Wiring Matters

Issue 87

September 2021

Hello and welcome to the September issue of Wiring Matters. As we near the end of summer and move into autumn, we are happy to be bringing you a jam-packed issue, including articles in successful ongoing series such as *Back to the Forum* and *Mythbusters* as well as original topics.

Several IET Codes & Guidance and Technical Regulations publications are currently moving forward. Look for your opportunity to comment on the forthcoming *Earthing and Bonding for AC Electrified Railways* when it goes to DPC stage in the next few weeks. This new title has been created to provide a greater understanding for this hugely important market and we're excited to read your comments when the DPC page goes live.

Also on the horizon is the 2nd edition of *Guide to Electrical Maintenance* by Wiring Matters contributor Cameron Steel. Regular readers will be familiar with Cameron from his three part series looking at content from another publication *Designer's Guide to Energy Efficient Electrical Installations*, with the final instalment being included in this issue. The whole series can also be found as a complete PDF download from the Wiring Matters September issue main page, which we hope you enjoy.

We hope you enjoy the September issue of Wiring Matters; we'd love to hear your thoughts on this month's articles or any ideas for articles that you may have so please feel free to contact us at wiringmatters@theiet.org. We look forward to bringing you the November issue, see you then!

- Evaluation and metrics- Cameron Steel

  Cameron Steel caps off his three-part series inspired by his work on the *Guide to Electrical Maintenance* with his final article, looking at evaluation and metrics, an invaluable reference resource for the practitioner.

- Mythbusters Mixing devices- James Eade

  James Eade returns to his myth-busting series of articles with an article explaining a commonly misunderstood point that is a source of calls into the IET Technical helpline

- BACK TO THE FORUM Current-carrying capacity of cables buried in the ground- Michael Peace

  Michael Peace's ongoing series continues with a well-researched look at buried current-carrying cables.

- TT earthing considerations- Michael Peace

  Michael's second article this issue is an in-depth look at TT earthing considerations, which includes a look at the history of these installations and what the practitioners needs to keep in mind now.

- Electrical Safety Standards in the Private Rented Sector- Richard Giddings

  IET Technical Engineer Richard Giddings returns to Wiring Matters to look at the private rented sector, and what the practitioner needs to be aware of when working in these properties.

Evaluation and metrics

Part 3 of 3

By Cameron Steel

The design framework of IEC 60364-8-1 provides guidance on a more energy efficient electrical installation through careful placement of electrical supplies, considered infrastructure design, controls and energy management. All of this is designed to minimise energy loss in the distribution of electricity and reduce energy consumption at the point of use in the electrical installation, whilst still maintaining a suitable and comfortable environment for the end users.

It should be noted that this is not just about embedding energy efficiency into the design phase though. An electrical installation needs to be fit for purpose throughout its lifespan.

We are all familiar with the requirement of BS 7671 to carry out regular inspection and testing to certify continual electrical safety. The IEC standard suggests an updated energy efficiency assessment at intervals not exceeding three years for industrial and infrastructure installations and five years for commercial installations. Realistically a fresh assessment is advisable when any installation undergoes a significant change in use or load addition.

The introduction to IEC 60634-8-1 states that "this document is intended to provide requirements and recommendations for the electrical part of the energy management system addressed by ISO 50001." Energy management is the focus of ISO 50001 and it describes a process of regular checks, identifying improvements, remedial works, and further reassessments to ensure that energy management measures remain on track.

Section 4.2 of IEC 60634-8-1 discusses regular assessment of energy efficiency and states particular periods for commercial and industrial installations when reassessments should take place.

Annex B provides scoring matrices and overall energy efficiency evaluation methods to demonstrate just how efficient the electrical installation is. These are used during the design, installation, and commissioning phases of a project and to provide a benchmark for future improvements. It is worth noting that Annex B is published as "Normative", so required activity, except in Austria and the UK where it is deemed as "Informative" (refer to Annex C for country specific information).

The design team should determine the level of energy efficiency measures required. The implementation of these measures should then be monitored through the installation and commissioning stages. The operational team subsequently provide continual assessment and monitoring until the installation is subsequently decommissioned.

Annex B of IEC 60634-8-1 highlights four principal energy efficiency themes that apply to electrical installations and should be assessed including:

- initial installation

- energy management
- performance maintenance
- power monitoring

There is also a bonus theme for the inclusion of low carbon technologies.

