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summer 2015

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Update on electric vehicle charging equipment installation requirements

Paul Bicheno, Publishing Manager of the *Code of Practice for the Installation of Electric Vehicle Charging Equipment*, explains the updates made to the Code of Practice – and what you need to know to ensure that you are fully compliant with the latest regulations.

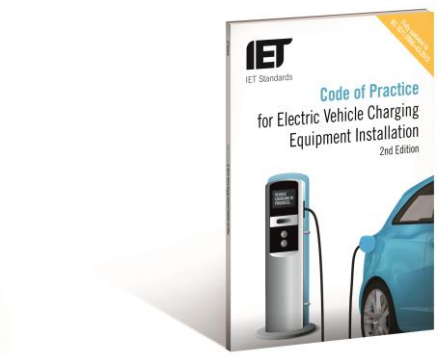
As recently as October 2014, the electric vehicle industry was looking healthy, with the Guardian reporting that the sales growth of electric vehicles outperformed petrol and diesel counterparts. This is despite figures released by the Department of Transport in their report, Public Attitudes to Electric Vehicles, published in June 2014, which indicated a fairly low public interest in electric vehicles. It seems that the general public are still hesitant about considering electric vehicles as a viable method of transport.

However, with the Office for Low Emission Vehicles (OLEV) plug-in grant scheme in full swing and the number of electric vehicles in the UK passing the 13,000 mark last year, it seems hopeful that this industry is becoming more familiar to buyers and common sense dictates that this will be a necessary area of potential growth in the future.

BS 7671:2008 now contains regulations for the installation of electric vehicle charging installations. These were introduced in September 2013 as a separate Amendment No. 2. However, these requirements are now incorporated with Amendment No. 3 that published in January.

Amendment No. 2 introduced requirements of a new Part 7, namely Section 722 Electric Vehicle Charging Installations. This means that anyone planning to install electric vehicle charging equipment will need to comply with these specific requirements, which can be summarised as follows:

- introduction of new definitions relating to various ‘modes’ of charging arrangements and connectivity terminology for an electric vehicle;
- the need for a dedicated final circuit for a charging point;
- due to the type of load, there is no diversity allowed when considering the demand unless load management is used;
- introducing restrictions on the use of particular protective measures;
- specific requirements when connecting a charging point to a Protective Multiple Earth (PME) arrangement if located outdoors or if a vehicle could be reasonably expected to be charged outdoors;
- requirements for the use of particular types of Residual Current Devices (RCDs); and
- requirements for suitable socket-outlets and connectors.



In early 2012, IET Standards published the *Code of Practice for the Installation of Electric Vehicle Charging Equipment*. This provided those interested in specifying, procuring, installing or managing electric vehicle charging equipment with essential guidance on various general considerations and technical requirements that needed to be complied with. This preceded the publication of Section 722 in Amendment No. 2, so the Code of Practice has now been updated (see Code of Practice for Electric Vehicle Charging Equipment Installation 2nd Edition) to ensure it reflects the above listed requirements of Section 722. The opportunity has also been taken by the Energy Networks Association (ENA) to improve the notification process included in the Code of Practice. The impact of the required changes can be summarised as follows:

- Section 2 has been updated to describe the specific requirements of socket-outlets, connectors and cables relevant to the various charging modes;
- Section 4 has been updated to align to the requirements for the height of controls and socket-outlets;
- Section 5 has been updated to describe the key requirements for the various defined electrical systems commonly used, including the specific requirements associated with connecting to a PME arrangement. This section also includes updates on the requirements for dedicated circuits and residual current devices (RCDs);
- Sections 6, 7 and 8 have been updated to align with the electrical installation requirements applicable to dwellings, on-street locations and commercial and industrial premises respectively;
- Section 10 has been updated at the request of the ENA to improve the notification process of charging equipment installations to the Distribution Network Operators (DNOs); and
- The various Annex checklists have been updated to align to the above changes.

As mentioned above, OLEV has a series of electric vehicle charging equipment installation grant funding schemes. Anyone wishing to take advantage of this funding will need to ensure they are compliant with the updated requirements of both BS 7671 and the Code of Practice. Further information is available online.

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Low and extra low voltage direct current power distribution in buildings

Blane Judd – Chair of the IET Standards Technical Committee 2.4 DC Power Systems responsible for developing the new IET *Code of Practice on Low and Extra Low Voltage Direct Current Power Distribution in Buildings* – writes about the growing significance of low and extra low voltage d.c. power distribution in buildings.

Introduction

As energy costs continue to rise, the pressure is increasing on engineers to make use of new and innovative solutions and alternative energy sources to power buildings. In order to respond to this demand engineers now need to take a more integrated approach to energy efficiency, looking to find opportunities to apply engineering solutions to existing innovation.

Low (and extra low) voltage d.c. power distribution infrastructure

The myths and misunderstandings – and even disagreements! – over the use of a.c. or d.c. for power distribution are deep-rooted, perhaps dating back to Edison, Tesla and Westinghouse. But, with increasing d.c. powered loads in building services (for example, in LED lighting circuits, portable device charging, access and security systems, or environmental control) and with almost every office desk now hosting several, often extremely inefficient, transformer/rectifier units (contributing to localised heating of the working space through I^2R losses), clients are looking to reduce power conversion losses without compromising performance or functionality while increasing the number of low voltage (LV) and extra low voltage (ELV) d.c. powered systems.

Dedicated d.c. power distribution infrastructure is emerging as a popular solution to this challenge, one with both standardised and proprietary approches that need to be appropriately managed. This concept is being adopted globally – for example through IEEE standards, or those under development through the EMerge Alliance – and it is therefore vital for UK professionals to have access to high-level knowledge that will prevent the UK from being left behind.

Standardised and proprietary solutions

One important consideration is the difference between standardised and proprietary solutions. The trend towards d.c. power distribution has been based, in part, on the use of telecommunications cabling infrastructure, which was not initially designed or installed for the

delivery of power. As a result, there is a need to understand how to control provision of power over legacy cabling as well as the design of future installations. This is particularly important as much of the growth in this area is based upon the attachment of remote internet-protocol (IP) enabled devices, providing separated extra-low voltage (SELV) circuits, which are compliant with IEEE 802.3 – generally termed power over ethernet (PoE) circuits – that are evolving to increase the power level delivered over each cable.

It is critical to note that not all the implementations of ELV d.c. power distribution over telecommunications cabling infrastructures adopt the IEEE solutions. Some of these implementations are clearly proprietary but use power levels lower than those of the IEEE specifications, while others claim compliance but deliver power levels significantly in excess of those specifications. As a result, greater awareness needs to be applied in such circumstances, in relation both to the cabling and to the devices supplying and receiving the power.

Heating effects

While investigations into the heating effects of power delivery over telecommunications cabling infrastructures have been undertaken in accordance with the recognised structured (or generic) cabling standards (i.e. the BS EN 50173, ISO/IEC 11801 and ANSI/TIA-568 series), not all cables used in telecommunications cabling infrastructures are compliant with these standards and so these may experience significantly higher than expected temperature rises for a given level of current. In addition, some powering solutions use cabling infrastructures that are of proprietary design (i.e. not standards-based) but that are installed explicitly for the delivery of power using d.c. within the ELV or LV bands (for example, provision of 380-400 V d.c. supplies to equipment within data centres), while certain solutions employ existing mains power supply cabling converted to d.c. distribution.

