

WIRING MATTERS



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Protective bonding habits

By Michael Peace and Leon Markwell

Introduction

Over the years, the requirements for protective bonding in the IET Wiring Regulations have changed. This article expands on James Eade's November 2018 Wiring Matters article, where he touched upon some items of metallic equipment, which are usually bonded even when they are not considered to be extraneous-conductive-parts.

What is protective equipotential bonding?

Protective equipotential bonding is a method of applying a low impedance path from exposed-conductive-parts to extraneous-conductive-parts, to ensure equal potential throughout the installation thus preventing a hazardous potential difference occurring between such parts in the event of a fault.

Regulation 411.3.1.2 of BS 7671:2018 states that;

"In each installation main protective bonding conductors complying with Chapter 54 shall connect to the main earthing terminal extraneous-conductive-parts including the following:

- (i) Water installation pipes*
- (ii) Gas installation pipes*
- (iii) Other installation pipework and ducting*
- (iv) Central heating and air conditioning systems*
- (v) Exposed metallic structural parts of the building.*

Metallic pipes entering the building having an insulating section at their point of entry need not be connected to the protective equipotential bonding."

It should be noted that the list above are only examples of extraneous-conductive-parts which may require protective bonding. It must be determined whether they meet the definition of an extraneous-conductive-part before connecting them to the main earthing terminal.

What is an extraneous-conductive-part?

The definition of an extraneous-conductive-part, as defined in BS7671:2018 is:

"A conductive part liable to introduce a potential, generally Earth potential, and not forming part of the electrical installation."

Note that the description states, “not forming part of the electrical installation”. This is the main difference from an exposed conductive part, which is part of the electrical installation.

It should be noted that the term extraneous-conductive-part is hyphenated which means it is a single term which has a specific meaning. It can sometimes be difficult to determine if a metallic part meets the requirement. This can be overcome by breaking the definition into the three separate parts:

- i. a conductive part;
- ii. liable to introduce potential, generally earth potential; and
- iii. not forming part of the electrical installation.

Therefore, a metallic pipe in contact with Earth and entering the building would meet the definition of an extraneous-conductive-part, but the same metal part with a plastic insert above ground, does not.

Containment such as a ladder rack or cable tray carrying sheathed or armoured cables is unlikely to be in contact with Earth and would not require protective bonding to be applied.

What is supplementary protective bonding?

A supplementary protective bonding conductor is used to connect simultaneously accessible exposed conductive parts and accessible extraneous-conductive-parts to prevent a hazardous potential difference from occurring between them. It is usually only required in special locations, such as rooms containing a bath or shower or when automatic disconnection of the supply cannot be achieved. However, the current Edition of BS 7671(2018) allows this to be omitted, providing all of the requirements in Regulation 701.415.2 are met. The main requirements being that the circuits are RCD protected and the extraneous-conductive-parts are connected to the main earth terminal through the main protective bonding conductor.

It is likely that all the circuits within a new domestic installation supplying socket-outlets, lighting circuits and cables buried less than 50 mm from wall surfaces will be RCD protected.

Why do metallic parts get bonded if they don't need to be?

The 15th Edition of the IET Wiring Regulations (1981) has a lot to answer for in this respect. Regulation 413.7 required metal parts within the equipotential zone to be supplementary bonded to maintain the equipotential zone, where those parts;

- i. **Extract from 15th edition Wiring Regulations** *Are extraneous-conductive-parts, and*
- ii. *Are simultaneously accessible with exposed-conductive-parts or other extraneous-conductive-parts, and*
- iii. *Are not electrically connected to the main equipotential bonding by permanent and reliable metal-to-metal joints of negligible impedance.*

NOTE – *Where local equipotential bonding is provided in accordance with Regulation 413-7, metalwork which may be required to be bonded includes baths and exposed metal pipes, sinks, taps, tanks, and radiators and, where practicable, accessible structural metalwork.*

The 15th Edition definition of an extraneous-conductive-part referred to 'a *conductive part likely to transmit a potential*' hence the NOTE.

The definition was subsequently changed in the 16th Edition to 'a *conductive part liable to introduce a potential*' which means that only metal parts that are already in contact with Earth may, under certain circumstances, need to be bonded.

Existing installations with metallic parts that are bonded were probably installed to the 15th Edition of the IET Wiring Regulations.

As can be seen in the list above, there was a requirement to bond nearly everything that was metal including baths, radiators, sinks, taps, and tanks. The bonding is now not required.