There are four sectors considered with each of these themes: industrial, commercial, infrastructure and residential. All aspects should be considered for the first three.

An abridged version should be used for the residential and only highlighted energy efficiency measures are applicable. The points allocation is also different for residential installations. For each of the categories there is a short assessment process, sometimes with a calculation where the output is a percentage whilst others are straight yes/no assessment.

If a particular measure is not directly applicable to an installation, it is typically given a score of 0. Where the installation has an LV supply and does not involve a transformer (II04 and MA04 refer) then maximum points are given as it is assumed that the supply authority has already dealt with transformer efficiencies.

Initial Installation (II) has five categories (II01 to II05) that evaluate the efficiencies within the fixed wiring electrical infrastructure.

II01 assesses, as a percentage, the coverage of energy consumption sub meters so that downstream energy use can monitored. Comprehensive sub-metering is also a factor in Part L of the UK Building Regulations.

II02 looks at the efficiency of the location of the substation and compares distances from the point of supply to the principal switchgear and also to the furthest load using the barycentre calculation method.

II03 looks at voltage drop and is a natural extension of BS 7671 design activities. Circuits which carry 80 % or more of the total energy consumption should be assessed collectively and installations with overall low volt drops score higher points.

II04 is for installations with their own transformer and examines manufacturers data. Higher declared efficiencies will gain higher scores.

II05 assesses the efficiency of the fixed electrical installation and equipment at the point of use. The example in the tables is lighting and ensuring that the same lighting performance is achieved when the energy consumption is minimised. This is also a requirement of Part L of the UK Building Regulations.

		Maximum points available				
Category	Table	Industrial	Commercial	Infrastructure	Table	Residential
II01	B.3	7	6	7	B.31	20
II02	B.4	6	4	6		
	B.5	6	4	6		
II03	B.6	6	6	6		
II04	B.7	3	3	3		
II05	B.8	4	4	4		

Energy Management (EM) has nine categories and evaluates the deployment and operation of efficient controls at the time of use.

EM01 assesses zones of control and compares the zoned areas (in m^2) to the total installation. The requirement is that the installation should ideally have more than 80 % of the electrical installation within control zones.

EM02 assesses usage. Points are awarded where there is comprehensive use of energy meters for a number of usages across the installation and within zones.

EM03 looks at demand response and load shedding controls. There are two aspects covered, the amount of load and the duration. Greater numbers of points are awarded when larger percentage loads are disconnected from the mains grid supply. Similarly, a load that is shed for more than 10 minutes is rewarded under the points system.

EM04 focuses on meshes and refers back to the criteria discussed earlier in IEC 60634-8-1. Where evidence exists of control criteria being considered to determine the meshes, more points can be awarded.

EM05 also assess usages and examines, as a percentage, how comprehensive sub-metering is across the installation for different usages compared to the energy consumption of the whole installation.

EM06 has a couple of tables to check and focuses on the deployment of automatic occupancy controls to reduce operation of the fixed installation when the areas are empty. There are tables for the total area of coverage and for level of occupancy.

EM07 is concerned with the Electrical Energy Management System (EEMS) and assesses how much energy is monitored by the EEMS compared to the overall electrical energy consumption. Bear in mind that an EEMS may form part of a wider energy management system if there are other energy sources.

EM08 assesses controls for heating, ventilation and air conditioning across the installation and points are awarded for general temperature control or room level temperature control or room level time and temperature control.

EM09 focuses attention on lighting controls and compares the amount of automatic lighting controls to the total energy consumption of the lighting across the whole installation.

		Maximum points available				
Category	**Table**	**Industrial**	**Commercial**	**Infrastructure**	**Table**	**Residential**
EM01	B.9	1	1	1	B.32	3
EM02	B.10	2	2	2		
EM03	B.11	5	5	5	B.33	16
	B.12	1	1	1		
EM04	B.13	6	6	6	B.34	20
EM05	B.14	4	6	4	B.37	20
EM06	B.15	4	10	8		
	B.16	2	2	2		
EM07	B.17	12	12	8		
EM08	B.18	6	6	6	B.35	18
EM09	B.19	2	6	4	B.36	6

Performance maintenance (MA) has five categories and looks at the processes and procedures to ensure continuous monitoring of energy consumption. Electrical installations will only remain energy efficient if they are maintained regularly and correctly. This is an important aspect of ISO 50001 as well.