The IET d.c. Code of Practice

The new IET *Code of Practice on Low and Extra Low Voltage Direct Current Power Distribution in Buildings* has been scoped and developed with an expert panel drawn from industry, academia and government, with the aim of helping to dispel many of the myths that have emerged about using LV and ELV d.c. power distribution. It aims to provide engineers, technicians and technical managers with an opportunity to engage constructively with d.c. power systems to achieve benefits such as integrated management of services, reductions in energy consumption and improvements in energy efficiency.

The Code of Practice sets out the requirements for the design, specification, selection, installation, commissioning, operation and maintenance of LV/ELV d.c. power distribution in buildings. It considers d.c. installations using telecommunications cabling, d.c. wiring or existing a.c. wiring infrastructure, including standardised solutions (such as PoE) as well as proprietary approaches for d.c. power distribution.

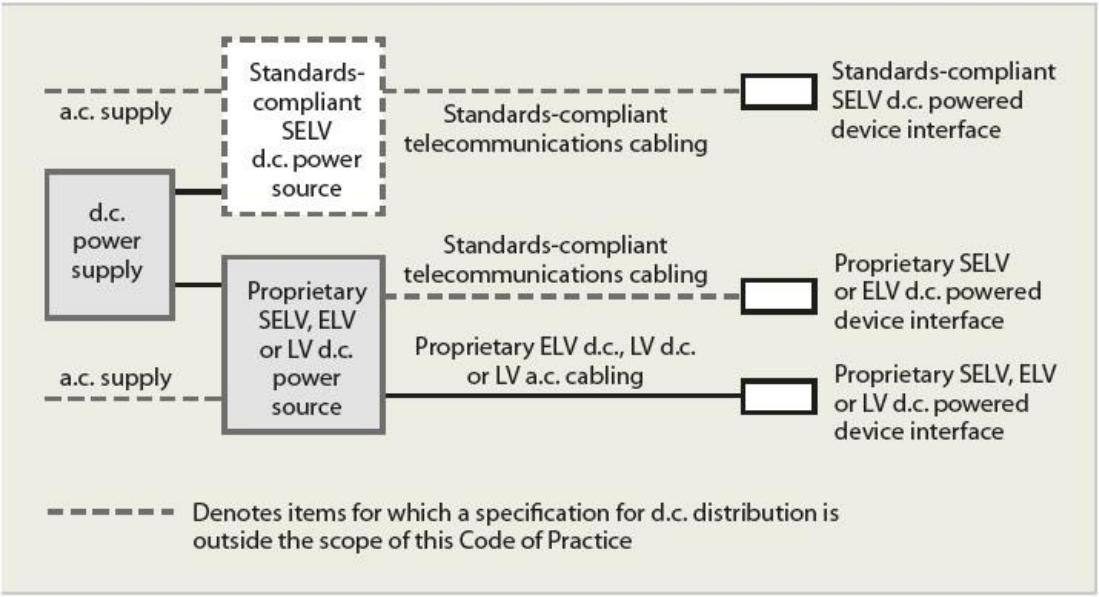

Figure 1: Schematic showing items within the scope of this Code of Practice (reused from the *Code of Practice on Low and Extra Low Voltage Direct Current Power Distribution in Buildings,* © The Institution of Engineering and Technology)

Next steps

While the d.c. Code of Practice provides a strong start as the first consensus standard for use of d.c. infrastructure in buildings, there remain issues to be considered in the wider market, including around awareness, education (informed users) and supply chain development, i.e.:

- product availability (including relevant test/certification protocols) and costs – given that quality assurance will remain a key determinant of the future uptake of technologies at scale;
- customer education and raising awareness around the benefits that d.c. power systems can offer; and
- workforce competence (including training/certification) in the use of d.c. power systems – moving beyond specialist skills to build wider industry capability and market confidence.

In particular, electricians and installers need to understand the key differences between a.c. and d.c. systems, including such points as:

- disconnection under load;
- identification of conductor and wiring;
- Electro-magnetic Compatibility;
- d.c. termination;
- use of appropriate LV d.c. and/or ELV d.c. switchgear and protective devices; and
- understanding who has overall responsibility for the installation.

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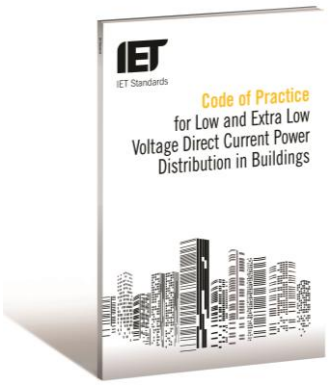
Further information



To learn more about d.c. power systems, why not attend the d.c. Code of Practice launch event – *Low Voltage Direct Current: Powering energy demands in our digital world* – which will be held on 18th June 2015 in London. Please visit: www.theiet.org/lvdc for more information.

For more detail on the *Code of Practice for Low and Extra Low Voltage Direct Current Power Distribution in Buildings*, due for publication in May 2015, please visit: www.theiet.org/dc-cop.

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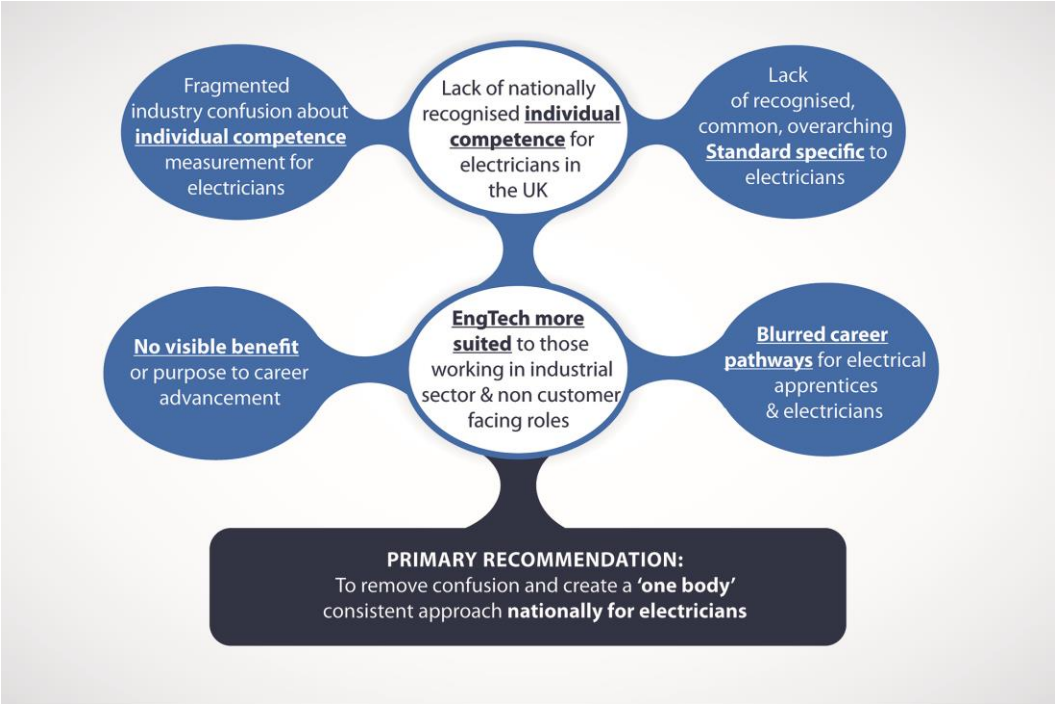
IET-Employer Leeds workshop: individual competence and accountability

More than 45 technical professionals from local authorities, housing associations and electrical contractors joined the IET and the Engineering Council (regulator of the engineering profession) in April this year for a discussion workshop that focused on the individual competence and accountability of electricians.

