WiringMatters

Your insight into BS 7671 www.theiet.org/wm

Spring 2019

The year as it was: a review of 2015

Wiring Matters chats to the IET Technical Regulations team about 2015 and discusses what to expect in 2016.

Mark Coles, Technical Regulations Manager

Mark is Secretary to Panel D of JPEL/64 – External Influences. Mark is also Great Britain expert to four international and CENELEC technical committees.

What was the most interesting aspect you worked on as part of Amendment No. 3?

Well, I enjoy a good technical discussion! Within committee work, everyone brings a position and/or opinion to the table and, like in any group of people, opinions differ. In the meetings it's important to ensure everyone has their say. Often, the committee naturally arrives at a consensus as the positions or arguments presented lead to a generally accepted view. Sometimes, however, there can be entrenched positions, which may lead to a voting situation. I'm sure I echo my colleagues in saying that the most interesting aspect was the development of requirements for non-combustible consumer units

In terms of your IET work, what defined 2015?

Beyond the committee work, I very much enjoyed presenting Amendment No. 3 seminars and lectures across the UK. Without doubt, the key topic has been the requirement for non-combustible consumer units. There were some stimulating debates and just when you think you've got a topic straight in your head a member of the audience can ask a question that can turn your position around.

What will you be focusing on in 2016?

The panels of JPEL/64 have a heavy workload over the next two years to track changes internationally and at European level. Great Britain, along with every other CENELEC member country, has to adopt the technical intent of European HDs to prepare documents for GB implementation. In addition, there are areas of guidance I want to focus on where technology has moved on, such as diversity; an example here is lighting circuits, where lamps of a far lower power rating than ever before are installed and electrical loadings in kitchens.

What will be of most interest to you in the 18th Edition of the IET Wiring Regulations?

We are a long way off being able to state what will and what won't be included in the next edition but one important aspect is the inclusion of 'requirements for consideration'. Historically, the IET Wiring Regulations have been very specific, i.e. RCDs shall be used in specific circumstances or a protective conductor shall be sized in accordance with Section 534, etc. What we're seeing more of is "'the designer shall consider', for example, Regulation 332.2: "Consideration shall be given by the designer of the electrical installation to measures reducing the effect of induced voltage disturbances and electromagnetic interferences (EMI)". I think we'll see more of this.

Geoff Cronshaw, Chief Engineer

Geoff is Secretary of JPEL/64, which is the UK's national wiring regulations committee.

What was the most interesting aspect you worked on as part of Amendment No. 3?

I think the one area that stands out is the new requirements for non-combustible consumer units.

In terms of your IET work, what defined 2015?

Apart from the international work I found updating the IET Guidance Note 7 *Special Locations* very interesting.

What will you be focusing on in 2016?

The national committee (JPEL/64) has a full programme of work to develop the requirements for the 18th Edition. A great deal of work has been carried out at international level in areas such as surge protection, arc fault detection, embedded electric heating, energy efficiency etc. As Secretary of JPEL/64 I will be closely involved in incorporating these requirements into the IET Wiring Regulations.

What will be of most interest to you in the 18th Edition of the IET Wiring Regulations?

Incorporating the requirements for energy efficiency into the IET Wiring Regulations will be a major change and will be very interesting. Exactly how this will impact the work of designers is not yet known but could mean designers having to take account of how lighting is controlled. Also, types of electric motors, use of motors, how energy can be saved using variable-speed drives etc. In addition, the use of metering to measure power quality, voltage levels and loads etc. Finally, ways in which power factor correction can be provided to improve the power factor of inductive loads, such as induction motors.

You're a regular contributor to Wiring Matters. What was your favourite article of 2015?

I enjoyed writing the article of shore supplies to ships. As Secretary of JPEL/18 (Ships and Off Shore Installations committee) I found this an interesting and complex area.

Leon Markwell, Senior Engineer

Leon is Secretary of JPEL/64 Panel B, Thermal Effects and attends the meetings of JPEL/64 and of the other panels. Leon also sits on BSI committees FSH/12 and FSH/12/1 covering fire alarm installations and TCT/7/2 covering the installation of IT cabling.

You returned to the IET in June 2015, how have you enjoyed being back at the IET?

I initially worked for the IET in the 1990s but when I left IET employment I retained my seats on some of the panels, so I'm not back as such as I've never really been away! I enjoy the technical discussions and the mental discipline it requires to debate a technical point and draft technical requirements.

In terms of your IET work, what defined 2015?

Really just getting back into the swing of the technical authoring work and re-establishing contact with all the engineers I'd not seen regularly for the last few years.

What will you be focusing on in 2016?

Planning for the 18th Edition of course, but I had previously been working in Facilities Management and that made me think more about operation and maintenance and areas where the IET can provide further information and guidance to industry and installers.

What will be of most interest to you in the 18th Edition of the IET Wiring Regulations?

Trying to get a set of regulations that will be helpful guidance to industry and installers and not produce more questions.

Chief engineer Geoff Cronshaw discusses Special Locations.

Richard Townsend, Senior Engineer

Richard is the Secretary of Panel A of JPEL/64, which covers Verification, and also attends JPEL/64 meetings and working groups. Richard also represents the IET on BSI committee CPL/061 (Safety of household and similar equipment), the ECA's Power and Technical committee, CIBSE's Electrical Services Group and The Electrical Safety Round Table.

What was the most interesting aspect you worked on as part of Amendment No. 3?

Working on the new model forms and schedules of inspections was most interesting for me, as I come from a facilities management background and certification and reporting is very important.

In terms of your IET work, what defined 2015?

Launching Amendment No. 3 was a defining moment of 2015 for me, as this required a great deal of involvement with the industry from all of us. We needed to shine a light on the changes and try to explain both why they came about and how the industry could begin to comply with them.

What will you be focusing on in 2016?

My focus for 2016 will be the upcoming changes required for the planned 18th Edition. From a Panel A perspective some of the changes could impact significantly on the way the industry operates.

What will be of most interest to you in the 18th Edition of the IET Wiring Regulations?

I'm looking forward to the possibility of incorporating energy efficiency and environmental impact within BS 7671. This is a very new concept for BS 7671 and will make the industry look very closely at how it operates and installs new installations.

Steven Devine, Electrical Engineer, Educational Sector

Steven is the Secretary to JPEL/64 Panel C Shock Protection.

What was the most interesting aspect you worked on as part of Amendment No. 3?

To me, the most interesting aspect of the work for Amendment No. 3 to the IET Wiring Regulations is the requirement for the supports used for wiring systems in escape routes. The need for this requirement is in part a result of investigations into the deaths of several firefighters in the UK where the coroner's reports concluded that the cause of death was contributed to by the equipment used by the firefighters being entangled in cable from a wiring system that had prematurely collapsed. I think this is a good example of how the IET Wiring Regulations are developed as a direct response to incidents that occur.

In terms of your IET work, what defined 2015?

In October 2015 the *Student's Guide to the IET Wiring Regulations* was published. I had been working on this publication from mid-2014 and with the help of a fantastic team at the IET and some external experts we managed to get it out and available to students across the UK this year. The *Student's Guide* is the first of many resources being produced at the IET designed for students studying to become electricians, electrical engineers and many other professions that require some knowledge of electrical installations. This is certainly the title that defined my work at the IET during 2015.

