and systems available.

Whether the project involves updating an existing wiring system, or is the start of a brand new domestic or commercial building project, there is a home automation system that will deliver the right solution while meeting the required budget. From radio frequency (RF) wireless control of lighting and heating through to the all-singing, all-dancing, interactive multimedia systems, smart technology is here to stay.



## Intelligent energy saving

By intelligently controlling the lighting and heating throughout a home it is possible to make significant cost and energy savings and this is also the case with wired and wireless automation. For instance, central heating systems, instead of heating the whole house, can be split into different zones so that rooms or areas are warmed as and when they are required. In the same way, lighting systems can be controlled so that the right light output is delivered when and where it is needed.

## Wireless control

To enjoy the benefits of home automation in an existing dwelling but with minimum cost and disruption, a wireless system is the answer. Complete control of the heating, lighting, shutters, blinds, gates, garage doors and appliances is achievable without the need for additional cabling or cutting into walls. Receivers are simply fitted behind the light fittings or into suitable installation boxes and the transmitters are powered by battery so require no additional power supply.

Once a decision has been made on which features are to be controlled, the system can be installed and up and running in a very short space of time. Heating, switching, dimming, control of shutters, window and door openings can all be quickly and easily set and adjusted. Daily and weekly switching programmes can be set and it is also possible to simulate occupancy when a house is empty - setting the lights to come on and curtains to close in the evenings, for example – giving total peace of mind.

## Wired for sound

Operating at the other end of the market is the wired home automation – or BUS – system. This high-specification type of system allows a myriad of different functions to be operated throughout the home or the workplace – even where there is no-one on the premises – thanks to the remote control capability of the whole system via a computer or mobile phone.

With the click of a mouse, a quick text or the sound of a voice, any number and combination of commands can be set in motion to operate the gadgets in a home – lights switched & dimmed, heating regulated & curtains and blinds set to create the desired ambience.

It offers total control over the number of features and appliances to be managed, as well as the configuration of the controllers that will operate them – from wall switches, voice control units, touch screen panels and IR remote controls. Sensors, switches and actuators all interact with each other to deliver the commands that have been programmed into what is effectively a bespoke system.

Because everything is set from the computer via a simple program, it is possible to change or modify the settings of any of the devices and units connected to the system – such as creating or modifying lighting mood scenes and varying the time it takes dimmers to fade up or down. It is also possible to add and extend units at any time, which means that there is ultimate flexibility to adapt the system to suit changing needs and requirements.

With the touch of a button it is possible to regulate the heating and lighting; close the shutters and gates; see who has arrived at the front door; dim the lamp in a child's bedroom and set the coffee machine percolating. The options are endless.

Whichever system provides the required solution, what they have in common is a means of reducing costs and saving energy, and with the 2016 deadline that will require all new dwellings to be 'zero carbon' looming, it is within everyone's interest to embrace the technology that is helping to shape the future of our homes and work places.

## Click iNELS RF Wireless System

The Click iNELS Radio Frequency Wireless Control System from [Scolmore](#) is suitable for both refurbishment and new build projects and can be used to update an existing wiring system.

Simple and flexible installation, significant energy savings and easy programming are the key attributes of the new system, and the unique one touch centralised control panel means that everything can be easily set and adjusted from this one single control panel.

Because of its flexibility it can be easily installed into any property – with a whole house installation taking on average no more than three days. This makes it a very attractive proposition for electrical installers who can offer it to their customers as an entry level smart home solution.

## Interview with Karl Rawlins – smart home installer



**What is the scale of home automation – does it need to be a complete refit of the customer's electronics, or are there minor installations that can nonetheless make a big difference to the customer?**

Home automation is available in various formats, wired 'BUS' systems which utilises data cables with programmed control via a central computer, X10 which uses the electrical cables already fitted and then RF 'radio frequency' which uses wireless technology.

For full refurbishments and new builds people have generally looked at wired home automation systems with wireless previously being for smaller, simple installations and solutions. Today, due to the digital wireless technology available and the reduced costs, wireless control is now being requested for most areas, be it new build, full refurbishment or retro-fit.