Background

In summer 2013, the IET commissioned national research with electricians and employers, which provided key findings and insight.

These findings were discussed at the 2014 Leeds IET-Employer workshop and included:



Summary feedback from the initial 2014 Leeds IET-Employer workshop concluded the need for the introduction of:

- a national, rigorously applied Standard for electricians;
- a public register for electricians that includes:
  - Electrician Professional Award entry to the register;
  - professional competence regulated by the Engineering Council; and
  - current competence annual return to the IET that is audited.
- a protected title for electricians awarded as a mark of:
  - individual competence differentiation;
  - electrician professional recognition;
  - peer reviewed competence assessment; and
  - national public awareness of a competent electrician.

In March 2014, the Communities and Local Government Select Committee published a report, *Building Regulations certification of domestic electrical work*. This report raised concerns about the competence of those actually carrying out electrical works in domestic premises. Their recommendation emphasised the need to raise the competence and qualifications of those persons carrying out the work.

The April 2015 IET-Employer workshop

At the April 2015 IET-Employer workshop, local authorities, housing associations and other representatives discussed the findings from the 2014 workshop and shared their concerns about the competence of the individuals actually undertaking electrical installation, maintenance and remedial works in UK properties (highlighting the need for a stronger focus on individual competence), accountability and annual continuous professional development (CPD) recording and monitoring by electricians.

Many noted that the continual increase in rework and unplanned costs are a main concern, some of which relates to individual competence of those undertaking the actual work. Some of the representatives have already taken part in the Communities and Local Government Select Committee ongoing investigation.

Ryan Dempsey, Electrical Service Manager, Leeds City Council, was instrumental in co-ordinating the 2014 and 2015 IET-Employer workshops. He is passionate about the competence of electricians as well as annual CPD that is audited by a recognised body. After the April workshop, Ryan said:

"We're taking positive steps towards a register that not only provides a higher level of assurance to employers, but also gives our industry and those aspiring to be an electrical engineer the ability to continuously develop their skills, knowledge, experience and overall professional development.

The recent workshop in Leeds confirmed that there are various levels of competence and that this creates ambiguities when managing the lifecycle of electrical installations. Every Landlord should be confident that the work being carried out in and around their asset is of a guaranteed level of quality. I believe peer reviewed individual competence and professional recognition is something that would help achieve this".

The Engineering Council's CEO, Jon Prichard, attended the April 2015 workshop and provided further information about the role of the regulator, as well as further understanding about individual competence, peer reviewed assessment for professional registration qualification(s) and the Engineering Council's competence framework UK SPEC. The group welcomed the involvement of the regulator at the workshop.

Next steps

The IET will be collating further insight from electricians (qualified to NVQ Level 3 or equivalent with +3 years on the job experience) and employers of electricians during 2015 to further address the key points raised at the 2015 workshop. A key focus for the ongoing work relates to the individual competence and accountability of electricians.

The employer group, led by Ryan Dempsey and Michelle Richmond, Director of Membership and Professional Development at the IET, will continue with the ongoing work, with a view to introducing specific professional recognition for electricians.

How can you get involved?

The IET is planning further research this year about individual competence of electricians. If you would like to take part, please register your interest by emailing: electechs@theiet.org

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Guide to how BS 7671 is updated

Nicole Whitton explains the process behind the updates made to BS 7671 and how you can get involved.

The world's electrotechnical standard-setting body is the International Electrotechnical Commission (IEC). They publish the international series of standards, which has a designated reference IEC 60364 *Low voltage electrical installations*. The European Committee for Electrotechincal Standardization, CENELEC, is the European standard-setting body and is responsible for adopting IEC 60364 standards, either as an identical or amended publication, as well as developing European-only applicable requirements. These are published as a series of standards with the designated reference of HD 60364 *Low voltage electrical installations*.

Finally, the British national standards body is BSI (British Standards Institution). BSI and the IET jointly publish BS 7671, which is primarily based on the IEC and CENELEC *Low voltage electrical installations* standards. A committee of experts from the electrotechnical industry is responsible for the maintenance and updating of BS 7671, taking into account the new and amended international and European standards. This committee is referenced JPEL/64.

('J' stands for 'joint' (as in, the committee is jointly run by BSI and IET). 'P' stands for 'power' (as in power generation). 'EL' stands for 'electrical' (as in the electrotechnical industry) and '64' relates to the number allocated by IEC and CENELEC to their electrotechnical committees producing the 60364 series of standards into which JPEL/64 provides the UK input.)

Who makes up JPEL/64?

JPEL/64 should be representative of the UK's electrotechnical industry, so members are carefully selected on the basis of their experience as well as the organisation that they represent. Each new regulation or modification is only made once all views from the committee have been considered.

Committee members come from various backgrounds, including representatives from the Health and Safety Executive (HSE), manufacturers of electrical equipment, competent person scheme providers, training bodies and many more.

Debbie Stead from BSI summed up the process:

"The development of a new standard or a revision or amendment to an existing standard is undertaken by the responsible technical committee. Technical committees consist of organisations with an interest in the standard. The organisations nominate individuals to represent the wider views of that organisation and it is the expectation that the individual consults with the organisation they are representing to obtain views from other members and comes to the technical committee with a single view."

When is the next set of changes to BS 7671 expected?

Because of the complex relationship between BS 7671 and international/European standards, changes for this standard are batched into an amendment or new edition and usually occur every 3 years.

Work on the third Amendment to the 2008 version of BS 7671 (i.e. BS 7671:2008+A3:2015) was completed in December 2014, published in January 2015 with an implementation date of 1st July 2015.

The next update to BS 7671 is expected in 2018.

How can you keep updated?

For BS 7671, the committee constitution is in the public domain together with its work programme: http://standardsdevelopment.bsigroup.com/Home/Committee/50001574.

You can submit information relating to the work being undertaken through any of the nominating organisations of which you may be a member. In addition, there are currently two public commenting systems available for individuals to provide their input. All standards, revisions and amendments are issued for public comment.

For proposals for new work, please see: http://standardsproposals.bsigroup.com/.

For drafts out for public comment, please see: http://drafts.bsigroup.com/.

Once a standard is published, and indeed at any time during the lifecycle of the standard, comments can be submitted to the Secretariat which will then be passed to the technical committee for consideration.

We will also be introducing more regular technical updates related to BS 7671, written by Mark Coles, Technical Regulations Manager at the IET, and other members of the IET's Technical Regulations team where appropriate. These will keep you informed about technical issues, although it cannot go into the specific details about what happens inside committee meetings. The aim of these updates is to better prepare you for the next round of amendments to BS 7671.