You authored the Student's Guide to the IET Wiring Regulations. What was this experience like for you?

Writing the *Student's Guide* was a fantastic experience that has given me the opportunity to reach out to a huge number of students. Having worked closely with electrical students in the past I know all too well how difficult it can be starting an electrical qualification. I have designed the *Student's Guide* in a way that provides easily accessible information to students that is relevant to the qualification they are studying as well as essential hints and tips for working in the electrical industry.

Will you be doing any more work in this area in future?

The *Student's Guide* is the first of many publications designed for students. Our close relationship with awarding bodies and learning providers, such as Further Education (FE) colleges, will ensure that the content we produce will meet the requirements of students as well as lecturers and employers.

What will you be focusing on in 2016?

2016 will be an interesting year. Our primary focus will be incorporating any new work and changes to BS 7671 for the 18th Edition. Each of the panels has a lot of work to do to make sure we can capture as much information as possible to include in the 18th Edition. Panel C will be focusing specifically on

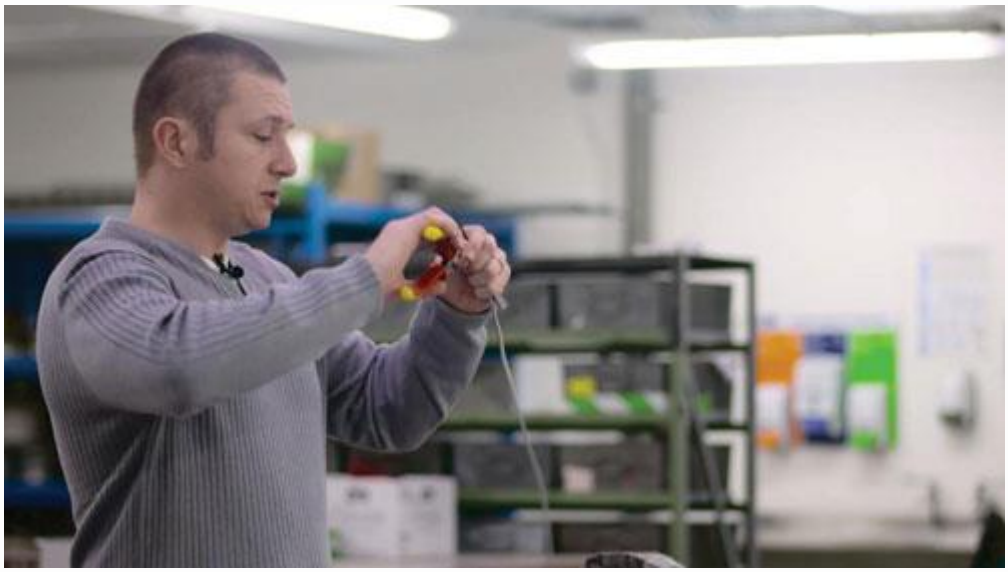
Chapter 41 and Chapter 53. We are also looking into developing a UK requirement for foundation earthing based on existing requirements in some European countries.

What will be of most interest to you in the 18th Edition of the IET Wiring Regulations?

There is a document that is to be incorporated into BS 7671 relating to the co-ordination of electrical equipment for protection, isolation, switching and control. The Harmonised Document (HD) specifies the requirements for the selection and erection of electrical equipment for protection so that various protective devices on the same circuit function correctly and in order.

Nicole Whitton, Publishing Manager and Editor of Wiring Matters

2015 was incredibly busy for Assistant Editor Amy Walker and me, with the primary focus being the publication of the BS 7671 guidance titles. All but two were published in the same year that BS 7671 came out; the *Commentary* and the *Electrical Installation Design Guide* will be published this year. We published a new title last year, the ***Student's Guide to the IET Wiring Regulations***. We want to make it easier for students to understand the fundamental concepts of their coursework. We achieved endorsement of the book's accessible language and clear illustrations from the Plain English campaign and we've received positive reviews on Amazon and on the IET Electrical Forum. We're now working on a series of videos to help students even more – please keep an eye on Wiring Matters, where we'll tell you more about these during 2016.



Student's Guide to the IET Wiring Regulations *author Steven Devine gives a tool demonstration.*

Speaking of our favourite electrical magazine (no bias here!), Wiring Matters has gone from strength to strength. Thank you to all our readers who have continued to support the online magazine. Subscription numbers are climbing and we receive a lot of good feedback. Our biggest challenge is to take a fairly complicated and lengthy process – the committee work behind the changes to BS 7671 – and make that process as clear and accessible to you as possible. We read the IET Electrical Forum and we know that you want more clarity about the changes to BS 7671 before they are made. We're working hard to find more ways to get information to you on a regular basis, via podcasts, videos and, most recently, the blog. Please keep checking the IET Electrical site and reading Wiring Matters online so that we can keep you informed. If you want to know when new issues of Wiring Matters are published, please subscribe and you'll get an email notifying you whenever a new issue has been published.

We have some exciting titles coming out this year, such as *Guide to Energy Efficiency*; *Guide to Consumer Units* and *Guide to Electrical Installations in Medical Locations*. We're always happy to receive non-technical questions – for example, questions about the magazine or suggestions for articles: wiringmatters@theiet.org. For any technical queries, please phone the Technical Helpline: +44 (0)1438 765599 Monday and Friday, 09.00-12.00 and 14.00-16.30 (please see http://electrical.theiet.org/wiring-regulations/help/ for more details).

How to become an electrician: a brief overview of training options

Student's Guide to the Wiring Regulations author Steven Devine discusses gaining an education and starting your career in the electrical industry.

The electrical industry is vast and there is an ever increasing demand for experts in various different areas. Anyone can see the impact that electricity has on our lives; it's everywhere. One of the many reasons people are drawn to work in the electrical industry is because it offers such a diverse field to work in, and there is always something that is of interest to someone.

What kind of work is available?

As well as domestic there is also commercial and industrial work. Electricians can be trained to work on high voltage transmission and distribution lines, substation installations, panel building, generators and many other specialist areas. Anything you can think of that involves electricity in some way almost certainly has an electrician that specialises in that area.

If physical work doesn't sound like your ideal career, an office job may be more appealing: you can become an electrical supervisor, authorising engineer, electrical design engineer, manage your own electrical company or, once you have gained experience, you can move into consultancy, teaching, or standards development. This is only a handful of the different career paths you can pursue.