The 15th Edition requirements were revised in the 16th Edition of the IET Wiring Regulations in 1991, where protective bonding is only required for extraneous-conductive-parts.

There can be other reasons why bonding is carried out, when it is not required by the IET Wiring Regulations. Sometimes it can be from a lack of understanding, for example some people install protective bonding to gas and water pipework as they believe its purpose is to protect against live parts coming into contact with the pipework, causing a voltage rise. This is not the case, there are other regulations in place which protect against this danger, this is typically covered within Chapter 52, Selection and erection of wiring systems.

In other instances, it may be a case of, we do things a particular way because we were taught to do it like that and have never questioned why.

Examples of metallic parts that are neither exposed or extraneous-conductive parts but are commonly bonded

Metallic sinks



Kitchen sinks are manufactured with a tag on the underside which is often used for connecting a bonding conductor. It is common to see the sink connected with a green and yellow cable which is linked to the hot and cold-water pipes supplying the sink. This can be seen as supplementary bonding at best, but as a kitchen is not a special location, and a kitchen sink is an isolated piece of metal so cannot introduce a potential from anywhere, there is no requirement to install supplementary bonding.

Metallic kitchen furniture



Commercial kitchens are another area where bonding is often installed but not required. Kitchen furniture is usually made from stainless steel for ease of cleaning in food preparation areas, this is often found to be bonded. This can cause issues for cleaning as the tables are usually connected together with earth clamps and cable at the feet, making it difficult to move the furniture to enable cleaning. There is no requirement in BS 7671:2018 to install bonding to metallic kitchen furniture.

Raised metal access floors



Raised access metal floors are installed to provide easy access to wiring concealed under floors. Metal tiles are installed on suspended legs which can vary in height. These support legs are often found to be bonded, connected to the main earthing terminal. Whilst the socket outlets installed in the flooring will have their own circuit protective conductors installed. The floor itself does not meet the definition of an extraneous-conductive part, therefore does not require protective bonding to be installed.

Whilst there is usually no requirement to install protective bonding to a raised access floor, because it is not an extraneous-conductive part, in certain types of installation such as heavily serviced, densely populated data centres or equipment/server rooms, there may be other requirements with regards to electromagnetic compatibility (EMC) or electrostatic discharge (ESD). However, a general office space would not meet this requirement.

Suspended grid ceilings



Similar to raised access floors, whilst suspended grid ceilings are metallic, they do not meet the definition of an extraneous-conductive-part. The luminaires will have circuit protective conductors installed but there is no requirement in BS 7671:2018 to install protective bonding to the ceiling grid.

Fuel Tanks



A separate earth rod is often seen installed at oil tanks but as the tank does not meet the definition of an extraneous-conductive-part, there is no requirement in BS 7671:2018 to provide protective bonding.

Whilst the tank itself does not meet the definition of an extraneous-conductive-part and will not require protective bonding to be installed, it is likely that the service pipe will require bonding where it enters the installation, providing that it is metallic, introduces earth potential and enters the building. The protective bonding connection is required to be located as close as practicable to the incoming point into the building, preferably within 600 mm and before any branch pipework.

However, it should be noted that there may be other requirements, for example it may be necessary for a lightning protection system to be installed to protect fuel storage tanks. This

is not covered in BS 7671:2018. This should be determined by carrying out a risk assessment in accordance with BS EN 62305.

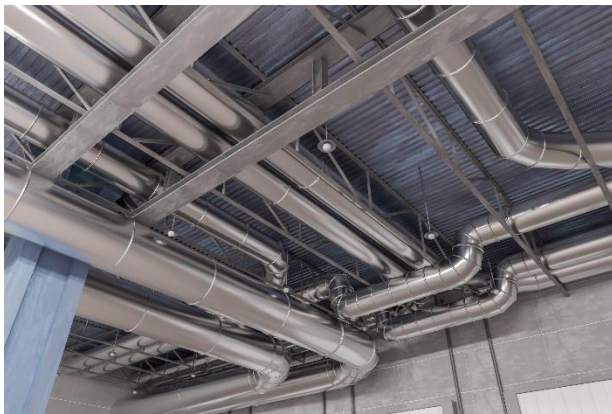
Special locations

Section 706 of BS 7671:2018 details further requirements for protective and supplementary bonding for conducting locations with restricted movement, for example inside a boiler vessel, metal tank, storage silo, a large diameter pipe or ventilation duct. Regulation 706.411.1.2 states that:

If a functional earth is required for certain equipment, for example measuring and control equipment, supplementary protective equipotential bonding shall be provided between all exposed-conductive-parts and extraneous-conductive-parts inside the location and the functional earth.