MA01 is a "yes or no" assessment and only awards points if there is proof of a satisfactory and auditable maintenance regime in place

MA02 checks the frequency of the checks made on energy performance. Manual checks can be tie consuming, so it is possible that these checks could be automatic and driven by a network of meters connected to a central computer system.

MA03 is about data management and retention of historical data. This is important to track energy consumption trends and could highlight potential issues relatively early. A track record of energy consumption over several years can be an important comparative tool.

MA04 is for installations that have their own transformers and assesses the performance of the transformers. It does this by comparing the actual power used to the optimum working point declared in the manufacturers data sheets. An underutilised transformer will not work quite as efficiently.

MA05 looks at continuous monitoring of large loads (typically more than 10% of the installation's total energy requirement) coupled with automatic warnings of any variance so that anomalies can be addressed at the earliest opportunity. Large loads could include heating or cooling systems.

		Maximum points available				
Category	Table	Industrial	Commercial	Infrastructure	Table	Residential
MA01	B.20	8	8	8		
MA02	B.21	6	8	8		
MA03	B.22	10	8	8		
MA04	B.23	1	1	1		
MA05	B.24	5	5	5		

Power monitoring (PM) has two categories that look at how real time power quality analysis is conducted, using appropriate devices, to check power factors and harmonics.

PM01 focuses on power factor correction. It does not specify whether power factor correction should be deployed centrally or at the point of use. The main stipulation is that it is measured at the origin of the installation and maximum points are awarded for a power factor of over 0.95.

PM02 assess total harmonic distortion (THD), again at the origin of the installation. There are tables for THD_u (voltage) or THD_i (current) and points are awarded depending on the outcome from either table but not both.

It is worth bearing in mind that electricity supply companies typically state the maximum impact they will allow from installations with poor power factors or harmonic distortion.

		Maximum points available				
Category	Table	Industrial	Commercial	Infrastructure	Table	Residential
PM01	B.25	6	4	6		
PM02	B.26	4	3	4		
	B.27	4	3	4		

Bonus (BS) provides two further categories to demonstrate deployment of low carbon technologies. These can improve energy efficiency but not all installations will be in a position to use them.

BS01 discusses the deployment of on-site electricity generation through renewable energy sources and compares the output of the renewable source to the total energy consumption of the installation. Renewable sources mentioned include photovoltaic panels and wind turbines. It also includes hydro power, geothermal and biomass.

BS02 looks at electrical energy storage provided it is associated directly with a renewable electrical energy source as described in BS01.

		Maximum points available				
Category	**Table**	**Industrial**	**Commercial**	**Infrastructure**	**Table**	**Residential**
BS01	B.28	5	5	5	B.38	6
BS02	B.29	3	3	3	B.39	3

Once each of the categories are assessed all of the points awarded can be added together to provide an overall assessment. It is worth noting where the emphasis on the five themes is for energy efficiency in electrical installations

	Maximum points available			
Category	**Industrial**	**Commercial**	**Infrastructure**	**Residential**
Initial Installation	32	27	32	20
Energy Management	45	57	47	83
Performance maintenance	30	30	30	0
Power monitoring	14	10	14	0
Bonus	8	8	8	9
Total points available	129	132	131	112

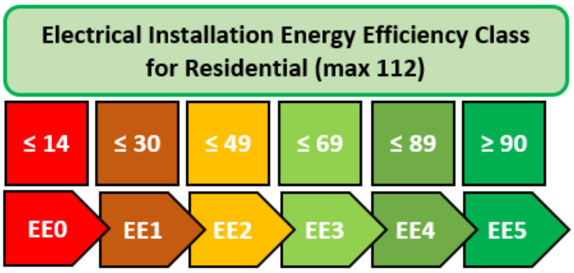
There is a strong emphasis on the initial installation design and on robust energy management including controls at the point of use. The numbers also stress the importance of a satisfactory maintenance regime.