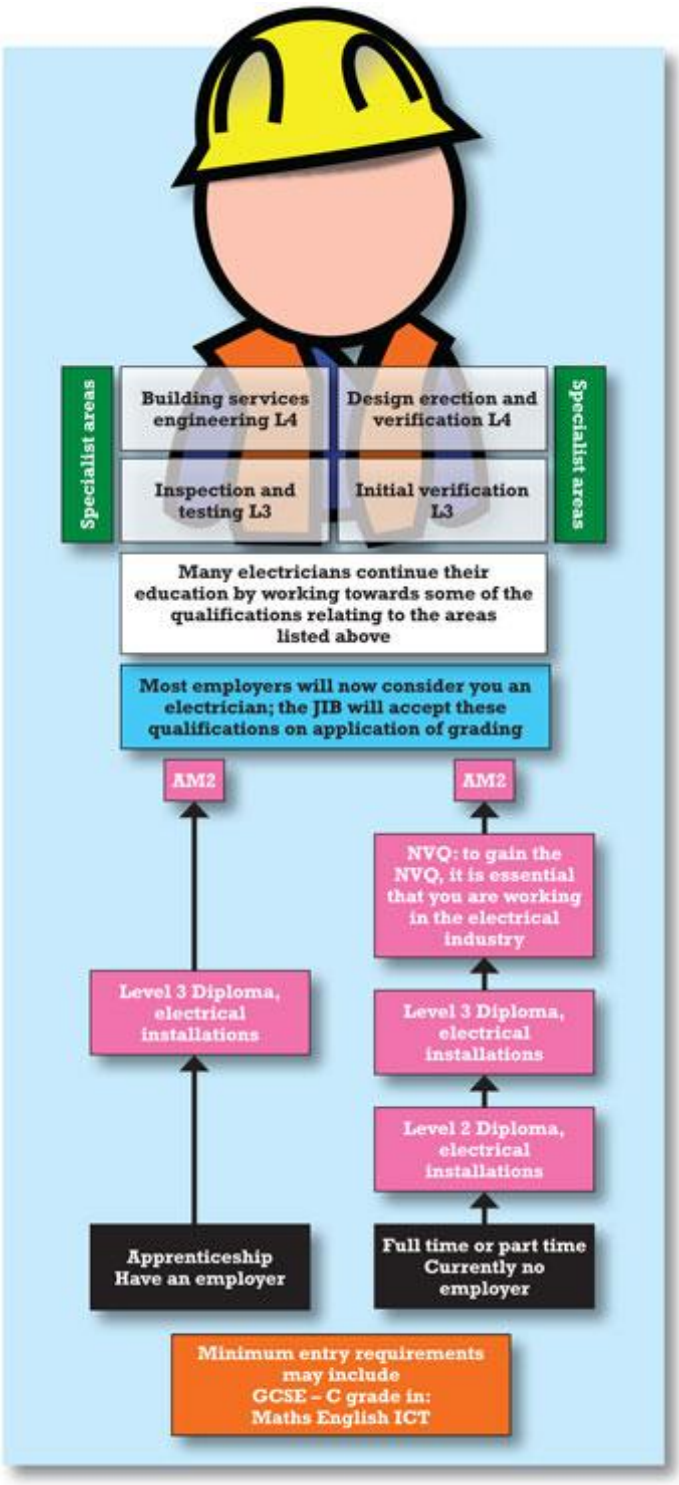
Education and the electrical industry

It is essential that anyone working in the electrical industry is adequately trained to do so. Unlike a lot of careers, learning on the job just isn't enough. Electricity is a science, so when you're studying to become an electrician you're studying a science. To be a good electrician you need to have a fundamental understanding of this science. Education will enable you to learn from other people's mistakes, have expert guidance from experienced lecturers and access the resources provided from awarding bodies. A successful assessment at the end of a qualification is just the beginning.

What are the options available for people who want to pursue a career in the electrical industry?

Minimum requirements

The minimum requirements for people intending to enrol on any electrical qualification are generally basic maths, English and Information and Communication Technology (ICT) at GCSE grade C or equivalent. Many colleges and learning providers give students the opportunity to gain these qualifications while simultaneously studying an electrotechnical qualification.



Apprenticeships

Students generally start an apprenticeship at around the age of 16. The level 3 qualification usually runs for around three to four years, possibly extending to five. Any electrical company can employ an apprentice whether it is small or large. Apprentices will gain valuable on-site experience as well as learning the essential science and fundamental principles of electricity while on day release at a college or learning provider. Some larger companies provide in-house training that, in most cases, award nationally recognised qualifications.

Colour deficiency

When applying for an apprenticeship, students are normally expected to pass a colour deficiency test before being accepted. Students who sign up for full time courses may not necessarily be asked to take the test and may face some difficulty when attempting to transfer their full time course to an apprenticeship.

Full time courses

Full time courses (usually three days a week) are available to people who have difficulty finding an apprenticeship as the demand for apprentices can fluctuate depending on the state of the economy. There are a number of full time electrotechnical courses available, the most popular ones being the level 2 and level 3 electrical installations courses that can, in most circumstances, be mapped over to an apprenticeship. Students tend to use these full time courses to gain qualifications so that they are more favourable to employers when applying for apprenticeships.

Part time courses

Part time courses are generally better suited to older students who have a little knowledge of

the electrical industry. Part time courses can be intense as the student will have one day or two evening classes as opposed to three full days, so it's essential that the student can commit to self-studying out of college.

Domestic installer

Domestic installer courses should provide you with the minimum training required to consider registering as a domestic installer. They are popular with people who wish to pursue a career working predominantly on domestic properties. However, if you do embark on a domestic installer course, you would be expected to have sufficient experience of domestic electrical installation work so that you can be confident that the work you carry out is safe and meets the requirements of the latest version of BS 7671 (the IET Wiring Regulations). Some training providers run short courses that may only take several weeks to complete; these are only recommended for people who have already had substantial experience working in the electrical industry.

On successful completion of a recognised domestic installer course you should hold a qualification in line with latest version of BS 7671 (e.g. at the time this article was written, a 17th Edition qualification), such as the C&G 2382-12 as well as an inspection and testing and initial verification qualification, such as the C&G 2394-95. Once you have gained these qualifications, domestic installer scheme providers offer guidance on what you would be expected to know to successfully pass their assessments and register as a domestic installer.

What next?

Many electricians like to have their level of education and experience recognised. One way of doing this is to apply for grading to the Joint Industry Board (JIB), who will assess and review your application and offer you one of several grades. Once someone has reached the status of electrician they have really just begun their career. The next logical steps are to gain qualifications and experience in inspection and testing, initial verification, electrical installation design, project management as well as taking a specific route to specialise in a particular area of the industry.

What is the best route?

Whatever route is taken to pursue a career in the electrical industry it's essential that electricians know what they are doing before carrying out electrical work unsupervised. In such a diverse industry, it's virtually impossible to know everything, but knowing the fundamental principles of electricity and how to work safely with it will secure a long and exciting career.

Electrical maintenance: the importance of good practice

Cameron Steel, Electrical Design Engineer and Director of BK Design Associates UK Ltd, writes about the importance of good electrical maintenance.

Good maintenance regimes do not happen by accident: they need careful planning, proactive management and comprehensive reporting. The tone for good maintenance is also established beforehand by considerate design, intelligent construction and satisfactory commissioning.

There are specific legislative and regulatory responsibilities placed on the occupier of a building and associated premises as duty-holders to ensure the safety of the electrical installation. There are also statutory obligations to ensure the successful operation of life safety systems, such as emergency lighting and fire detection and alarm systems, when they are actually needed. Transportation systems such as lifts, escalators and moving walkways also need periodic assessment. Insurance policies may be an additional driver of this – if periodic certification cannot be produced then insurance policies may not be honoured if the need arises. BS 7671 (the IET Wiring Regulations) and the accompanying Guidance Notes discuss the periodic testing and inspection that should be at the heart of any maintenance regime for the premises' electrical installation.

Maintenance activity, especially on life safety systems, needs to be recorded and signed off. To demonstrate compliance of fire alarms, emergency lighting and similar systems with statutory requirements a log book recording periodic tests should be used. This in turn must be left available for auditing purposes. Dates of test, anomalies, and remedial actions should all be noted.