Other items

Other items which are commonly bonded that generally need not be, either with main protective bonding or supplementary protective bonding include:



- metallic pipework which is not in contact with Earth, due to incoming service pipe being made from plastic;
- metallic baths;
- metallic sinks;
- metallic HVAC ductwork;
- metallic desk frames;
- metallic doors and windows; and
- metallic cable tray and ladder rack systems.
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These items are not likely to meet the definition of an extraneous-conductive-part as they do not introduce earth potential, therefore do not require protective bonding to be installed.

Observations and hazards

It is a common misconception that bonding such items won't cause any harm even if it is not required by BS 7671:2018 so a 'better to be safe than sorry' attitude is taken. But it is important to remember that by connecting to the main earthing terminal, fault currents can be exported throughout the installation. These currents would likely not be present if protective bonding had not been applied. This could cause an electric shock risk for persons

outside of the installation in contact with the general mass of Earth and earthed equipment such as pipework or class 1 metal equipment. Each situation should be judged on its merits.

It is also sometimes argued ‘what if’ – what if the protective conductor connection to a socket-outlet in a raised floor or to a luminaire in a ceiling grid became disconnected and the item then developed an earth fault, if the ceiling or floor metalwork were bonded this would then provide extra protection against faults. It is a ridiculous argument to consider that this provides a “second line of safety” and if installations are properly maintained and regularly inspected and tested any disconnected or damaged protective conductors would be discovered and repaired.

Some manufacturers issue guidance which can be confusing, in some cases the guidance will be as simple as, bonding to be carried out in accordance with BS 7671:2018. As it is not considered to be an exposed-conductive part or an extraneous-conductive-part, there is no requirement to provide protective bonding.

Summary

Generally, there are two main reasons to connect a protective bonding conductor or circuit protective conductor to the main earthing terminal. It is either an exposed-conductive-part, which is a conductive part likely to become live under fault conditions or an extraneous-conductive-part, which is a conductive part, not forming part of the electrical installation, likely to introduce Earth potential. In normal circumstances the items listed above fall into neither category and are usually bonded due to lack of knowledge.

Thanks to ECA and Phil MacDonald for their support and contributions to this article.

An Interview with Michael Peace

The IET's newest Senior Engineer, Michael Peace, will be familiar to Wiring Matters readers as the author of last issue's article 'To Bond or not to Bond'. The IET's Cameron Fraser sat down with him, and found out more about the newest addition to the team.



How long have you worked in the electrical engineering industry?

I started my career in 1993 as an apprentice electrician, becoming qualified in 1997 and began working in the domestic and commercial environments, initially in new housing developments with a few industrial units as well. I then started my own electrical contracting business in 2001 where I employed ten electricians, mainly carrying out industrial electrical installations including PLC control system installations. After which I went to work as an electrical manager with thirty electricians and apprentices to supervise. There I was responsible for day to day management, quoting, electrical design, as well as being the NICEIC qualified supervisor

It was in this role that I caught the 'electrical design bug' if you like and started using software packages such as AutoCAD and Amtech Pro Design. I knew that I wanted to be a designer, but the problem that I had back then was lack of design experience and my City & Guilds 236 electricians qualification was not enough to apply for a role as an electrical designer. The roles which I was applying for were at consultancies where you are expected to have a degree or equivalent in electrical engineering.

It was at that stage that I decided to do a City & Guilds 2391-20 electrical design course, to get my foot on the ladder and then show that I was interested and capable in electrical design. This allowed me to knock on the door of more consultancies and show them I had experience of being an electrician AND had a design qualification, which meant I was actually more desirable than some competitors. While a lot, if not all of my competitors, had the academic qualifications to do the job, I could offer additional expertise and experience, because I had been on the ground and had the relevant hands on experience. This really turned everything around for me, and the employers appreciated that I had taken the time out to get the qualification, just to prove a point!

In 2012 I secured a role with a consultancy, as a designer, carrying out designs in the leisure, retail and education sectors. This was not enough for me as I wanted to have a formal qualification which was equivalent to a degree to recognise my commitment to the role. However, I did not have the time to commit to completing a degree in addition to full time work, but this was when I discovered that the IEng qualification would fulfil the criteria and I could gain it without a degree if I went down the technical report route. This required certain academic qualifications such as HNC and a written technical report to demonstrate competence and experience

I decided to go back to college part time and completed an HNC in electrical and electronic engineering in two years. Armed with this and the experience I had gained as an electrician and electrical designer, I decided to apply for my IEng professional registration. All that experience really lead me to here...