The IET is preparing to publish a Student's Guide to the Wiring Regulations, available later in 2015. The Student's Guide to the Wiring Regulations covers, amongst other areas that are beneficial to students, the standard-setting process and the committee in more detail.

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JIB Apprentice Exchange winner announced

Twenty-five year old Samantha Jones has been named winner of the 2015 Apprentice Exchange Programme, organised by the Joint Industry Board (JIB).

Employed by Melvin John Electrical in Coleford, Gloucester, Samantha will fly out to the United States in May and spend six weeks living and working in New York. During her trip she will learn how electrical contracting works in the US and will act as an ambassador for the UK industry.

The selection process involved a shortlist of six potential applicants taking part in a challenging interview. Samantha impressed judges with her preparation, confidence and existing commitment to promoting the industry.

“For such a young woman, Samantha’s achievements to date are impressive, including from her work with JTL as an ambassador promoting the role of women in the construction industry and with the NICEIC in their “Jobs for the Girls” campaign,” said Ivor Williams, chairman of the JIB’s Further Education Committee.

“Samantha is a confident and knowledgeable apprentice who will only excel within the industry and I have no doubts will be a fantastic ambassador in New York,” he continued. “She was selected from a particularly strong group of apprentices at interview, which is a great achievement in itself, and certainly bodes well for the calibre of future operatives in the industry.”

Commenting on her win, Samantha said: “I am very much looking forward to my new overseas ambassador role, to experience travelling to another country, to work in a different environment, to experience the differences in work ethic, training and installation methods and to bring back positive and negative feedback, which could help the industry standards in this country. It’s also going to be very interesting to see at what level women are engaged within the electrical industry.”

During her trip Samantha will be writing a blog and uploading pictures of her adventures.

The 2015 exchange is a tripartite programme that will also see an Australian apprentice visit England later this year and a New York apprentice travel to Australia. The scheme is being run by the JIB in conjunction with training provider JTL, the Electrical Contractors’ Association and Unite the Union.

What is the JIB apprentice exchange programme?

The JIB apprentice exchange programme was set up by the JIB’s Further Education Fund Committee to help address one of its aims: ‘to enhance individuals’ learning through cultural exchanges’.

When a delegation from Australia visited the JIB in 2008 the idea of an apprentice exchange was proposed, and the inaugural exchange was in 2010 when Shona Rawlins went to

Queensland for 6 weeks. Two further apprentice exchanges have taken place since then, with Thomas Hyland of Balfour Beatty also travelling to Australia in 2013, whilst Luke Wheeler of SPIE Matthew Hall completed his exchange programme in New York in 2012.

Get involved

If you're interested in taking part in future apprentice exchanges, you must be a JTL apprentice and a member of Unite the Union. Your employer must also be an ECA and JIB member.

For the application process, the apprentices are endorsed by their employers but also by their JTL Training Officers. JTL actively seek the best performing apprentices and provide them with recommendations. These are the apprentices with consistently high scores and who are particularly eager and committed.

What do the judges look for?

The apprentice must be in the 3rd or 4th stage of their apprenticeship, so they will be undertaking their portfolio building and/or AM2 assessment. In general, the apprentices that do well are those at the later part of Stage 4. Samantha, for instance, will be a graded electrician by the time she is in New York. As long as the apprentice is Stage 3 or Stage 4 at the time of applying they will be considered.

As well as asking the candidate why they would be suitable for the exchange, they are also asked to provide insight into their views as to how the industry could be improved. The answers to these questions, along with the employer endorsement and the training officer's endorsement, are the basis for selecting those to take to interview.

The judges look for apprentices who are achieving high standards in their apprenticeship, are confident in their presentation, knowledgeable about the industry (and the organisations that operate within it), are intelligent in their answers, eager and willing to learn (as many of those will also be undertaking additional higher certificates alongside their apprenticeship).

At present there is no set date for the 2016 apprentice exchange but if you're interested in applying, follow JIB on Twitter @JIBElectrical and you'll receive news alerts on when the next application process is open.

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Energy efficiency, the IET Wiring Regulations and future 'smart' installations

Bill Wright, Head of Energy Solutions at the Electrical Contractors' Association and member of the JPEL/64 committee, writes about what we might expect on energy efficiency in the 18th edition of BS 7671.

A new Standard: IEC 60364-8-1

The IET Wiring Regulations, BS 7671, are primarily concerned with the safety of electrical installations. They do not cover how to design an electrical installation in an energy efficient manner. It is left to the designer and client to define how efficient an installation should be and what energy efficient products could be used in the design. The market for energy efficient products is growing as the cost of energy has increased over the years and energy efficient transformers, motors and other equipment are increasingly specified either by the customer requiring an efficient installation, or by regulation. In the current version of BS 7671, the section that comes nearest to requiring an energy efficient installation is Chapter 33, Compatibility.

The International Electrical Commission decided that a new part to the regulations was required to fill the gap. The result is a new Standard – IEC 60364-8-1*, Low Voltage electrical installations Part 8-1 Energy Efficiency*, which is available now. There is a view that this will become part of the 18th Edition of BS 7671.

The specifics about IEC 60364-8-1

IEC 60364-8-1 is unique in that it allows an installation to be specified as to how electrically efficient it is, not how it is operated. It gives guidance on all aspects of the design, including, for example, the position and type of transformer when supplying a load in a building and the sizing of cables for efficient transmission of power. Other installation equipment, such as PFCs (power factor correction), can also be specified in various formats and an 'Efficiency Code number' can be produced, which indicates the level of efficiency that is specified. A code EM0 would indicate that efficiency has not been taken into account in the design of the installation while a code EM4 would show that the installation is designed with maximum energy efficiency.

For instance, when sizing a cable do you design for the less expensive option of specifying the smallest cable possible to meet the load or would you specify the cable size that would have the smallest losses? If the cable is long and supplying a constant high load it may well be more cost effective to up size the cable to minimise losses. The capital cost may be higher but the long-term running costs could substantially outweigh the capital savings. This brings back the old argument of the cost of building versus the operational cost over the lifetime of the installation. Using IEC 60364-8-1, the client or specifier could specify that they require level EM4 for wiring systems.

IEC 60364-8-1 covers the following areas of an installation and defines the level of efficiency from EM0 (no consideration given) to EM4 (optimised system):

- Load Profile
- Location of main sub station

- Motors
- Lighting
- HVAC equipment
- Transformers
- Wiring system
- Power factor correction
- PF measurement
- Power measurement
- Voltage Measurement
- Harmonic measurement
- Renewable Energy

There are also Energy Efficiency performance levels classified EEPL0 to EEPL4 in in a number of categories, including:

- annual consumption splits between various loads;
- transformer efficiency; and
- power factor.

Each category is marked EM0 to EM4 and given points, so a level EM4 gets 4 points. The total points for the system can then be calculated. The totals of all these are then classified by giving them an Energy Installation Efficiency Class (EIECO) where EIECO is less than 16 points in total (i.e. virtually no energy efficiency measures applied) to EIEC4, which is between 48 and 58 points, showing that many measures have been applied.