1.1 Instigating a maintenance regime on an existing property

The challenges of instigating a maintenance regime after taking over an existing property that may have been neglected for a few years has probably taxed the undoubted skills of many experienced facilities managers. Satisfactory maintenance of electrical building services and systems should not be left to chance; neither should the responsibility land solely on the contract electrician without any input from the building occupier.

For an existing installation that has been left unattended for a period of time there will be a lot of input required to get it back to a satisfactory operational standard. Often more involved refurbishment activity, rather than just some basic remedial tasks, will be necessary. Sometimes, expired equipment will be obsolete, requiring yet more intrusive work to be carried out as part of what should have been a simple maintenance exercise.

1.2 Creating a maintenance regime for a new property

With a freshly commissioned project that is handed over as a turnkey operation, maintenance of the electrical installation should be easy … shouldn't it? Yet on larger estates, such as universities and hospitals, there is sometimes a breakdown in communication between the capital project teams and the maintenance and facilities teams. Budget drivers mean that expectations of the maintenance teams might be higher than the design team can deliver. Likewise, the design team may consider that maintenance is not their problem as long as regulations and design standards are adhered to. Notwithstanding those constraints any electrical installation design must carefully consider not just for the needs of the end users, but also the needs of those that will be employed to maintain the premises.

Space planning is of paramount importance to allow an installation to be constructed easily and make maintenance more straightforward. Coordination of building services, working at height, safe handling of loads and the simple ergonomics of access and egress with tools and equipment need to be at the forefront of the designer's mind. Checklists, questionnaires and design workshops can aid both the designer and the maintainer.

The maintenance team must be seen as a key stakeholder in consultations during the design and the construction phase of a project. Proper assessment of the connections to the existing infrastructure should also be thought through. This will ensure that the infrastructure can support the new build and

can also deal with seasonal demands. Any residual design risks going forward should be noted to allow for future growth and any planning that needs to be assessed. That information will help inform the next project designers.

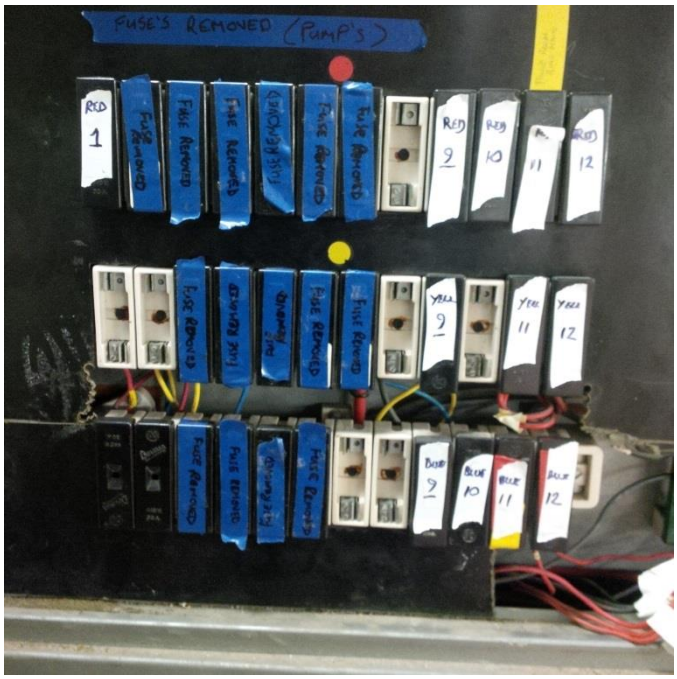
Robust maintenance regimes do not just start with a project handover. They should start far earlier. Project handover, with a comprehensive and site specific Operation and Maintenance (O&M) Manual, should indicate that correctly managed and documented maintenance practices have already commenced. The only maintenance management process left to start should be regular auditing and any consequent replacement of expired equipment.

It is vital for both designers and construction teams to recognise the importance of the O&M Manual that they pass on to the maintenance team when they leave site. This is an integral part of the project completion process. However, it is often left until the last minute and rushed, leading to mistakes. By the time the construction team produce their as-built drawings the design team have moved on to the next job. Drawings and documents do not always get the rigorous review they need to ensure accuracy. The advent of Building Information Modelling (BIM) may improve this situation in terms of up-to-date information being produced as the project develops, but that remains to be seen. In the meantime, most projects will follow traditional patterns with the inevitable gaps in continuity in the flow of information.

1.2.1 Asset management

Asset management tools should also be considered. Adequate labelling of cables, switches, isolators and equipment should all be carefully correlated with schedules, drawings and associated documents. Physically tracing cables can be an onerous task, especially in basement walkways and through walls and risers. Adequate labelling of cables, not just at each end, but at appropriate intervals, can greatly assist, especially during reactive maintenance or disaster recovery situations. Labelling that helps the maintainer to instantly understand where the source of supply is can be beneficial in terms of isolating the right part of the infrastructure in a timely manner.

Example of good labelling



Example of bad labelling

1.2.2 Managing safety

Managing safety for maintenance operators as well as building occupants is a very important consideration. Providing electrical maintenance in a safe and efficient manner is much more than just changing a lamp when it fails or replacing a socket when it is damaged. Correct procedures should be followed to ensure that a system is safely isolated to allow maintenance work to commence.

It should be recognised that maintenance of electrical systems can be intrusive and disruptive. To mitigate these issues safe systems of work should be adopted. Electrical maintenance will often require isolations to normal service. Contingency plans to avoid unnecessary disruption will often involve out-of-hours work. Some electrical systems incorporate back-up or standby supplies to mitigate such interruptions. However, on reinstatement, it is important that the system is returned either to its original design parameters or to an agreed change in those parameters.

Careful management of the electrical maintenance process will include:

(a) safe commencement through the issuing of permits to work, the review of risk assessments and the preparation of method statements; and
(b) safe cessation and satisfactory reinstatement through defined handback procedures, operations checklists and rescinding of the permits.

When the work is completed it must be properly tested and correctly returned to service – this effectively recommissions the electrical system that has been maintained.

1.3 Skills needed for good maintenance

As well as the hard, or direct, electrical engineering skills required for good maintenance philosophies, the soft, or indirect, skills of design, commissioning and documentation of electrical systems need to be understood to ensure a safe and satisfactory maintenance regime. Part of that is the training of staff on the equipment that is to be maintained. Familiarisation, coupled with a safely managed process, will reduce downtime in breakdown periods.

Understanding the strategies for maintenance and knowing when to use them is a responsibility for maintenance mangers and technicians alike. Different responses will be required for preventative,

reactive or predictive maintenance. Regular on-the-job training in particular can help to assist in moments of reactive maintenance to ensure safety and the prompt reinstatement of an electrical service. Having a pre-defined set of standing operating procedures (SOP) to deal with most circumstances can also assist maintenance teams, especially those that are slightly less familiar with the site in the early hours of a Sunday morning.

It is also important to recognise that an urgent breakdown is not a licence to circumvent the normal safety requirements of thinking about risk and methodology. There will be financial drivers or, more importantly, life safety imperatives, to get a system back up and running. Do not cut corners. Prepared electrical maintenance SOPs, which are thoroughly reviewed and updated regularly, can assist greatly in these situations to get the mind in the right space and react safely and promptly.