What would you say was the most challenging moment of your career? Would it be the training?

I wouldn't say the training but the transition part definitely, going from being an electrician on a building site to someone in an office preparing documents for those electricians, it was daunting at the start. Not just the method of working but the change of environment as well. Going from 6am until 6pm on a building site to 9am until 5pm in an office and coming home more tired, it was very challenging at the start.

And what would you say was a particular highlight?

So far, I have to say that gaining my IEng professional registration was particularly rewarding for me, it was a very important milestone in my career. It really did benefit me, and I'm not just saying that because we're sitting in the IET!

What would you say brought you to the IET?

It wasn't that I was unhappy doing electrical design, I just went in search of my dream career. I didn't mind if it took me two or three years to find it, but it was something I was keen to pursue. I sat down and thought long term about where I would really love to work, and the first place that come to my mind, when you have been an electrician following 'the book' (The IET Wiring Regulations) all your life, is here, The IET. Not for everybody obviously, but the dream job for me really was to work at the IET.

The real crux of the matter is, I wanted to improve electrical safety and make the world a safer place. Having studied and practised the Regulations since I was a young lad, there really is not a better place to do that than here at the IET.

Is there anything you would recommend to younger people looking to start in the industry?

Definitely, work towards your Chartered Engineer (CEng) status, it can open so many doors in your career, but I think my main advice to young people would be to enjoy your work. You're at work a long time and being happy in your work will make you excel naturally. Always try to learn something new every day and keep up with the forever changing requirements in the workplace, but remember, whilst the regulations may change frequently, electrical engineering principles don't.

What would you say is the biggest thing you've noticed about working at the IET?

The size and wider impact of the organisation! To me, as a young electrician, I thought it was all about the Regulations, but I now realise there's a lot more to the IET.

Can you run through your main duties at the IET?

I am Secretary to Sub-Committee A of JPEL/64, which means managing meetings, managing and understanding the technical topics and documentation and liaising with other committees. As well as this I also represent the IET at external events, such as the Elex Show (The Electrician's Exhibition).

In the future I will be attending international meetings representing the UK as an expert on various IEC and CENELEC committees, which is something that I am particularly looking forward to.

I have also been put forward to be a member of a number of external committees, such as BS 8629 which is a new British Standard for fire evacuation systems for firefighters use, intended primarily for high rise buildings. Previously, I had actually written my own 'fire blog', trying to detail my own observations of shortfalls in the industry following on from the tragic incident at Grenfell. I detailed what I thought could be new protocols and procedures for fire evacuation, including ideas for new evacuation systems, and when I started at the IET I was invited to be part of the committee responsible for producing the British Standard in this area, which is a huge privilege. Dissemination of information is a huge part of my job, which of course includes writing articles for the IET Electrical website and Wiring Matters!

How has the industry changed since you started?

Whilst electrical engineering principles haven't changed over the years, the products have evolved, requiring the Regulations to adapt. Micro-generation and electronic equipment, all of which present new challenges to the electrical installer and designer.

What areas do you think are going to develop the most in the next few years?

Short term, EV charging, connected environment and energy conservation will be massive in the future. I think we've got huge challenges coming up in the next few years with EV charging, which we haven't come across yet. Basically we just don't have the infrastructure in place or enough power to charge all of them up, especially at the same time of day!

Are there any technologies you are particularly excited about at the moment?

I am really looking forward to the introduction of autonomous vehicles, the sooner computers are driving our cars the safer our roads will be, and that's a fact! Yes, computers will make one in one million mistakes, but a human will do it several times on every journey! Deaths and accidents on the roads are dropping, but it's still something like 2000 a year, and when you consider how few incidents we have with electricity for example, it puts it into perspective. Also, this is not something that's in any way new, but I do think it's being underused, and that's Building Information Modelling (BIM). If you're familiar with 2D drawing packages, the next step is an intelligent 3D drawing tool. When completed, a BIM drawing is actually a database which will hold all the relevant details of the building construction and the installed items of equipment. For example, if you need to know the make and model of a particular luminaire you can instantly print out a full schedule of installed luminaires to facilitate maintenance. It's a brilliant tool for coordinating across different trades, from concept, through construction to facilities management. I understand that initially it can be a time-consuming process, as it is a very different way of working compared to traditional 2D drawings with plan views, sections and elevations but once this is overcome, the advantages are massive. I think it will be adopted more eventually, it's just taking longer than initially predicted, probably due to the associated costs.