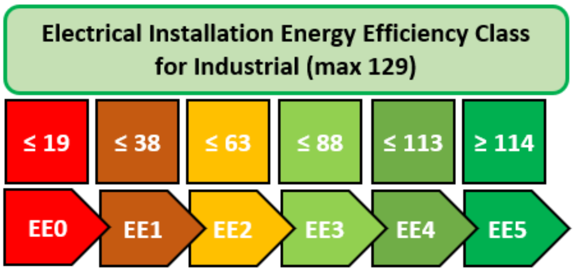
	Theme focus on overall efficiency			
Category	**Industrial**	**Commercial**	**Infrastructure**	**Residential**
Initial Installation	25%	20%	24%	18%
Energy Management	35%	43%	36%	74%
Performance maintenance	23%	23%	23%	0
Power monitoring	11%	8%	11%	0
Bonus	6%	6%	6%	8%

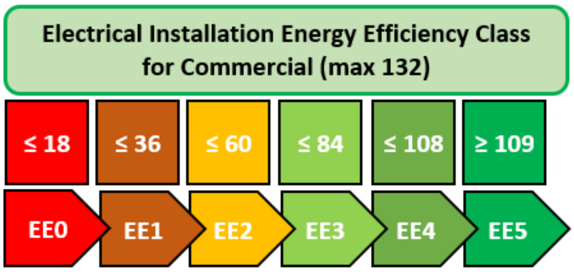
It is interesting to note that on-site renewable energy supplies and energy storage do not attract high scores. The main focus is on getting the energy efficiency of the electrical installation set up correctly in the first place, monitoring its performance regularly and maintaining that performance.

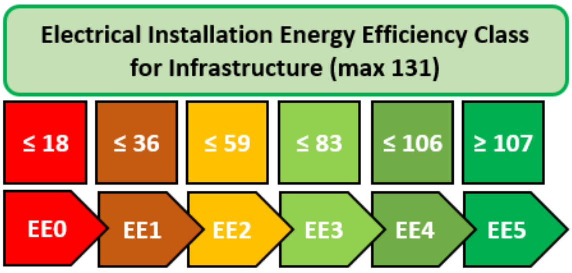
Renewable energy supplies and energy storage act as an added bonus to installations that are already energy efficient. They should not be seen as a carbon off set for poorly performing installations.

The cumulative score provides the overall electrical installation efficiency classes (EE). The electrical installation efficiency classes are rated from EE0 (low efficiency) to EE5 (high efficiency).