Another skill for the on-site maintenance crew is customer relations. You have completed the hard work, got the electrical system back up and running and operating successfully when you left the department. Go back half a shift later and make sure it is still working. The end users will be grateful and you will be reassured too. In hospitals, for example, the clinical team has enough to worry about without ringing the estates department – again. Pre-empt that call.

The availability of spare parts is one more maintenance consideration, especially for installations that operate shift patterns outside of normal working hours when wholesalers may be shut and contractors are not available. Can the factory afford not to operate for several hours? Can it afford to carry the overhead of spares within the building? Do these spares have a shelf life, so that just at the moment they are needed they are no longer viable?

1.4 Ongoing maintenance regimes

New installation or existing, fully refurbished or simple remedial works: if some time and effort is put into setting and managing the maintenance process the task becomes easier – does it not? In theory, surely less qualified resources can take over and less time can be allocated? No process can afford the luxury of resting on its laurels. The only constant in life is change. Different components fail at different times; maintenance regimes need to constantly react to different challenges. Proper and regular evaluation of the maintenance process and the performance and knowledge of the maintenance staff are important cornerstones of the maintenance regime.

Different mangers will have different models of operation, but it should be clear that any process should be subject to constant review and improvement where it is required. The advice here is not necessarily to change for change's sake, but the old adages of 'if it works, why fix it?' has no place in the modern electrical maintenance world. Equally, staff turnover and new contractors can add to the complexity of day-to-day management. Each member of the maintenance team will build up a body of knowledge about the site and that will be lost when they move on. This can be a real problem on larger, more complex sites, all of which have their own particular foibles. Making sure qualified and experienced resources are available when required is part of the maintenance challenge.

Electrical equipment has become increasingly more efficient and better controlled but it all has a limited lifespan. Maintenance is a necessity not an inconvenient overhead.

1.5 The future of maintenance

Increasingly we are all urged to use less fossil fuel and hence release less carbon dioxide into the atmosphere. Modern electrical installation designs are using technologies that consume less energy during their lifespan, but only if they are looked after properly. Robust maintenance regimes have an important role in a more sustainable world. There can be no doubt that correctly maintained electrical systems will operate at their maximum energy efficiency for much longer. The trend for energy costs has been upwards for many years. The financial imperative of a well maintained, low energy electrical installation needs to be correctly appreciated by the business manager – otherwise poor maintenance will undermine the bottom line.

As technology develops it is likely that the maintainer will be presented with automated means of monitoring performance and computer systems to plan, manage and report on maintenance activities.

Various electrical systems within buildings are becoming more integrated and complex. An integrated supply chain from concept design to planning and construction to commissioning will be increasingly amalgamated through tools like BIM. This will provide the maintainer with a series of compatible computerised tools to identify replacement parts and ongoing operational analysis of the electrical systems. Linking this into existing practices of monitoring and integrating the status of equipment using Building Management Systems could make life easier for the electrical maintenance manager and on-call duty staff. Going forwards, perhaps in time the 'M' in 'BIM' will become 'Management' to reflect the integrated use of this database over the whole lifecycle of the installation, from design through operation and use and on to decommissioning and disposal.

This new technology also presents a new requirement for the maintainers' skill base – a knowledge and understanding of cyber security. A cost effective cloud based maintenance software solution, with on-site sensors, automated alerts via text or email to on-call staff and off-site diagnostic tools, might be one manager's dream scenario. Equally, it can become another manager's security nightmare through hacking and IT related problems.

The final obligation of the maintainer is to ensure the time-expired equipment is disposed of correctly at the end of their lifecycle. Regulations need to be considered here too as most electrical and electronic equipment at the end of their useful life will be covered by the Waste Electrical and Electronic Equipment Directive.

There is a lot more to electrical maintenance than just turning up with a tool box and pack of light bulbs. You should not run your car without an annual MOT and regular servicing of the vehicle is advisable. Do not neglect your electrical installation either.

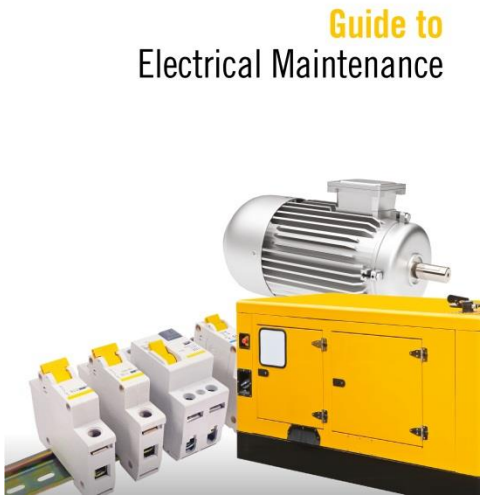
IET work you may be interested in!

The IET is doing a lot of work in the area of electrical maintenance and associated subjects.

Guide to Electrical Maintenance

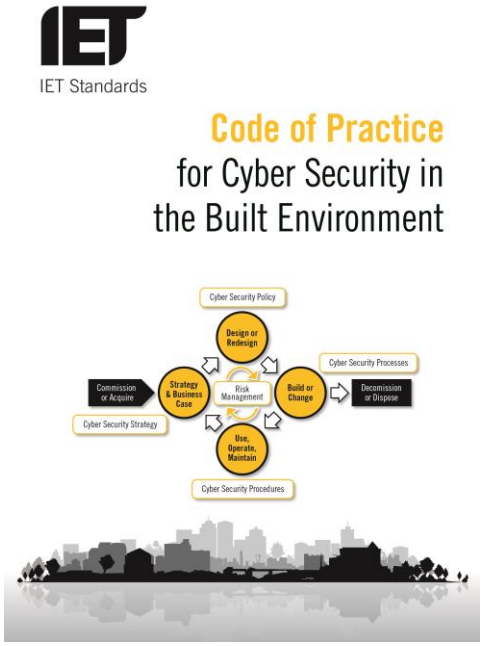
The obvious choice if you're working on anything related to electrical maintenance – from designer to electrical maintainer – the Guide provides clear and informative guidance on carrying out maintenance activities and ensuring good practice.

IET Standards



Code of Practice for Cyber Security in the Built Environment

As Cameron mentioned earlier, advancements in electrical maintenance and the introduction of BIM are likely to lead to integrated electrical systems and a smarter, cloud-based way of monitoring the performance of those systems. Any new technology comes with new challenges, and in this case cyber security is a growing concern. This Code of Practice explains why and how cyber security should be considered throughout a building's lifecycle and explains good practice, focusing on building-related systems and all connections to the wider cyber environment.



Future title: Designers Guide to Energy Efficiency in Electrical Installations

CENELEC HD 60364-8-1 was published in October 2014 and is expected to be included as a new section in the 18th Edition of BS 7671 (the IET Wiring Regulations). We don't expect significant changes to the underlying principles of HD 60364-8-1 so, in the spirit of ensuring that UK designers are prepared and 'ahead of the game' when it comes to designing energy efficient installations in the UK, we're preparing this Guide for publication in early 2016.

The Guide will provide information about designing installations in an energy efficient manner using an internationally agreed standard, and will also provide guidance on the HD.