What type of articles are you thinking of writing for us in the future?

I would like to keep it topical, I don't have a predetermined type of article that I would like to write, I want to see what the industry is unsure about and answer those questions. I enjoy the subject of earthing, I think I could write an article about it every week for the rest of my life and there would still be questions to be asked about it, so I'm sure there will be more about that. What I like to do is hear from electricians, to find out what they are wanting to know so I really do welcome any suggestions.

To sum up, do you have any final advice?

Don't be afraid to put your hands up when you have made a mistake. Making mistakes is part of becoming an Engineer, it's how we deal with them and learn from it to prevent it happening again that really matters.

If you would like to email Michael with suggestions for articles, or you have a query you think needs addressing, contact us here at Wiring Matters



Latest developments in International Standards for supplies for electric vehicles.

by Geoff Cronshaw

In this article we look at some of the international standards for electric vehicle charging.

HISTORY.

Work on the 1st edition of IEC 60364-7-722 was initiated back in 2009 (10 years ago) and the first edition was published in February 2015. This was developed to answer the needs of the EV market in term of safety of supply of EVs installations , reliability and proper functioning of the supply. It was developed with the aim to provide specific requirements for electric vehicle supplies and to help low voltage installation design.

Work on a second edition started in 2015 and the second edition was published in September 2018. This second edition includes a number of significant changes to keep pace with the progress of electric vehicle charging.

MAIN CHANGES IN LATEST EDITION OF IEC 60364-7-722

Protection against electric shock.

Clarification of the requirements regarding the protective measure placing out of reach has been included in order to allow the use of pantographs in areas accessible to the public.

Wireless power transfer

In addition IEC 60364-7-722 Edition 2 recognises wireless power transfer (WPT) systems for EVs and requires compliance with the appropriate parts of the IEC 61980 series. Part 1 (general requirements) gives a list of possible WPT technologies. These are new and emerging technologies. Possible technologies include:

- Inductive power transfer - Energy transfer through magnetic field (MF-WPT)
- Capacitive power transfer - Energy transfer through electric field (EF-WPT)
- Microwave power transfer - Energy transfer through electromagnetic waves 1 GHz – 300 GHz (MW-WPT)
- Infrared power transfer - Energy transfer through electromagnetic waves 300 GHz – 400 THz (IR-WPT)

It is expected that future Parts of IEC 61980 series will cover specific requirements. For example Part 2 will cover communication between electric road vehicle (EV) and wireless power transfer (WPT) systems including general background and definitions.

A future Part 3 will cover specific requirements for electric road vehicle (EV) magnetic field wireless power transfer (MF-WPT) systems including general background and definitions (e.g. efficiency, electrical safety, EMC, EMF).

As you would expect the technical requirements for the various wireless power transfer (WPT) technologies are very different, and therefore the particular requirements for each technology will be dealt with in a specific part of the 61980 series.

EV operating as a source in parallel with other sources

In IEC 60364-7-722 Edition 1 it was stated that feeding back electricity into the supply network was under consideration. The new standard (IEC 60364-7-722 Edition 2) introduces requirements covering the case where the EV may operate as a source in parallel with other sources and states that where electric vehicles are intended to feedback energy to the electrical installations, the requirements of IEC 60364-8-2 apply. However, it's important to note that IEC 60364-8-2 is under preparation and that the requirements for these circuits are under consideration.

Overvoltage control.

IEC 60364-7-722 Edition 2 now makes it clear that a connecting point accessible to the public is considered as part of a public service. Therefore this means it must be protected against transient overvoltage's, as clause 443.4 of IEC 60364-4-44 states that protection against transient overvoltage shall be provided where the consequence caused by overvoltage affects public services.

CHARGING MODES.

IEC 60364-7-722 Edition 2 makes reference to IEC 61851 (Electric vehicle conductive charging system). IEC 61851 describes the charging modes.

Mode 1 charging. Connection of the EV to the AC supply network utilizing standardized socket-outlets not exceeding 16 A and not exceeding 250 V AC single-phase or 480 V AC three-phase, at the supply side, and utilizing the power and protective earth conductors.

According to a note in IEC 61851 Mode 1 charging is not permitted in the UK.