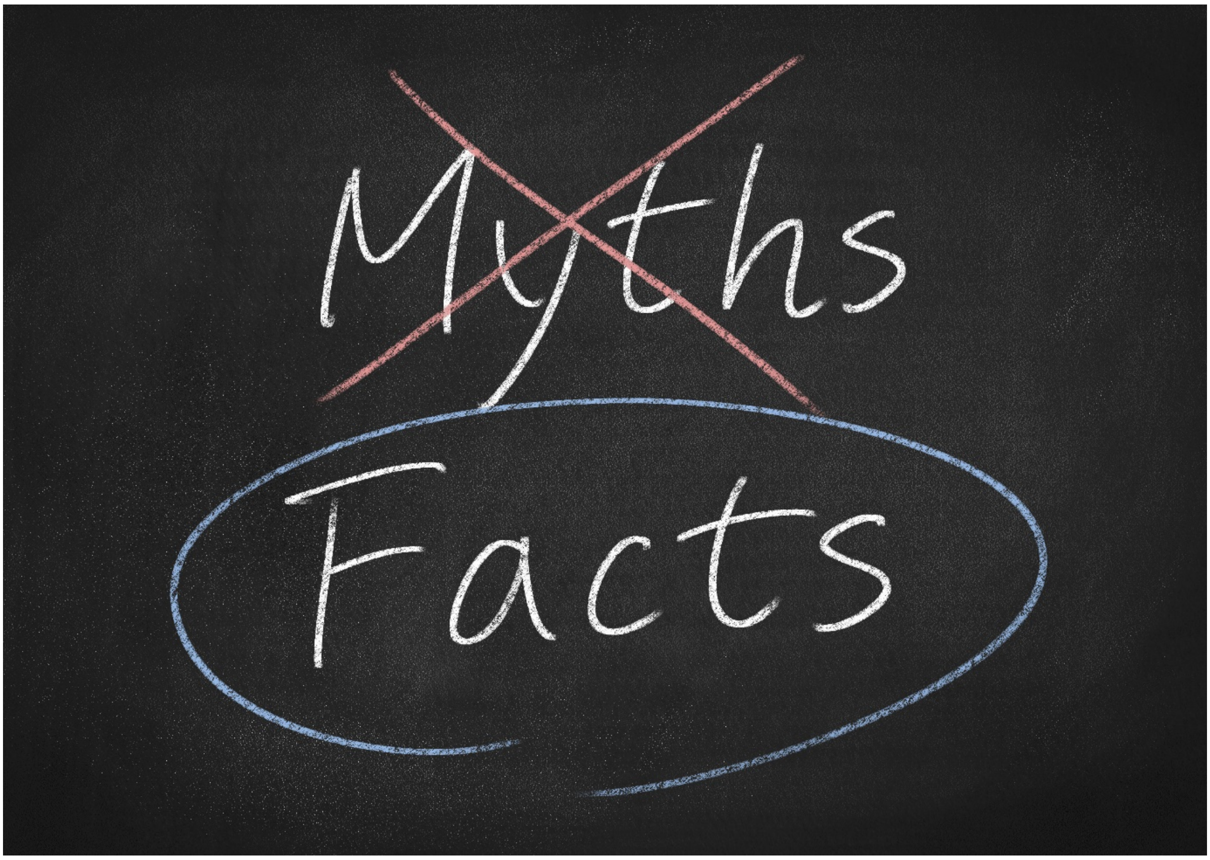






It is important to remember that when a building is occupied and working the EE rating should be regularly monitored and checked. Iterative changes to control settings, maintenance upgrades and improvement projects can always help to set new targets and improve ratings. Examples of these can include

- additional metering and sub-metering,
- more efficient equipment (e.g., high efficiency motor specifications, LED lighting)
- controls (e.g., better motor controls and automatic lighting controls)
- introduction of local renewable generation and energy storage.



Myth Busters #7

Out with the old, in with the new?

The introduction of the 18th Edition of the IET Wiring Regulations (BS 7671:2018) saw a new regulation buried in Part 536 *Co-ordination of electrical equipment for protection, isolation, switching and control*. Part 536 is about ensuring (amongst other aspects) that the performance of devices for protection against faults and overloads are co-ordinated so that the effectiveness of operation of individual items of equipment, under both normal and abnormal operating conditions, does not impair the safety or proper functioning of the installation. It includes, for example, the set of regulations that provides requirements for selectivity of protective devices for residual currents, overloads and short-circuits.

This issue's *Myth Buster* is not so much 'busting a myth', but explaining something that is commonly misunderstood, and which is a source of a steady trickle of calls to the IET Technical helpline. The regulation in question, 536.4.203, was introduced by BEAMA (the UK trade association for manufacturers of electrical equipment including switchgear) to warn designers and installers of the possible dangers of mixing devices from different product ranges or manufacturers in the same distribution board; mainly, but not exclusively, circuit-breakers. When installing a new final circuit for example, if there is a spare space in a consumer unit and a circuit breaker that appears to fit is to hand, it is tempting to use it. Another example is replacing a circuit breaker with an RCBO to afford better protection for the user.

Before delving into the detail of this change, as ever it pays to start at the beginning – namely the Fundamental Principles of Part 1.

Regulation 133.1.1 requires that '*Every item of equipment shall comply with the appropriate British or Harmonized Standard*.' For distribution boards, this is the BS EN 61439 series. Part 3 is a specific part of the BS EN 61439 suite and it includes requirements for Distribution Boards intended for use by 'ordinary persons. The requirements for compliance are varied and include the performance of the distribution board under internal and external fault conditions, internal creepage distances, temperature rise limits, short circuit withstand strength and more. In order to prove compliance, manufacturers will populate a distribution board with their own protective devices, before testing the assembly as a whole.

When purchasing a consumer unit or distribution board, the manufacturer's instructions will state which devices can be used in the unit – and don't forget according to BS 7671 (regulation 510.3) there is an obligation on designers and installers to follow manufacturer's instructions when selecting and erecting equipment.

The regulation in question (536.4.203) specifies requirements for integrating devices and

components into low voltage assemblies to the BS EN 61439 series and the regulation highlights:

- The need to ensure conformity with the relevant part of BS EN 61439 series,
- That just because individual components conform to their respective product standards and are CE marked, it does not indicate their compatibility for integration into an assembly; and
- The person introducing a modification/alteration becomes the original manufacturer with the corresponding obligations for that assembly.