Electrical installations in theatres and performance venues

Bord Gais Theatre, Dublin ©Ros Kavanagh

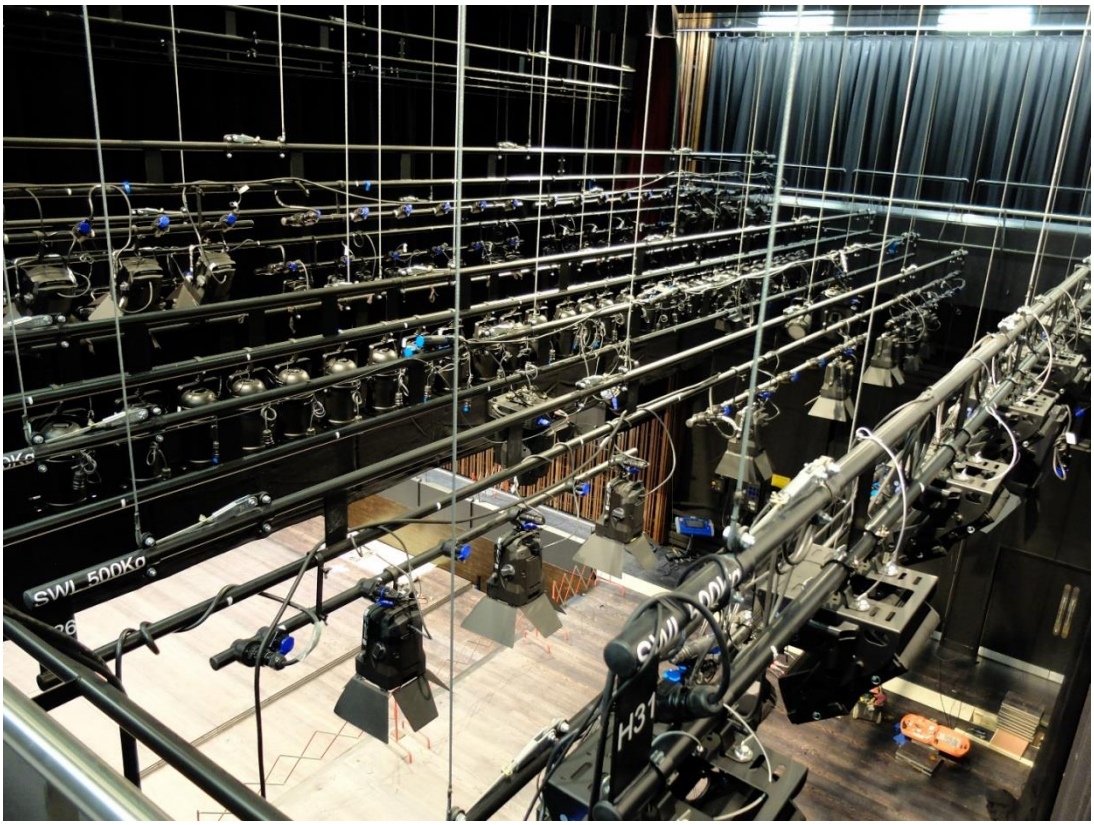
In this, the first in a series of articles looking at electrotechnical job roles in the entertainment industry, the Association of British Theatre Technicians (ABTT) talks to Richard Bunn about the role of contractors and engineers in designing and installing the permanent electrical systems in theatres and performance venues.

Richard Bunn MA CEng MIET is a theatre consultant with Arup, an independent firm of designers and engineers. Arup's work in performing arts stretches back to the iconic Sydney Opera House, and includes landmark theatres, concert halls, stadia and arenas as well as smaller spaces in cities and colleges serving local communities. Richard advises electrical engineers on the particular requirements for services installations for performance venues in the UK and around the world.

Richard is also Vice-Chairman of the Association of British Theatre Technicians (ABTT), a charity that campaigns on behalf of the theatre industry to ensure that legislation is appropriate to the industry's needs and that regulations are appropriately drafted and enforced.

What makes theatres and similar performance venues different from other buildings?

Theatres are some of the most heavily serviced of all buildings. The systems and complexity are sometimes compared to those found in a hospital. This comparison highlights the requirement for significant specialist electrical systems in supporting a performance. These include systems for production lighting, sound, video, broadcast, stage machinery and special effects. These systems are safety critical in an environment with heavy moving scenery, variable lighting, loud audio and large numbers of performers and audience members.



A view from above stage at the Bryn Terfel Theatre, Bangor, ©Arup

At its heart, the use of a performance venue is driven by creative directors, designers and performers. The same stage may have a large-cast musical one night and a single stand-up comedian the next. Consequently, necessity demands that the electrical and associated systems must enable flexible use and do not constrain the artistic vision. Careful planning is needed to provide just the right amount of services and equipment in all the required locations; too much could get in the way or not earn its keep.

Although they are focused on performance spaces, these systems permeate throughout the building to provide audio and video for show relay and communications in backstage spaces and for performance presentations in foyer spaces.

What standards should be considered for performance building installations?

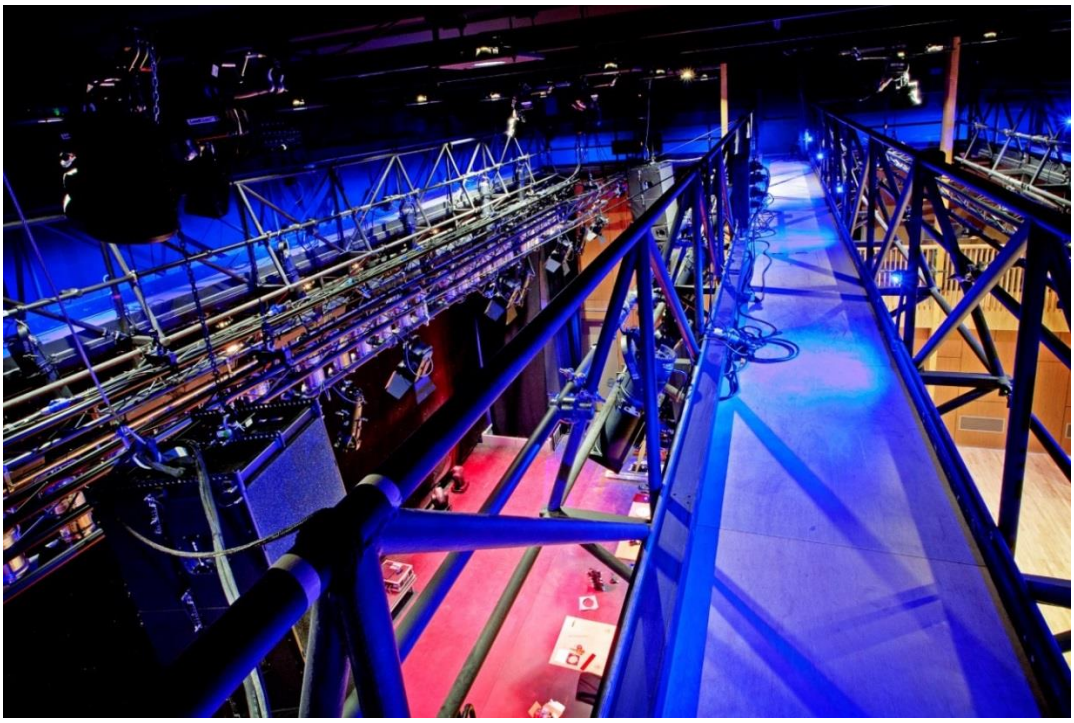
BS 7671 remains the primary reference document for the UK and sets the foundation for safe electrical installations. The *Technical Standards for Places of Entertainment* co-published by, and available from, the ABTT (www.abtt.org.uk) is essential reading to understand theatre operation and how regulations should be applied, particularly to assist in compliance with licensing requirements. As well as providing commentary and recommendations on core electrical installations, this guidance also includes recommendations for the planning of general and emergency lighting systems and fire detection systems.