**Is this very much 'customer driven' or are there any challenges/barriers to home automation that need to be discussed with the customer? For example, are there concerns about changes in technology making today's installations redundant too soon? Are there concerns about costs?**

Customers are looking at how they can add security and energy-saving features to their property whilst at the same time adding a little bit of luxury with automated control. The additional bonus of it potentially adding value to their property is also a big advantage. This is where the cost factor will play a big part in terms of which brand they look at, the different technologies available and how long the product has been available.

Product and component longevity is key in customers' thoughts. Replacing obsolete products can be both costly and time consuming and may be beyond the capabilities of the home owner themselves. As a result, reassurances will be sought that simple software updates will future-proof the installation for an acceptable timeframe.

The fact that the components are electronic devices will mean that they will at some point need to be replaced. This is something that needs to be conveyed to the consumer and a plan put in place to maintain the installation. In most cases, updates will take the form of simple software updates.

For installers, this is where vital information can be learnt during the training process so that the installer is made aware of the procedures for product updates, enabling the relevant information to be passed on to the customer.

**Is there a particular segment that is driving home automation trends – for example, new builds?**

The largest sector for home automation is now retro-fit, where home owners are adding wireless security and energy saving features without having to alter their wiring or disrupt their decor. The new build market and home automation installations are on the increase as sales add-ons, with wireless control being specified more often due to costs and the flexibility of the systems now available.

**How can I get involved in specialising in home automation or working in this area? Is there any training available?**

With the number of electrical events now available around the country, there is no easier way for contractors to see systems working and to ask questions. Most manufacturers will offer a comprehensive training support offer, which is always recommended on any system, as you learn about the system and what it can do and offer, but also to understand its limitations, be it cable runs with wired systems or the signal range with wireless systems.

**What are the particular skills you would recommend?**

With general wiring skills it is then down to the system being installed and the data to be logged. For wired systems it can be installing the cables as necessary with no additional skills required, to then progressing to be trained on the final terminations and PC programming and commissioning.

For wireless systems, retro-fitting small installations (single receiver with transmitter) can be achieved without any additional skills other than reading the manufacturers installation

requirements. For larger installations I would always recommend additional training to help in understanding more about the components, programming, their signal range and also their transmission through the various building materials.

**What has been your most satisfying home automation project so far?**

There have been quite a few, with the majority being small to medium-sized solutions using wireless control. Eliminating the disruption to walls, gardens and driveways by switching the required circuits via radio frequency gives the greatest satisfaction. One project saved a primary school thousands of pounds when they realised they had not provided power from the main school building to the security gates at the front of the premises – we were able to overcome the problem using wireless controls.

**In your opinion, what will home automation look like in the next ten years?**

For most home owners, a typical installation will be automated control whilst monitoring energy saving and security elements based on our everyday movements. Systems will then allow us to control and over-ride manually via smart phones, watches and tablets.

Most of these features are available today at a cost, but as energy companies and the government strive for us to reduce our carbon footprint and consumer's requirements become more and more sophisticated, more home owners will look to install home automation features sometime in the future and this will become a standard requirement within the building industry.

## Smart electricity meters revisited

**A roll-out programme to introduce smart electricity (and gas) meters into consumers' homes starts in 2016.**

**Geoff Cronshaw provides an update on the newest developments with smart meters since our last article on this subject in 2010.**

The [Department of Energy and Climate Change](#) (DECC) is directing energy suppliers to start a [roll-out programme](#) to introduce smart electricity and gas meters into consumers' homes from 2016. The programme is expected to run through until 2020, with the aim of helping customers to better manage their energy consumption.

These smart meters will provide customers with information on their energy consumption via a visual display. This information will then be stored and will be accessible to the energy supplier from a remote location, thus avoiding the need to have a meter reader visit the site.