Mode 2 charging. Connection of the EV to the AC supply network utilizing standardized socket-outlets not exceeding 32 A and not exceeding 250 V AC single-phase or 480 V AC three-phase, at the supply side, and utilizing the power and protective earth conductors together with a control pilot function and system of personnel protection against electric shock (RCD) between the EV and the plug or as part of the in-cable control box.

IEC 61851 points out that socket-outlets and plugs designed for household and similar use might not be designed for extended current draw or continuous use at maximum rated currents and might be subject to national regulations and standards for supply of energy to an EV.

Generally Mode 2 is the minimal charging solution for single phase domestic socket-outlets. It usually provides charging currents of 10A or less.

Mode 3 charging. Connection of the EV to the AC supply network utilizing dedicated electric vehicle supply equipment where the control pilot function extends to control equipment in the electric vehicle supply equipment, permanently connected to the AC supply network.

IEC 62196-2 gives details of vehicle inlet and vehicle connector Type 1 and Type 2 and Type 3 for Mode 3 charging. A mechanical or electromechanical means must be provided to prevent intentional and unintentional disconnection under load of the vehicle connector and/or plug according to IEC 62196-1.

Mode 3 recognises various levels of charging currents. A typical Type 2 Mode 3 charging point could be 32 Amp (7.2 kw).

Mode 4 charging. Connection of the EV to the AC supply network utilizing an off-board charger where the control pilot function extends to equipment permanently connected to the AC supply. A mechanical or electromechanical means must be provided to prevent intentional and unintentional disconnection under load of the vehicle connector and/or plug according to IEC 62196-1.

One of the advantages with mode 4 charging is that it can provide fast high power charging. When charging a vehicle from an AC output charge point the charging power is often limited by the on-board battery charger of the electric vehicle. With (Mode 4) DC charging, DC power is provided directly to the battery system and is not limited by the on-board battery charger of the electric vehicle.

Therefore, mode 4 charging appears to be suited for use at motorway services, shopping centres, and busy urban areas where a fast charge is required to minimize charging time.

CONCLUSION.

This is only a brief overview and highlights some of the key changes in the new IEC standard. For more information refer to IEC 60364-7-722 Edition 2.

Important: please note these are requirements at international level (world standards) which may or may not be incorporated in BS 7671 in the future.

Elex Show by Shamsul Jaifrey



See the IET on stand E56 at Elex Tradeshow, Coventry – 19th & 20th September

As an electrician it is now more important than ever to stay up to date with the latest information and regulations within the industry. Following the Harrogate Elex tradeshow, show sponsors the Institution of Engineering and Technology (IET) are heading to Coventry on the 19th & 20th September.

At the event the IET experts will host industry forums on hot topics from the 18th Edition IET Wiring Regulations, covering topics including Earthing and Bonding and Electrical Vehicles which will be packed with practical information and guidance.

Our team of experts will also be on hand to answer any technical questions that you may have during the two days.

Take advantage of show discounts on the 18th Edition, expert guidance, digital e-book packages and IET Academy e-learning courses

18th Edition Wiring Regulations & expert IET guidance

Make sure you have the latest copy of the 18th Edition Wiring Regulations (BS 7671:2018), the national standard to which all electrical installations should conform. Get discounts on BS 7671, the popular On-Site Guide and Guidance Notes series, directly from the IET stand. Free demos of the digital Wiring Regulations are also available.

Academy Courses

The IET has partnered with industry to provide expert online e-learning courses covering the field of electrical installation from BS 7671:2018 to LED lighting and EV charging. The e-learning platform offers flexible training that fits around your work, offering interactive course content that helps embed your learning.

Registration for Elex is free. Visit www.elexshow.info to find out more.

Crabtree: 100 years of safety remembered and celebrated.



Crabtree began on 17th April 1919 when John Ashworth Crabtree designed a quick make and break switch.

Marking this momentous occasion, members of the Crabtree family flew to the UK to attend a special memorial service in Walsall on Crabtree's Centenary and were joined by colleagues past and present for a gala evening to celebrate the brand's history. Colleagues also held special events with customers throughout the country.

Mike Cash, Group Marketing & Channel Manager at Electrium commented: "Throughout the year we're encouraging customers to share their memories of Crabtree. From using our products as an apprentice, up to the work they still do with Crabtree, simply tweet @electriumnews and use #CrabtreeCentenary to share your story."

When it launched in 1919, Crabtree had a motto: "That which is built soundly endures well". It was inscribed into the company plaque and rightly so. Crabtree was built soundly enough to provide 100 years of electrical safety to its customers and here's to another century of the same.

For more information please visit www.electrium.co.uk/crabtreecentenary