What are the particular challenges and considerations for the electrical installation?

Although performance buildings are large, space is at a premium. The spaces close to the stage are needed for performers' dressing rooms and technicians' workshops meaning that spaces for electrical distribution are rarely in ideal locations.

Areas that look empty on plans are critical to the flexibility required to produce spectacular performances. As an example, an over-stage grid may look similar to a plant space, but the use is very different. It is a working area for technicians to suspend scenery and create effects, so a misplaced piece of containment may easily compromise the artistic possibilities for the space.

Several systems of containment are required, and these need to be rigorously separated to prevent noisy power associated with dimmers and machinery from introducing noise to sensitive millivolt-level microphone signals. In key areas such as balcony fronts and control rooms, this wiring will have to fight for space and be coordinated with structure and other services. Handling of low noise air demands big ducts that also consume large amounts of space, thereby making early containment planning important. Entertainment technology is constantly evolving and low-fill factors are needed to allow space in containment for future cabling.



Lighting bridges above the auditorium at Mareel Arts Center, Lerwick ©Phatsheep

Associated with this is the way that an auditorium and stage carves a void in the building requiring cables to be routed around a wide, long volume several stories high. All this means that cable runs end up longer than may originally be anticipated, which impacts on cable size to meet volt drop and loop impedance requirements. Care is also needed to ensure data cable run length limits are not exceeded.

What is the role of specialist contractors and how does this interface with the work of the electrical contractor?

A specialist contractor will usually be employed to supply, install and commission specialist lighting and sound equipment. These systems depend on electrical supplies, wiring and containment provided by an electrical contractor. There will also be interfaces between the specialist systems and other electrical systems, for example, between fittings and controls for architectural lighting and the fire and building management systems.

Close coordination between the specialist and electrical contractors is important to achieve a successful and well integrated project. At the outset, responsibilities should be agreed between both contractors to ensure that everything is included and interfaces are well understood. This relationship is usually mirrored in the design team, with a theatre consultant defining the specialist packages to interface with the systems specified by the electrical engineer.

Side stage gallery, Swansea University Great Hall ©Arup

How much power is required for a theatre building and how is it distributed?

Because a theatre building needs to offer flexible use in order to support a wide range of performances, the brief for the building must be analysed. Central to this is whether the building is designed as a 'producing house', with workshops and rehearsal rooms for creating shows, or as a 'receiving house' designed to accommodate touring shows.

Stage lighting remains the largest electrical load and supplies need to be sized to illuminate the stage to give the impression of the brightest summer days. In the next instance this could be replaced by a single spot on a solo performer. So, although big supplies are required to meet maximum demand, average electrical use is much lower. Stage machinery is similar with large supplies required for lifts and motorised bars during scene changes, but minimum power use in between.

Dimmer rooms, audio rack rooms and motor rooms are usually provided as hubs for the electrical and control infrastructure. These are similar to other plant areas, but dedicated to the specialist systems and with access controlled by theatre technicians.

Dimmer racks at Theatre Royal, Bury St Edmunds / Motor room at Victoria Halls, Singapore ©Arup

In addition, large supplies are required adjacent to the stage and in other locations to support extensive temporary power distribution as part of a touring show or for powering outside broadcast vehicles. The size of these supplies varies with venue size, and may be up to 800 A TPN.

Resilience of supplies is essential. There is an expectation that 'the show must go on', and loss of a show due to power failure is financially and reputationally damaging. Providing some UPS to protect critical systems is advisable, but full back-up generation for all the theatre systems can rarely be justified against the cost and space required for worst case loads. Sub-metering and monitoring is increasingly used to alert users early to any risk of overloading during technical rehearsals prior to a performance.

How are new and emerging technologies changing the planning of electrical installations?

There have been some recent significant changes in technology that affect the design of electrical installations for performance spaces.

Widespread adoption of LED lighting for the stage has lagged behind other sectors. It has taken time for the technology and products to develop to meet the industry's exacting requirements – smooth dimming, excellent colour rendering, full spectrum colour mixing, high output, compact size, low acoustic noise and affordability. However, LED sources are now here to stay and require cabinets of relays with switched power.

This is a change from the previous generation of thyristor dimmer racks developed for controlling power to tungsten lighting. To allow for the migration to new technologies, hybrid dimmer racks have been developed, which include dimmers and relays compatible with both future and historic luminaries. The new lighting fixtures eliminate some of the old challenges of managing the noisy low frequency triple-n harmonics associated with the chopped waveforms. However, they introduce new issues associated with having large quantities of switch mode power supply LED drivers with high inrush currents, high frequency switching noise and high leakage currents to earth, which need to be managed.

There have also been significant changes in the audio and video world. To minimise noise associated with analogue audio systems, separate low impedance earth networks (often referred to as 'technical supplies') have historically been used to eliminate noise from other equipment and manage circulating currents. For this reason, great care should be taken when works are undertaken to maintain or provide additional circuits in existing buildings.

The digitisation of professional sound and video systems over the past 10 years, coupled with a greater understanding of electrical magnetic compatibility (EMC), means that separate earth networks are no longer preferred for managing the high frequency noise present in audio and video networks. Use of a common bonding network (CBN) or mesh earthing arrangement following the guidelines of BS EN 50310 (and the related advice in Part 444 of BS 7671) is now more appropriate for most installations in order to manage the potential impact of both high and low frequency noise.

The widespread adoption of Building Information Modelling (BIM) is changing how buildings are designed and refurbished, particularly for publicly procured projects. Any change in working practices is challenging, but BIM is providing great opportunities for co-ordinating space requirements early in design and capturing the details of the electrical installation to allow future maintenance and expansion.

Why do you choose to work on theatres and performance venues?

There is no doubt that these projects can be long and challenging, but they also provide the opportunity to work with great architects, engineers and contractors. The project stakeholders almost always have great passion and vision for their new venue, and share this expectation with their cities and communities. There is a special reward when the first show opens, and satisfaction in seeing these spaces and systems that allow the audience to connect with a performer and with each other.

Performance at Stormen, Bodo, Norway ©Arup

Fairgrounds: what you need to know

You might find yourself working on fairground or amusement park installations this year. Geoff Cronshaw, Chief Engineer at the IET, gives us an overview of Section 740 of BS 7671:2008+A3:2015 – Temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses.