As well as putting an end to estimated bills, this technology will also allow customers access to information on any energy sold back to the energy supplier where the customer has a microgenerator installed, such as a wind turbine or solar photovoltaic (PV) panels.

### What is a smart meter?

A smart meter is an electricity, or gas, energy meter that incorporates a communications unit.

It is understood that, in most cases, smart meters will use wireless technology to communicate between the meter and the communications hub within the premises. To transmit the meter reading data to the energy supplier one of two communication options will be used; either radio or mobile phone technology. Mobile phone technology will be used in central and southern England, while in the north of England and Scotland radio technology will be used.

In the future, smart meter systems may be capable of controlling the consumer's load (with their consent) by sending signals to their appliances to switch them off at peak times etc. It is also expected that the smart meter will offer suppliers the opportunity to provide innovative flexible tariffs.

### Who is responsible for installing the smart meters?

At this point it is worthwhile explaining how the UK electricity industry works. Distribution Network Operators (DNOs) own and operate the distribution network of towers and cables that carry electricity from the national grid transmission network to homes and businesses. The selling of the electricity to consumers is undertaken by the electricity suppliers.

Electricity suppliers are therefore responsible for the installation of the smart electricity meters but this work may also be carried out by their agents. The smart meter roll-out programme is probably the largest project ever undertaken within the UK electricity industry. It is estimated that around 50 million meters (gas and electricity) will have to be changed and some 28 million homes will have to be visited.

The smart meter roll-out programme is planned to commence in 2016 with suppliers being required to use all reasonable endeavours to complete the installation of all their customers'

meters by 2020. In order to achieve successful completion within the challenging timescales, all the industry parties involved are recruiting and training new staff.

## What you need to know

The [Energy Networks Association](#) (ENA) represents the interests of its member companies who operate the national and regional networks for energy to transport gas and electricity into UK homes and businesses. The ENA has created a [Service Termination Issues group](#), which will identify the various issues that can be encountered with network equipment when installing a smart meter and communicate these effectively to installers.

In partnership with the Association of Meter Operators, the ENA has produced a Service Termination Issues Guide to assist meter installers to identify and accurately report network equipment issues to the local network operator. This comprehensive guide lists a range of defects and issues that a meter operative may encounter when installing a smart meter. It also provides meter installer checklists and processes for various installation types, with descriptions of reporting and rectification processes to ensure that issues associated with distribution-owned equipment are resolved efficiently.

In addition, the ENA has set out clear descriptions of a wide range of operational issues in order that these can be accurately identified and reported by the organisations responsible for the smart-meter installation. Operational issues include:

- identification of service position faults;
- damaged distribution owned equipment;
- polarity issues;
- fused neutral cut outs;
- faulty earth connections; and
- signs of overheating, etc.

A typical defect could be that the cut out is showing signs of overheating if, for example, it is leaking bitumen. For many years bitumen has been used to fill voids and seal joints in electrical equipment. It has a relatively low melting point, so bitumen leakage may indicate overheating. The cause of any leakage may be historic, for example, if previous load patterns or the ambient temperature at the service position are very different to present day arrangements. Alternatively, the cause may be related to an ongoing issue. The guide gives a suitable code for this and advises on the action to be taken to report it correctly.

During the installation process there may also be issues relating to data communication and possible issues with the consumer's electrical installation itself but these are covered in other guides developed by suppliers and meter operators.

## What effect will the IET Wiring Regulations (BS 7671) have on the installation of smart electricity meters?

As mentioned in the previous article, systems for the distribution of electricity to the public (such as metering equipment) are outside the scope of the IET Wiring Regulations (BS 7671). The distribution of electricity to the public is controlled by the Electricity Safety, Quality and Continuity Regulations 2002 (as amended), which is published by the Department of Business, Innovation and Skills (BIS). The issue of smart metering is therefore not within the scope of BS 7671.



However, it is important to point out that meter tails from the electricity meter to the consumer unit are part of the consumer's installation and the IETs On Site Guide gives guidance on this area.