This is the first Standard to include efficiency measures applicable to electrical installation and from both a specifier's and an installer's point of view could prove useful in clarifying the measures that should be taken. Applying basic Part L Building Regulation measures will give a degree of efficiency but IEC 60364-8-1 takes this further. It is hoped that IEC 60364-8-1 will be incorporated into the 18th edition of the IET Wiring Regulations (BS 7671) when it is published in a few years' time.

What's next?

There is another Standard following on from this, IEC 60364-8-2, which is nearing completion and which includes the concept of smart electrical installations, the use of control systems such as BEMS (building energy management systems) in the control of loads, the integration of renewable energy sources and storage devices and their associated protective devices into installations. Whether this will be included in the 18th edition of BS 7671 has yet to be decided.

What of the future? Energy efficiency is going to have a higher profile than it has previously had as, despite the current low oil price, the cost of electricity will rise due to the cost of renewable energy and the replacement infrastructure in the UK. The electrical distribution

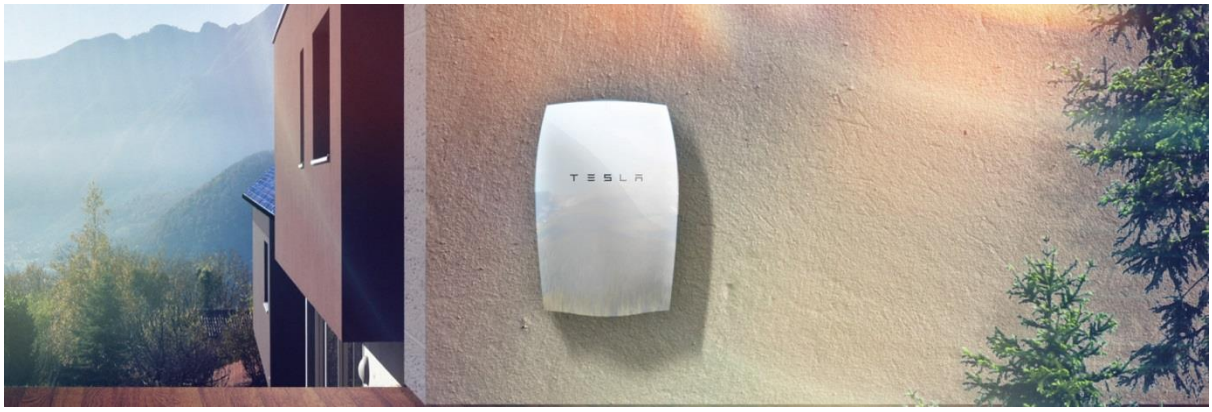
within a building has been sidelined up to now but, going forward, it should be taken into account in the design of a building. If measures to increase the efficiency above the current requirement under Building Regulations are undertaken at construction stage then the cost can be kept to a minimum. It is far more sensible, and cheaper, to reduce power requirements than build new power stations to provide more. There is an EU-wide requirement that countries should not only have a certain proportion of renewable energy by 2020 but also they should reduce their consumption. The recent EU Energy Efficiency Directive, which has brought in the Energy Savings Opportunity Scheme (ESOS) for the UK, is an example of governments being forced down the line of efficiency improvements.

Future challenges to be resolved

One of the problems of renewable energy systems in buildings is that they may produce power (i.e. via Photo Voltaic (PV) and wind) when it cannot be used or the demand exceeds the supply. A degree of smoothing out is required and the recent announcement by Tesla about their home and small business energy storage unit is a welcome initiative to help better use renewable energy. Excess energy produced, say, from PV during the day, is stored and used overnight giving a much smoother load profile for the building and for the incoming supply. Storage is nothing new; it is practised on a large scale in the UK by the 'Energy Mountain', Dinorwic, in Wales. Water is pumped up to a high level reservoir over night when power is cheap and available and then the water is used to produce hydro power during peak periods during the day.

The Tesla storage device is lithium ion battery based and Tesla draw on their electric car experience to package a unit to smooth out power from PV installations. Many advance orders have been placed though we will probably not see the first units in the UK until 2016.

The Tesla energy storage unit is wall mounted.



Shown here for perspective in size, dimensions are 1300 mm x 860 mm x 180 mm

The integration of storage systems into an electrical installation is covered in IEC 60364-8-2.

'Smart meters' will also make a difference in energy consumption if used correctly. Approximately 50 million smart meters are scheduled to be installed in domestic, commercial and industrial premises between 2016 and 2020, although this is to be confirmed by the new government. This will enable users to take advantage of different cost tariffs and, by having external control of connected devices through the meter, will enable management of supplies as well as the consumer having instant access to their consumption figures. If the meters meet expectations then users will be able to decide their own tariffs and have their demand reduced at peak times by data sent to their meter, which can then cut off supplies to appliances such as freezers, tumble driers or any non-critical supplies elsewhere that the consumer has agreed can be included in their supply contract. There is even talk about integrating domestic appliances to the meter by the use of low power radio frequency switching; appliances would be purchased already enabled to take advantage of any communication from the meter. The smart meter, which should not be mistaken for a straight 'AMR' (automatic meter reading) type, can both send and receive data and could transform the way consumers use electricity. It is hoped that wide-scale take up of the capabilities of this meter will enable countrywide grid control and reduce overall demand at peak periods.

The way electrical installations will be designed in the future will change as energy efficiency will have to be taken into account. As energy prices rise clients will realise that long term savings can be made by a small extra capital cost at the beginning of a project.

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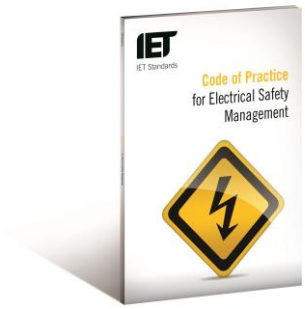
Electrical safety management event

Amy Walker reports on the recent *Code of Practice for Electrical Safety Management* seminar.

The fourth (and final) event in a series of seminars on the *Code of Practice for Electrical Safety Management* was held recently in the Strand Palace Hotel in central London. Since it was published in September 2013, the team behind the book has presented this event at various locations around the country and have now returned to the venue of their original seminar.



This Code of Practice not only highlights the dangers of working with electricity but also how to mitigate the risks. It is designed to be used internationally – there is no reference to any specific legislation. The principles can be applied anywhere in the world and used by anyone, whether or not you are an electrical engineer. This Code of Practice will help people and organisations identify the areas in which they need to improve to ensure the safety of all people working on a broad range of sites.

Three of the four lead contributors to the Code of Practice were speakers at the event:

- Bill Bates BEng(Hons) DMS CEng FIEE, who was a principal electrical inspector with the Health and Safety Executive (HSE) for 20 years, spoke about some of the incidents he had investigated during his time with HSE, highlighting, at times graphically, just why electrical safety management should be a priority on all sites.

- Terry Keenan MSc BSc(Hons) CEng FIEE, director for Prescient Associates Ltd, spoke about the importance of reducing risks in the workplace.

- Paul Bicheno BSc(Hons) MIET, project manager from the IET, took us through how to most effectively use the guidance and self-assessment criteria provided in the Code of Practice.

What I took away from the seminar was that there are many ways in which electricity can cause serious injury or death – not all of which are appreciated even by electrically trained workers. These include shocks, burns, explosions, falls, fires and injuries sustained from unexpected start-ups of machinery (caused bypoor operational processes and procedures) etc. What was particularly poignant is that, with proper measures in place, many of these accidents are entirely preventable.