As an example of the need for this regulation, consider a circuit-breaker clearing a substantial fault of several thousand amps. When the contacts open, there is a corresponding arc that needs to be safely dissipated. Circuit-breakers typically have a vent from an internal arc suppression chamber to the outside in order to help the hot air and gasses to escape during the disconnection. If devices from different manufacturers are used together, the venting characteristics may not be co-ordinated which could result in significant further damage to adjacent devices or other parts of the distribution board.

On a slightly more benign note, circuit-breakers are designed to run warm in normal conditions when carrying load current. The thermal performance of the assembly is considered in BS EN 61439 to ensure that the internal temperature is not excessive and the operation of protective devices is not impaired – when excessively warm for example, the thermal overload operating current of a device will reduce, potentially causing premature operation. Excessive temperatures may affect the control circuits of electronic equipment mounted in the enclosure.

For this reason, regulation 536.4.203 states that *'The relevant part of the BS EN 61439 series shall be applied to the integration of mechanical and electrical devices and components, e.g.,* *circuit-breakers, control devices, busbars into an empty enclosure or existing low voltage assembly.'*

Of note here is that a protective device may conform to the appropriate product standard (e.g., BS EN 60898) and be CE marked. If the devices are from different manufacturers, they are likely to be designed differently and will perform differently – though both may comply with the appropriate safety requirements of BS EN 60898.

In other words, adding together CE marked products from one manufacturer with another's CE marked products does not necessarily equal a CE marked assembly which is compliant with BS EN 61439. This may also be true when mixing product ranges from the same manufacturer. This is reinforced in Note 1 of regulation 536.4.203 which states that '*The use of individual components complying with their respective product standards does not indicate their compatibility when installed with other components in a low voltage switchgear and controlgear assembly.'*

Going back to the Fundamental Principles, regulation 133.1.3 states that *'Where equipment to be used is not in accordance with Regulation 133.1.1 or is used outside the scope of its standard, the designer or other person responsible for specifying the installation shall confirm that the equipment provides at least the same degree of safety as that afforded by compliance with the Regulations. Such use shall be recorded on the appropriate electrical certification specified in Part 6.'*

This is developed in Note 2 to regulation 536.4.203, which states that '*If an assembly deviates from its original manufacturer's instructions, or includes components not included in the original verification, the person introducing the deviation becomes the original manufacturer with the corresponding obligations'*.

In summary, can you mix devices in distribution boards (including consumer units)? Yes, you can. But you need to seek assurance from the manufacturer of the original assembly that the devices will be compatible, or conduct your own study to ensure the requirements are met. In the words of BEAMA, *'The installer has responsibility to act "with due care". If this is not done then there is a probability that, in the event of death, injury, fire or other damage, the installer would be accountable under Health and Safety legislation.'*

For more information the following guides are worth reading:

BEAMA technical bulletin on the safe selection of devices for installation into assemblies
https://www.beama.org.uk/static/uploaded/6a4ecf21-b4a1-4cbd-ab0e0c6603c26dda.pdf

BEAMA Consumer unit safety checklist

https://www.beama.org.uk/static/uploaded/fa3799ac-9e73-4680-a5006401014b16b3.pdf

GAMBICA Technical Guide to the requirements of BS EN 61439 Parts 1 and 2 (Note that the standard has been updated since this guide has been published, though the general information about the design and characteristics of distribution boards is still relevant)
https://www.gambica.org.uk/static/uploaded/7cce7df9-efb8-42bb-a7aba6bb1a7b824a.pdf

Current-carrying capacity of cables buried in the ground

By: Michael Peace CEng MIET MCIBSE

A question that arises periodically on the IET Engineering Communities forum concerns the current-carrying capacity of cables buried in the ground, in particular, the data used to select the appropriate cross-sectional area (CSA) of live conductors. The question is, **'what is the difference between manufacturer's data and BS 7671?'** In this article we look at the information available and why the information is perceived as different.

What are the effects of installing a cable in the ground?

Where a cable is buried in the ground its ability to dissipate heat is reduced, the extent of which depends on the installation method. Typically, cables installed in ducts will need to be larger than those buried direct in the ground as the air surrounding the cable is heated by thermal radiation from the cable, reducing heat dissipation.