## The British Gas example

British Gas recently announced that it had installed its 1.5 millionth smart meter at a home in Leicester. That is an incredible achievement, so we thought this would be a good point to get in touch with British Gas and get their view.

When we spoke with British Gas, they confirmed that having a smart meter means an end to estimated bills and, so far, has actually resulted in fewer complaints to the company. In addition, consumers have more insight into their energy use – which in turn drives down their energy bills.



Features of the smart meters include an in-home display unit showing how much energy is being used in near real time (in pounds and pence) and the ability for consumers to set budgets, compare energy use over time and see the impact of energy efficiency measures in their homes. As a result, 79 % of British Gas smart meter customers are more aware of their consumption and 90 % are taking steps to reduce use by using the information on the in-home display. The savings for a British Gas dual fuel customer are on average around 2 %.

British Gas is currently trialling Smart Pay As You Go with customers who have prepayment meters. The company is also creating new apps that give smart meter customers information about their energy use on their phone.

## Interview with Daniel Colford, British Gas Smart Energy Expert

**Are there any specific considerations you need to take into account when doing installations of smart meters?**

When a member of our customer service team first speaks with a customer about smart meters, they'll ask some standard questions to check their eligibility. But technology is evolving all the time, so there aren't as many considerations to factor into the installation process now.

We'll need to check that a customer lives in an area with good mobile phone signal; it can be any network as we use roaming technology. This is because we'll need a signal for the smart meter to communicate with us centrally to get the meter readings.



It's also better if existing meters are located in easier-to-reach areas. It doesn't matter what sort of condition the meters are in either, as we'll upgrade the electrical cables and the gas pipe-work as needed.

**How do consumers generally feel about having these smart meters installed as part of the roll-out programme?**

We talk to our customers all the time about how they are finding the experience. Nine out of 10 of a base of 1,500 customers surveyed (November 2013) said that they were already taking daily steps to review what energy they were using.

When I go to customers' homes, I find that we get really good feedback once we've installed the smart meters. Customers can see for themselves where their money is going. As they boil the kettle or switch on lights, they can see in pounds and pence how much energy they're using on their in-home display.

A lot of people like the fact that smart meters mean an end to estimated bills as the readings are sent back to us directly. Lots of customers like the reassurance that they know we're getting the information we need without needing to take calls from us to check readings.

**How do electricians and installers get involved with this programme if they are already working with British Gas?**

We have already supported a number of existing British Gas employees moving across to become Smart Energy Experts.

It is possible for existing British Gas employees to be trained to be dual fuel Smart Energy Experts. We have training courses that reflect any existing industry recognised skills so that only new skills and capabilities are covered.

Overall, we look at the needs of the business and the appetite of a number of our employees to be up-skilled in smart metering before we deliver any training. This would take place at one of our six training Academies located across the country.

*Special thanks to Energy Networks Association and British Gas for information in this article.*

*Further information can be gathered from: Department of Energy and Climate Change Business Innovation and Skills Energy Retail Association Energy Networks Association.*

## Solar PV: interview with Martin Cotterell

Nicole Whitton speaks to Martin Cotterell, managing director of [Sundog Energy](#) (acting in his role as a consultant to the BRE National Solar Centre), about the solar PV market and what you need to know about installing solar PV panels. Martin is the lead technical author of the IET's Code of Practice for Grid Connected Solar Photovoltaic Systems and currently represents the UK on the IEC (International Electrotechnical Commission) PV standards group — the leading international body for PV. He is the UK principal expert and co-chair of Working Group 3 (PV systems).



### **Aside from cost savings and using renewable energy, are there any other benefits of solar PV that consumers should be aware of?**

Well, the environmental benefits and healthy financial returns are, of course, the primary reasons that tens of thousands of people up and down the UK have chosen to install solar PV. However, installing PV means you have the satisfaction of generating and using your own energy; it also locks the price of a proportion of your electricity bill (insulates you to an extent from rising electricity bills). Systems with battery storage can give more independence – and provide power even during a power cut.