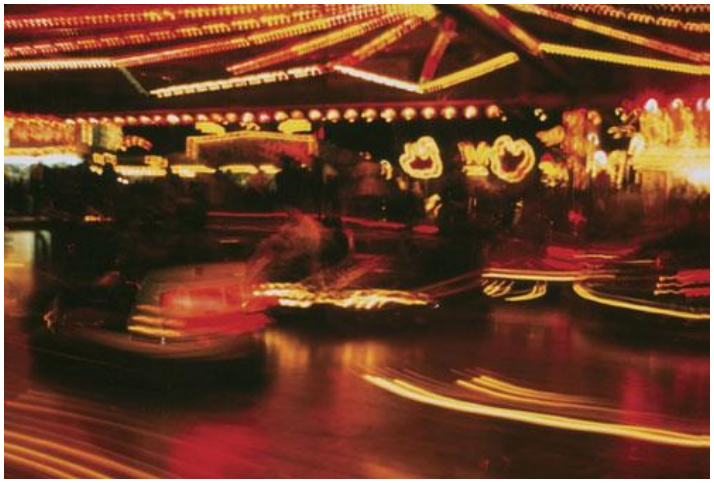
Section 740 specifies the minimum electrical installation requirements to facilitate the safe design, installation and operation of temporary erected mobile or transportable electrical machines and structures that incorporate electrical equipment. The machines and structures are intended to be installed repeatedly and temporarily, without loss of safety, at fairgrounds, amusement parks, circuses or similar places. The permanent electrical installation is excluded from the scope. Section 740 does not apply to the internal electrical wiring of the machines.

Protection against electric shock

As you would expect, the protective measures of obstacles, non-conducting location and protection by earth-free local equipotential bonding are not permitted. These measures are contained in Sections 417 and 418 of BS 7671:2008+A3:2015 and are not for general application.

The protective measures of Section 417 provide basic protection only and are for application in installations controlled or supervised by skilled or instructed persons. The fault protective provisions of Section 418 are special and, again, subject to the control and effective supervision by skilled or instructed persons.

However, placing out of arm's reach is acceptable for electric dodgems operated at extra low voltage under special conditions.



RCD protection

Automatic disconnection of supply to the temporary electrical installation must be provided at the origin of the installation by one or more RCDs with a rated residual operating current not exceeding 300 mA. The RCD shall incorporate a time delay in accordance with BS EN 60947-2 or be of the S-type in accordance with BS EN 61008-1 or BS EN 61009-1 where necessary to provide discrimination with RCDs protecting final circuits.

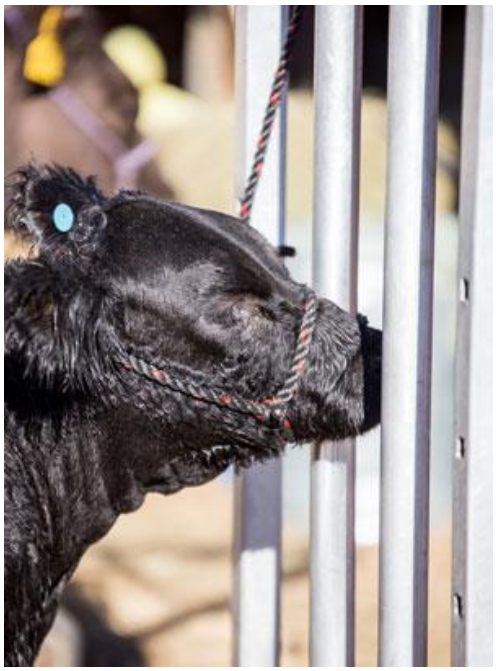
Important, please note: for d.c. installations seek advice from the manufacturer for the correct type of RCD.

All final circuits in the installation for lighting, socket-outlets rated up to 32 A, and mobile equipment connected by a flexible cable and rated up to 32 A, are to be protected by RCDs having a rated residual operating current not exceeding 30 mA for additional protection. However, there are some exceptions.

The requirement for additional protection relates to the increased risk of damage to cables within an installation of this nature.

Supplementary equipotential bonding

In addition to the general rules on protective equipotential bonding, Section 740 requires that, in locations intended for livestock, supplementary equipotential bonding shall connect all exposed-conductive-parts and extraneous conductive-parts that can be touched by livestock. There are also requirements for supplementary equipotential bonding of concrete reinforcement. See 740.415.2.1 for details.



Protective multiple earthing

Regulation 740.411.4.1 states:

A PME earthing facility shall not be used as the means of earthing for an installation falling within the scope of this section.

The Electricity Safety, Quality and Continuity Regulations 2002 (as amended) permit the distributor to combine neutral and protective functions in a single conductor provided that, in addition to the neutral to Earth connection at the supply transformer, there are one or more

other connections with Earth. This protective multiple earthing (PME) has been almost universally adopted by distributors in the UK as an effective and reliable method of providing their customers with an earth connection.

Such a supply system is described in BS 7671 as TN-C-S. Whilst a PME terminal provides an effective and reliable facility for the majority of installations, under certain supply system fault conditions (external to the installation) a potential can develop between the conductive parts connected to the PME earth terminal and the general mass of Earth. The potential difference between true Earth and the PME earth terminal is of importance when:

(a) body contact resistance is low (little clothing, damp/wet conditions); and/or
(b) there is relatively good contact with true Earth. Contact with Earth is always possible outside a building and, if exposed-conductive-parts and/or extraneous-conductive-parts connected to the PME earth terminal are accessible outside the building, people may be subjected to a voltage difference appearing between these parts and Earth.

External influences

Any wiring system or equipment that is selected and installed must be suitable for its location and able to operate satisfactorily without deterioration during its working life. The presence of water can occur in several ways, for example, rain, splashing, steam/humidity, condensation and, at each location where it is expected to be present, its effects must be considered. Suitable protection must be provided, both during construction and for the completed installation. For example, Regulation 740.512.2 states:

Electrical equipment shall have a degree of protection of at least IP44.

The IP classification code, BS EN 60529:1992 (2004)+A2:2013, describes a system for classifying the degrees of protection provided by the enclosures of electrical equipment. The degree of protection provided by an enclosure is indicated by two numerals. The first numeral indicates protection of persons against access to hazardous parts inside enclosures or protection of equipment against ingress of solid foreign objects. The second numeral indicates protection of equipment against ingress of water. More information on the IP classification code is given in IET Guidance Note 1 *Selection and Erection*.

Lighting installations

Section 740 includes a number of requirements for lighting installations and luminaires. These include requirements such as the IP rating, fixing arrangements, mounting heights, guards to prevent risk of injury to persons or ignition of materials, access requirements, restrictions on

the type of lamp holders that can be used, special requirements for neon signs, emergency switching, protection against accidental damage from projectiles (in, for example, shooting galleries), types of cable that can be used, and protection against mechanical damage. Regulation 537.6.1 gives requirements for firefighter's switches for certain types of installations.

Wiring systems

Section 740 includes requirements for protection against mechanical damage, such as use of armoured cables, types of conduit and trunking and requirements for buried cables etc. It also covers electrical connections, including cable anchorage(s), to avoid strain on terminals.

Other equipment

Safety isolating transformers shall comply with BS EN 61558-2-6 or provide an equivalent degree of safety. Electronic convertors shall conform to BS EN 61347-2-2.

When used outdoors, plugs, socket-outlets and couplers shall comply with BS EN 60309-2, or where interchangeability is not required, BS EN 60309-1. National standard socket-outlets with suitable mechanical protection not exceeding 16 A may also be used.

All generators shall be so located or protected as to prevent danger and injury to people through inadvertent contact with hot surfaces and dangerous parts. Earthing arrangements must comply with Regulation 542.1 and, where earth electrodes are used, and with Regulation 542.2. See 740.55.1 for more detail.

Inspection and testing

Regulation 740.6 requires that the electrical installation between the origin and any electrical equipment is to be inspected and tested after each assembly on site.

Conclusion

Please note that this article is only a brief overview of some of the requirements of Section 740. Please refer to BS 7671:2008+A3:2015 Section 740 for more information.