The event included a very interactive session, with the audience contributing on each topic – voicing their concerns and opinions. Some of the main points that were brought up were the definition of ‘competent person’ and the rules about the approach to using PPE in the US vs those in Europe when working on or near exposed live electrical equipment. Also discussed was how it would be helpful to have a community made up of people and organisations who are trying to improve their electrical safety management.

There is no doubt that this is an extremely important topic and this seminar made it clear that there needs to be a higher awareness of electrical safety management activities, by non-electrical as well as electrically trained staff, but just as crucially, managers and directors/owners who are ultimately held to account in the case of a serious incident in their organisation.

The *Code of Practice for Electrical Safety Management* focuses on identifying a broad range of good practice activities that need to be taken into account to ensure an organisation and the workforce can have an effective approach to managing their risks associated with the electrical system. For further information on this Code of Practice please visit the IET website.

Should you wish to increase your knowledge in this area, have a look at the IET's course on Electrical Safety Management – A practical course for managing risks associated with an electrical system. The course is running 4-5 November 2015 at the IET Birmingham, Austin Court.

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Young Engineering Professionals event: the future of engineering

Nicole Whitton reports on the Young Engineering Professionals event.

On 30th April, BSI, GAMBICA, BEAMA and the IET hosted a fantastic day for young engineering professionals – those studying engineering at university and those recently starting out in their professional careers. The overall aim of the day was to improve awareness of standard setting, not only how standards are used on a daily basis and are essential for developing future technology successfully, but also getting young engineers to think about standard setting as a future career option.

We had a fantastic range of speakers at the event – all the speeches were recorded and streamed live on IET.tv and are now available for viewing on demand on our recently launched Wiring Matters video channel.

- Warren East CBE, CEO of ARM Holdings (and future CEO of Rolls-Royce) spoke about how the aim of engineering is to tame science and nature to make our lives as humans better – and how standards allow us to collaborate to ensure that the aim of engineering is achieved.
- Gary Atkinson, Director of Emerging Technology at ARM, discussed how various industries can interact and relate, and function better, as part of the Internet of Things.
- Jacqui Taylor, Founder and CEO of FlyingBinary, spoke about how smart cities are the first step towards achieving the Internet of Things.
- Professor Paul Newman, BP Professor of Information Engineering at the University of Oxford and lead of the Oxford Mobile Robotics Group, asked us: what do we need from robots? What is the 'ingredients list' for the making of a successful – and, most importantly – useful robot?
- Christopher Baker-Brian, co-founder and CTO of BBOXX, spoke about his experiences as an entrepreneurial engineer has made real change in the world, providing people in Africa and the developing world with the opportunity of electric light for what is often the first time.
- Dame Ann Dowling closed the event by talking about the importance of engineering to various industries – and how engineering can save lives and make a real difference.

The attendees were invited to apply to win an all-expenses paid trip to attend the IEC standard-setting meeting in Minsk in 2015. The three winners are Roberto Fernandez, Emily Gould and Juliano Katrib – a big congratulations to them! The outline details of the event can be found at http://www.iec.ch/members_experts/ypp/workshop/.

From left to right: Geoff Young, Juliano Katrib, Roberto Fernandez, Emily Gould and Scott Steedman

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Career spotlight: working as an electro-technical officer on mega yachts

As summer approaches, here at Wiring Matters our minds turn to visions of bright blue skies and fresh sea air. And maybe some time aboard a mega yacht – well, one can dream! However, if you don't mind working on board as opposed to sunbathing, David Carlisle takes us through the electronics systems on the mega yachts, and what you need to know to become an electro-technical officer.

The *Motor Yacht Ice*

As the trend for ever bigger mega yachts continues, the electrical and electronic systems that power them is equivalent, and sometimes even superior, to what is being installed on modern cruise ships. As all these yachts are entirely bespoke; the cost of the biggest mega yachts is estimated to be many times higher than a cruise vessel of an equivalent size and can take years to design and build.

The most important electrical and electronic systems on board a mega yacht are described below.

The diesel-electric propulsion system

One of the biggest changes in the last 25 years for large passenger vessels is the use of a diesel-electric propulsion system. This system consists of a number of generator sets that typically have a medium speed diesel engine as the prime mover and an alternator that generates either 6.6 kV or 11 kV at 50 Hz or 60 Hz. This can then be used by the propulsion drives (which allow variable speed control of large a.c. motors for main propulsion) and can be stepped down to a lower voltage and used to supply the rest of the yacht's services. The main advantages of this platform are that generator sets can be started and stopped to adapt to changing load requirements thereby making the system efficient; the reduction of noise and vibration; and the ability to position the generator sets for optimum weight distribution in the engine room. An additional benefit is the ease of integrating large electrically driven side and azimuth thrusters to allow even the largest mega yachts to manoeuvre into tight anchorages or berths.

Due to the flexibility of the diesel-electric platform, most large mega yachts that are currently in production are adopting it for their propulsion system. As with passenger vessels, the propulsion load is by far the biggest consumer and the total available power from all the generator sets is in the region of 25 MW for the largest mega yachts, with about 80 % of this used by the propulsion system when at full speed.

Systems for self-sufficiency

The propulsion and all the other technical systems on board are controlled and monitored from an engine control room (ECR). As the yacht can spend weeks at sea it must be largely self-sufficient, with the ability to produce its own fresh water and have space in freezers and cool rooms to store enough food and drink for all the owner's requirements.

The HVAC system must be able to cope with outside air temperatures ranging from below freezing to above 40 ˚C and be able to accurately maintain individual room temperatures throughout the guest accommodation.

The waste treatment system can process all of the grey and black water produced on board until it is of high enough quality to be discharged overboard.

There's even a garbage treatment system to enable rubbish to be processed, sorted and stored until it can be taken ashore.

Navigation and bridge control systems

The navigation and bridge control systems allow the yacht to be navigated by a single person safely and accurately in all conditions. For transiting between ports, the bridge systems are built around the electronic chart display and information system (ECDIS), which provide electronic charts that can be used to plot a course for the autopilot to follow. The ECDIS can also show overlays from the radars, allowing the course and speed of nearby vessels to be monitored.

The automatic identification system (AIS) can display relevant information about any vessel within UHF range. This enables the navigation officer to maintain an overview of the traffic situation and compare the predicted course of all vessels in the area with the course set in the autopilot and to ensure that a safe distance is kept between all traffic.

Slow-speed manoeuvring: the dynamic positioning system

For slow-speed manoeuvring to bring the yacht alongside or to maintain position at an anchorage, a dynamic positioning system, or DP system, is commonly used. This system uses a computer generated model of the propulsion characteristics of the yacht and allows all the side and azimuth thrusters and main propulsion to be controlled in a consolidated way.

In the case of maintaining the yacht's position, the DP system compares the readings of several sensors that measure the yacht's heading and positions, and several environmental factors such as wind speed and direction, and then adjusts the outputs of the individual components of the propulsion system to keep the yacht at the same heading and position.