### **How is the solar PV market performing in the UK?**

The UK market has been very healthy for the last few years, even appearing in the world list of top five countries in 2014 (for added capacity during the year).

I started installing PV more than 20 years ago; the rate of installation growth was very slow for a long time, but that has all changed in the last five years. Now it seems that there is barely a street in some towns that doesn't sport at least one PV roof.

### **Do you expect the UK market to grow over the next five to ten years? If so, what are the reasons behind that growth?**

I expect the market to consolidate – I don't particularly expect rapid growth, but I also don't expect stagnation. PV is here to stay!

### **What is the domestic market for solar PV like in the UK (i.e. fitting domestic dwellings) – are more people fitting solar panels?**

As I said earlier and as anyone can see, PV arrays are now a very common sight on UK household rooftops. Fitting a PV array makes great environmental and economic sense – so yes, more and more people are choosing to go solar.

## **What is happening with the technology, how is it changing and how is integration improving?**

PV technology has been pretty stable for the last few years – the modules used now are not that different to those fitted five years ago. Neither are the mounting systems. What is changing are other parts of the system – new inverters etc. The biggest talking point at the moment is the appearance of battery storage systems – but this is a very new development and is not yet making a significant impact on the market (as it is not yet cost effective).

## **For those Wirings Matters readers who would like to get involved in fitting solar PV – what skills and training would you recommend?**

Fitting a solar PV system requires a number of skills, particularly electrical installation and roofing skills. The design of systems requires good product knowledge, electrical design knowledge and an understanding of building structures, solar resources/shading etc.

Looking at the [Microgeneration Certification Scheme](#) (MCS) website is a good start. This provides the installation and product standards that an installer needs to comply with in order for their systems to be eligible for FIT payments. Once you have looked at the MCS site, select a certification body and talk to them about what's involved in getting MCS certified. In tandem with this, identify and talk to a local distributor.

Another good option would be to get a copy of the new IET Code of Practice for Grid Connected Solar Photovoltaic Systems. We have tried to write this in a way that not only describes the design and installation requirements but also explains the reasons behind them (explaining how a solar PV system and its various component parts function).

## **Are there any problems that an installer should look out for when working on older solar PV installations in domestic dwellings?**

While the vast majority of systems are fine, there are of course issues with some installations. Some problems can be pretty obvious and are no different to the potential issues you would expect to see in any electrical installation. Other issues are more PV specific and it is hard to do justice to this in a short article. However, if pushed, I guess I would highlight: poor fixings on roofs (particularly systems on slate roofs, where many brackets have been simply bolted through the slates); poor d.c. wiring design and installation (loose cables and poorly assembled connectors); and shading (arrays located in sites subject to significant shade – from chimneys trees etc). The best bet is to get the Code of Practice for Grid Connected Solar Photovoltaic Systems, which describes what a good solar PV system should look like!

## **About Martin ...**

Martin founded [Sundog Energy](#) in 1995. As well as directing the technical and installation standards for Sundog, Martin has been a key driver of the PV industry in the UK. He chairs the British Standards PV committee (GEL82), has written many of the standard texts for the industry and is an active participant on several other key industry committees. He also speaks regularly on PV installation and standards issues.

Martin has a background in Engineering, BEng (Hons) Electrical & Electronic Engineering, and was elected as an IET Fellow (FIET) in 2014. Martin was awarded the Outstanding Achievement Award, for his personal contribution to the PV industry at the Solar Power Portal

awards in 2013 (Sundog was also awarded the BIPV installer of the year at the same awards ceremony).



## Code of Practice for Grid Connected Solar Photovoltaic Systems



If you're involved in the solar industry, or wish to get involved, the IET is due to publish the *Code of Practice for Grid Connected Solar Photovoltaic Systems* in October this year.

The Code of Practice provides the information required to ensure that a solar PV system is designed, installed and operated in compliance with relevant UK and international standards and good practice recommendations. It covers:

- (a) all parts of a grid-connected solar PV system up to and including the connection to the a.c. mains.
- (b) LV and HV connections and components.
- (c) all scales of installations, from small domestic systems to large-scale PV farms.
- (d) building-mounted, building-integrated and ground-mounted systems.
- (e) grid-connected systems with battery storage.

For more information and to pre-order the book, see our [website](#).

## A new international Standard for utility connections in port

Geoff Cronshaw, Chief Engineer at the IET, explains a new international Standard that is likely to be introduced for connecting ships to shore supplies in ports.

### Introduction

The IET and BSI jointly publish BS 8450:2006 Code of Practice for Installation of Electrical and Electronic Equipment in Ships and the IET provide the secretariat for the national committee JPEL/18 (electrical installations of ships and of mobile and fixed offshore units).

The UK participates in both International and European standards work. An area of development within international standards is the requirements for high and low voltage shore connections to ships whilst in port.

Shore power, also known as 'cold ironing', enables ships to turn off their electricity generators and connect to local electric power that is supplied to the ship from the utility at the dock. Cold ironing is a shipping industry term that first came into use when ships started to be fitted with steam engines and ancillary machinery. When a ship was tied up at port there was no need to continue to fire the boilers and the machinery would literally cool down, eventually going completely cold, which gives the term 'cold ironing'.

In larger ships fitted with high voltage systems the shore-ship power connection requires a sophisticated system of transformers, frequency changers for 50/60 Hz connections, switchgear, special cables, circuit breakers and control systems. Smaller ships fitted with low voltage systems can 'plug in' to relatively simple shore supply outlets provided at sea ports, inland navigation ports and river wharfs. Shore-based electricity then runs all onboard services while the ship is secured on a shore berth.

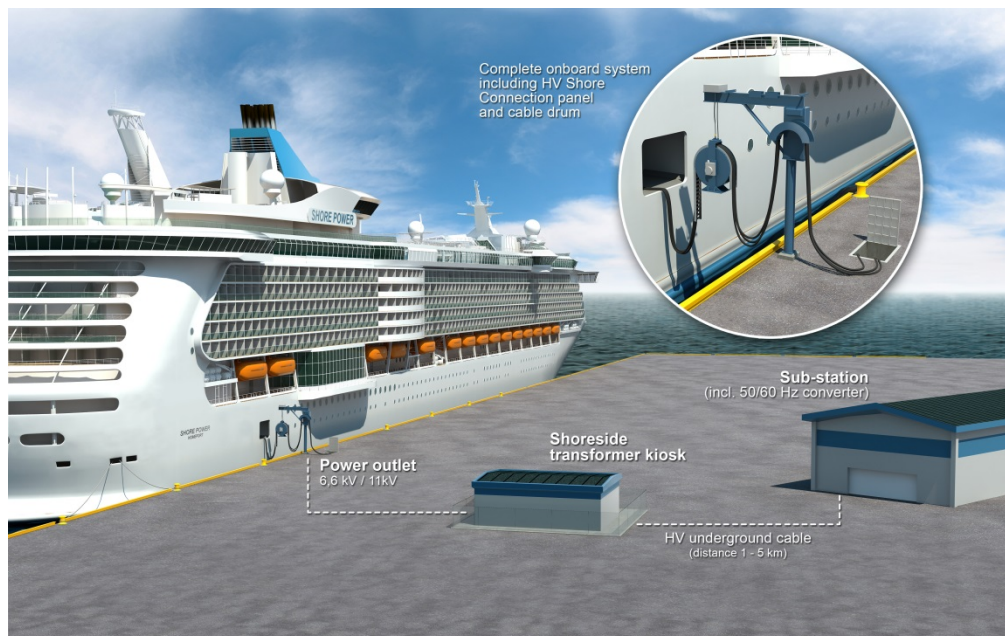


Image courtesy of ABB: <http://www.abb.com/>



## The rationale for utility connections in port

The rationale for supplying ships with electrical power from the shore utility supply while the ship is in port is to reduce pollution in the port area. Environmental considerations are becoming increasingly more important and the propulsion and electrical generation machinery of ocean-going vessels contribute to global air pollution by their exhaust gas emissions. These emissions are particularly significant for cruise ships when berthed in ports because of their constant need for ancillary power to meet domestic loads of lighting and heating, ventilation and air conditioning requirements. Smaller ships fitted with low voltage electrical installations often navigate between smaller ports and on inland waterways and the noise of their generators when berthed has been found to be intrusive to local inhabitants as well as emitting exhaust gases.