The DP system can also be used to manually manoeuvre the yacht at slow speeds; this is typically achieved using a 3-axis joystick that is controlled by the navigation officer on the bridge. The inputs at the joystick are translated into propulsion outputs to enable the yacht to

move in the desired direction so that very fine control of the yacht's movements can be achieved. This means that the yacht can be manoeuvred into berths only a little longer than the overall length of the yacht itself.

The safety system

In addition to navigation, the bridge is also responsible for the overall safety of the yacht, which is monitored with a dedicated safety system. This system is responsible for fire detection and damage and flooding control, with several more advanced systems also providing a decision-support system to allow the safety officer to have quick access to the recommended steps to deal with any emergency situation on board.

The electro-technical officer

The interior of the yacht is finished to the highest standard and would normally be equipped with a cinema, swimming pool and occasionally a mini-submarine. The lighting and audio/visual systems are state-of-the-art and there is usually at least one elevator that links all the guest decks.

The person on board responsible for maintaining all these systems, as well as all the other electrical sub-systems that allow everything to function properly, is called an electro-technical officer (ETO). Most large yachts carry a single ETO but the largest mega yachts are now carrying a senior and a junior ETO, as the amount of equipment to maintain would be too much for a single person.

How to become an ETO

There is an internationally recognised ETO qualification available in a number of UK maritime colleges but until recently there has been no requirement for yachts to have someone on board with that qualification, so the role of the ETO has been carried out by people with an HND or above in electrical engineering or an equivalent qualification.

Last year the Maritime and Coastguard agency announced that only people holding a recognised ETO qualification will be allowed to sign onto the yacht as an ETO, but there is a path for people who are currently serving in that role to obtain the ETO certificate based on their previous qualifications and experience. Currently, there are no requirements for yachts to carry an ETO, however, it appears that yachts with diesel-electric propulsion are soon going to be required to carry least one person on board with ETO certification.

This is a big step forward into the recognition of the complex and dangerous job that ETOs perform while working on the onboard systems and ensures that the position of ETO is now protected in the same way as an engine officer or deck officer. This reflects the growing importance of the role of the ETO for modern yachts and should allow for greater professional recognition of the ETO in the shipping industry.

To become an ETO you must first complete a cadetship with a sponsoring company that will consist of several academic phases at a UK maritime college and sea phases on a yacht controlled by the sponsoring company. While serving as a cadet, the sponsoring company will cover the costs of all your training and you will be given an allowance to live on for your college phases. Typically, a cadetship is three years long and some companies require a minimum amount of service (typically two years) after you complete your qualification.

Due to the number and the range in the size of yachts, the conditions for an ETO range from a full time position to time-for-time rotation. The salaries are in line with engine officers and are typically higher than the salaries of ETOs in the commercial sector.

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Students and the Wiring Regulations

With a great number of electrical courses available for anyone who wants to pursue a career in the electrotechnical industry, it's essential that those who intend on working with electrical systems, whether installing, maintaining or designing, have a good understanding of the IET Wiring Regulations, where they come from and what they mean. Nicole Whitton speaks to Steven Devine, Electrical Engineer, Educational Sector at the IET, about the IET's focus on students.

Students and the Wiring Regulations

Steven Devine was recruited from the educational sector to oversee the IET's further involvement with students and BS 7671, the IET Wiring Regulations. As Steven points out, when students begin studying to become an electrician, either through an apprenticeship or on a full-time course, they will generally have little or no knowledge of the Wiring Regulations and the related guidance, such as the *On-site Guide* and the Guidance Note suite.
Steven points out the pressure on students: "When introduced to such titles the content can be difficult to understand and relate to for someone just entering the industry. However, as the students progress in their education and training, they will have to become familiar with the content in order to complete certain aspects of their qualifications."

Awarding bodies such as City & Guilds have exams that require students to use the Wiring Regulations and the *On-Site Guide*. As Peter Tanner, Lead Technical Consultant: City and Guilds, remarked: "With the introduction of the new 'Trailblazer' Apprenticeship, one of the new units is *Requirements of BS 7671: IET Wiring Regulations*. This means that students will be assessed on their knowledge and understanding of the publication towards the end of their study. As this is a technical standard, students always have difficulty understanding the language used within the publication."

Steven recalls his experience as a lecturer: "Because many students find the Wiring Regulations a fairly dull subject and the information within difficult to interpret it tends to be the subject they are happy to see the back of and therefore do not become as familiar with them as they should. I have personally seen many students complete electrical qualifications and still have difficulty in understanding the purpose and origin of the Wiring Regulations – and many more who have given up because they find the subject too challenging."

Steven's focus is to provide students with a clearer understanding of the importance of standards and regulations – who is actually responsible for them and how much voluntary time is contributed from experts from the electrotechnical industry. In addition, it should be made clear to students the process by which various accidents and incidents that occur as a result of electrical systems failing are brought to the electrotechnical committee to be discussed. Ultimately, amongst the students of today are likely to be the industry leaders of tomorrow.

"Students should be confident that they will have a voice and an influence on how the regulations are reviewed and amended in the future," says Steven.

What is the IET doing?

The IET is getting closer to education, to encourage emerging electricians to thrive in the electrotechnical industry by providing students with the support and guidance they need, not

only from the time they are working as electricians but from the moment they begin their education in the electrotechnical industry.

Having access to this guidance at an early stage will begin to pave the way for future electricians who have the aspiration to achieve excellence, to thrive in their career and to work with confidence, knowing that the electrical systems they are installing are safe and in accordance with the regulations.

The *Student's Guide to the IET Wiring Regulations*

The *Student's Guide to the IET Wiring Regulations*, available later this year, will provide guidance for students, helping them to navigate their way through the information available in the Wiring Regulations while studying electrical courses. The book is designed to integrate with current qualifications being delivered and to provide relevant content that will support learning and development and clarify the purpose and origin of various regulations in the Wiring Regulations.

Peter Tanner adds that "A student's guide to BS 7671 would be a great tool for any student new to the industry to introduce them into the world of electrotechnical standards and provide the essential background needed to develop an understanding of electrical installations, the regulations and how to apply them."

In addition, the IET is working to put together multimedia tools, such as videos and podcasts, to complement the Student's Guide and to better convey the IET Wiring Regulations.

What are your thoughts?

Let us know at wiringmatters@theiet.org about your experiences studying – and how you found understanding the Wiring Regulations, and how effectively you worked with the Wiring Regulations after your studies.

About Steven Devine – author of the *Student's Guide to the IET Wiring Regulations*

Steven Devine has been appointed as Electrical Engineer, Educational Sector within the Technical Regulations team, and is the author of the *Student's Guide to the IET Wiring Regulations*. He will be driving the focus on providing more support to students to better prepare them both for their studies and for their future careers.

Steven began working in the educational sector as an assessor, working primarily with apprentices who had already completed at least one year of their technical qualification and had had experience working in the electrical industry. At that stage in their education they needed to demonstrate vocational skills, the ability to carry out various work activities safely and, most importantly, install all electrical systems in accordance with the Wiring Regulations while demonstrating knowledge and understanding of the Wiring Regulations and how they are applied.

Steven says, "All too often I found that the apprentices would comply with the Wiring Regulations without really understanding why. For example, when asked why they were installing equipment in a certain way they would often reply "because that's what the regs say" or when verifying test result and asked why the value is acceptable the answer would be, again, "because that's what the regs say". Apprentices were aware that the values and

requirements needed to be met but had almost no idea why. I found the best way to make a lasting impact on the students was to tell them of incidents where things went wrong to maintain the importance of following the Wiring Regulations and the potential consequences of not doing so."

Steven's experience within the educational sector makes him ideally placed to drive the IET's focus on empowering students and apprentices, and identifying the challenges that students face. Like any students, those entering the electrotechnical industry after studying will find the level of commitment that they have to apply to the work they are doing as one of their biggest challenges.

However, a second challenge that Steven has noticed during his time in the educational sector is the difference in views on the real world limitations on how systems should be installed against how the Wiring Regulations specifies they should be installed.

As Steven observes, "During the course of their qualification they will be installing various systems in the workshop on blank walls or boards with little or nothing to consider other than the bare bones of the installation they are working on. When they begin installing electrical systems in the workplace they will encounter many different environments such as loft insulation, existing installations that will not support additions to the circuit and special locations, zones in bathrooms etc. Although they may have covered this during their technical qualification, it is an area that is not always understood as well as it should be – like many other areas covered by the Wiring Regulations."

Steven emphasises that, in order for students to have the best opportunity to have a successful career in the electrotechnical industry, they must have a good understanding of how to apply the Wiring Regulations in practice – and how to find their way around the Wiring Regulations when confronted with unfamiliar situations.

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The new Trailblazer apprenticeships and the effect on electrical apprentices

Peter Tanner, Lead Technical Consultant: City and Guilds, writes exclusively for Wiring Matters about the changes made to the Trailblazer apprentice schemes.

Over the past 18 months the government has been introducing changes throughout education and training. This includes reforms to the apprenticeships known as Trailblazers. The apprenticeship for trainee electricians was included in the 'phase one' round of reforms to Trailblazers, which means that the development of the new framework is almost complete and is set to roll out from July this year.

One of the reasons that the electrical apprenticeships were included in the 'phase one' round of developments is because the current structure provides a model for all Trailblazers, as it has an independent end test (AM2). This end testing model is something that will feature in all Trailblazers across all sectors.

In the past, electrical apprenticeships were developed by the sector skills council SummitSkills following initial consultation with employers. The new Trailblazers involve employers throughout the entire development process and beyond.

The electrical apprenticeship was developed by a strong employer group representing a good cross section of small, medium and large enterprises. The group was led and chaired by the IET and also included representation from the awarding organisations (AOs), including City & Guilds, National Electrotechnical Training (NET) and EAL, as well as representation by some training providers who all acted as advisories to the employer group.

The new electrical trailblazer brings changes to:

- training and assessment (the qualification);
- AM2;
- grading;
- professional recognition; and
- funding.

The qualification

As there is more than one AO, the employer group were very keen to see parity between the AOs. As a result, a joint assessment plan was created to ensure assessment of the qualification was the same no matter what AO certificates the qualification. Assessment across all the units will use a mixture of:

- multiple choice online assessments (MC);
- practical performance assessments at the training centre (PP);
- written examinations (WE);
- project-based assignments (PA); and
- on-site performance assessments that are carried out in the workplace (OSP).

All knowledge-based assessments will take place at the training provider's facility, which could be an independent training centre or FE college. Performance-based assessments will

be carried out in the real working environment and assessed by a mixture of direct observation, witness testimony, reflective accounts and professional discussion.
The new City & Guilds 5357 qualification comprises of 15 units in the following subjects (jointly agreed assessment methods in brackets):

- knowledge of health and safety (MC, PP);
- performance of health and safety (OSP);
- knowledge of organising and overseeing the workplace (MC);
- performance of organising and overseeing the workplace (OSP);
- knowledge of cables, wiring systems and terminations (PP);
- performance of cables, wiring systems and terminations (OSP);
- knowledge of electrical science and principles (MC, WE);
- knowledge of the requirements of BS 7671 (MC) based on the current City & Guilds 2382 qualification;
- knowledge of installation design (MC, PA);
- knowledge of inspection and testing; initial verification (MC, PP, WE) based on the current City & Guilds 2394 qualification;
- performance of initial verification (OSP);
- knowledge of fault finding and diagnosis (MC, PP);
- performance of fault finding and diagnosis (OSP);
- performance of installing electrical installation systems (OSP); and
- performance of maintaining electrical installation systems (OSP).

Note: The final two units are optional. Selection depends on whether the trainee is to become an installation electrician or maintenance electrician. All other units are mandatory.

AM2

The AM2 assessment, as before, will take place at an independent assessment facility approved by NET. It will be extended to re-introduce the installation of common wiring and support systems and will serve, as before, as the final assessment of an apprentice, judging overall skills and competence.

The AM2 was seen as an invaluable method of testing the overall ability of an apprentice, which is why all other Trailblazers across various sectors will use this model of independent end testing in the future.

Grading

On successful completion of the apprenticeship, the candidate will be graded as pass, merit or distinction. The overall grading will be based on two factors: the grade obtained in the science and principles unit, and the grading obtained in the AM2 assessment.

Much discussion took place about the grading of all units in the qualification. It was felt, however, that many of the disciplines that make up the units should be graded pass or fail only. To give an example, when it comes to health and safety, an electrician is either safe or unsafe. This argument applies to many of the skills within the units: they can either work to industry standards, or they cannot.

The two elements that are graded will enable future prospective employers to see if an electrician who has successfully completed the apprenticeship excels academically (science

and principles) and/or by performance (AM2), which is why it was decided to only grade these elements and use them towards the overall grade.

Professional recognition

All candidates who have completed the qualification part of the apprenticeship will be eligible to make a streamlined application for EngTech status. Much of the qualification was developed and designed to align with the Engineering Council's standards for engineering technicians (electrical). This means that all candidates will be able and encouraged to make an application by providing a short reflective account only. If they have met the assessment requirements of the qualification, they have met much of the criteria for EngTech.

Funding

Initially, funding will be based on a system where the Skills Funding Agency (SFA) will contribute £2 towards training and assessment for every £1 invested by the employer.

The model for the future of Trailblazer includes a voucher system, where the SFA gives vouchers to the employer allowing choice of training provider based, perhaps, on an agreed price. It is still currently unclear how this will fully work and most small and medium enterprises are likely to appoint a lead provider who manages the funding aspects of the apprenticeship. The lead provider could be a training centre, further education college or industry training organisation such as JTL.

Electrical Trailblazer has been allocated the maximum funding bracket, meaning the government's contribution towards training and assessment currently stands at £18,000. This includes incentive payments to employers for recruitment and completion of apprentices.

Summary

In order for a trainee electrician to become qualified, recognised and eligible for JIB approval, they must successfully have:

- completed the new training and assessment units that make up the overall qualification (City & Guilds 5357);
- possession of, at minimum, level 2 functional skills or GCSE grade 4 (old C) in English and Maths;
- passed the AM2 independent assessment.

In addition, they should be encouraged to make an application for EngTech status.

It is anticipated that the apprenticeship would take four years to complete for an average candidate.

Further information on the apprenticeship reforms can be found on the City & Guilds website.

Further information on the City & Guilds 5357 apprenticeship qualification can be found on the qualification webpage.