## The challenges

There are a number of challenges in considering high and low voltage shore connections. This is a complex issue as the problems to overcome are both technical and operational. For example:

- load requirements vary from ship to ship. Power requirements for some cruise ships may be 20 MVA compared to only 300 KVA for some ferries or small cargo ships.
- voltage and frequency requirements on board the ship may differ from the shore supply utility; some ships operate at 50 Hz and some operate at 60 Hz.
- shore supplies vary from 50 Hz, for example, in Europe to 60 Hz, for example, in America.
- some ships operate at low voltage (for example, 400 V) and some ships operate at high voltage (for example, 1,1000 V).
- some ships may regularly discharge and load in the same berths, whereas cruise ships may only call at a particular port occasionally.
- there needs to be compatibility between ship and shore connection equipment including plugs, socket-outlets and ships couplers.
- when a ship is laid-up for inspection, maintenance and repairs a shore supply is often essential for work on board to continue.

## The Standard for shore connections

The utility shore connection Standard IEC/ISO/IEEE is being developed in three parts:

- Part 1 gives requirements for high voltage shore connection systems, which, as mentioned above, have complex systems.
- Part 2 provides the communication requirements for monitoring and control.
- Part 3, the draft low voltage Standard, covers the general requirements for an low voltage shore connection (LVSC) system, shore supply system requirements, the shore side installation, the ship to shore connection interface equipment, the ships requirements, LVSC system control plus monitoring, verification and testing, and documentation.

The Standard also includes a number of technical annexes.

One of the key requirements is to ensure that the operating frequencies (Hz), phase rotation and voltages of the ship and shore electrical systems match. This is because ships operate in different parts of the world and have to dock in countries with different voltages and frequencies.

The Standard also covers two important procedures for connection to a shore supply. The first is requirements for load connection to a 'blacked-out' ship by means of interlocking so that the shore supply can only be connected to a dead onboard receiving switchboard. This is often essential for smaller ships plugging into a low voltage shore supply facility. The second is load transfer via synchronization, which, for high voltage systems, is most often essential to maintaining continuity of supply onboard. (In an alternating current electric power system, synchronization is the process of matching the frequency, phase rotation, and voltage of one power source to another power source).

## Operating procedures

To create shore connections to ships that are in port requires detailed operating procedures. The electrical power has to be transmitted from the shore to the vessel using special flexible electrical cables on the dock. The cables require purpose-made cable handling systems, such as a large shore-based cable reel. The system needs to be designed to accommodate the rise and fall of the tide and a specially designed heavy duty plug and socket arrangement on the vessel.

For example, Part 3, which covers low voltage shore connections, includes a general operating procedure that requires electrical competence and/or special training for it to be safely performed. This particular procedure is for load transfer via synchronisation. The stages are given as follows in the Annex of Part 3:

- the ship arrives.
- safety checks must be carried out on shore and on board the ship.
- ship-to-shore communication starts.
- cable management system operation starts.
- connections are made.
- permission to start up LVSC from the ship is made.
- LVSC start up – shore connection circuit breakers closed.
- synchronisation of ships generators.
- coupling of ships power system to shore LVSC.
- ramp down of ships generators.
- ships generators turn off.
- ship now supplied on shore power.

## Conclusion

It is important to be aware that this article only gives a brief overview of the ongoing standards work on high and low voltage shore connection systems at IEC level.

*Special thanks to Eur Ing Anthony Plews for his help in the preparation of this article.*