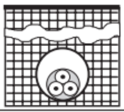
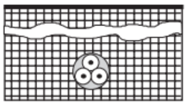
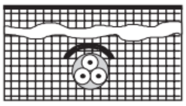
How do I select the current-carrying capacity for a cable buried in the ground?

BS 7671:2018+A1:2020 provides tabulated current-carrying capacity values for common installation methods. If cables are buried in the ground, either direct or inside ducting, reference method D (Figure 1) is applicable and the appropriate value should be selected according to its type from the relevant table identified in Appendix 4.

The installation method takes into account assumed parameters, such as ambient ground temperature (C_a), soil thermal resistivity (C_s), depth of laying (C_d) and spacing factor (C_g), the correction factors for which can be found in Tables 4B2, 4B3, 4B4 and 4C2 respectively.

It is important to remember that it is unlikely the cable will be buried throughout its entire length, at some point the cable will exit the ground to be terminated, where it will no longer be buried in the ground and a different reference method will also need to be considered.

Figure 1

Installation Method			Reference Method to be used to determine current-carrying capacity
Number	**Examples**	**Description**	
70		Multicore armoured cable in conduit or in cable ducting in the ground	**D** **For multicore armoured cable only**
71		*Not used*	
72		Sheathed, armoured or multicore cables direct in the ground: - without added mechanical protection (see note)	**D**
73		Sheathed, armoured or multicore cables direct in the ground: - with added mechanical protection (e.g. cable covers) (see note)	**D**

NOTE: The inclusion of directly buried cables is satisfactory where the soil thermal resistivity is of the order of 2.5 K.m/W. For lower soil resistivities, the current-carrying capacity for directly buried cables is appreciably higher than for cables in ducts.

What if the cable or installation method is not included in BS 7671?

Not every installation method is provided in BS 7671, as there are too may permutations. There are certain types of cables and installation methods which are not identified and the electrical designer must make an engineering judgement or carry out bespoke calculations.

Traditionally, tabulated values were not provided in the IEE Wiring Regulations, the current-carrying capacity ratings for cables buried direct in soil first appeared in the Thirteenth Edition of the IEE Wiring Regulations in 1955 as seen in Figure 2. Table 33 (as it was identified back then) was dedicated for current ratings for PVC insulated cables to BS 3346 installed direct in the ground.

Figure 2: extract from the Thirteenth Edition of the IEE Wiring Regulations

Armoured p.v.c.-insulated cables to B.S. 3346 (twin and multicore), direct in ground (COPPER CONDUCTORS).

TABLE 33

Current ratings for twin and multicore armoured p.v.c.-insulated cables, with copper conductors, to B.S. 3346, installed direct in the ground.

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Conductor		Current rating			Approximate length of run for 1-volt drop at rated current		
Nominal cross-sectional area 1	Number and diameter (in) of wires 2	One twin cable d.c. 3	One twin cable a.c. 4	One 3- or 4-core cable a.c. 5	One twin cable d.c. 6	One twin cable a.c. 7	One 3- or 4-core cable a.c. 8
in²		amp	amp	amp	ft	ft	ft
0·002	3/·029	10	10	10	11	11	12
0·003	3/·036	15	15	15	11	11	13
0·0045	7/·029	20	20	20	13	13	15
0·007	7/·036	35	35	31	11	11	15
0·01	7/·044	42	42	37	14	14	18
0·0145	7/·052	54	54	46	15	15	20
0·0225	7/·064	69	69	59	18	18	24
0·03	19/·044	81	81	69	19	19	26
0·04	19/·052	97	97	81	23	23	31
0·06	19/·064	120	120	105	28	28	36
0·1	19/·083	165	160	140	34	34	45
0·15	37/·072	205	200	175	40	38	51
0·2	37/·083	245	235	205	45	42	55
0·25	37/·093	280	270	230	49	43	58
0·3	37/·103	310	300	255	54	44	60
0·4	61/·093	370	350	300	61	45	60
0·5	61/·103	415	390	330	67	44	59

NOTE

NOTE.—The ratings set out in Table 33 are based on the conditions defined in the Supplement to Report No. F/T183 issued by the British Electrical and Allied Industries Research Association, as follows:

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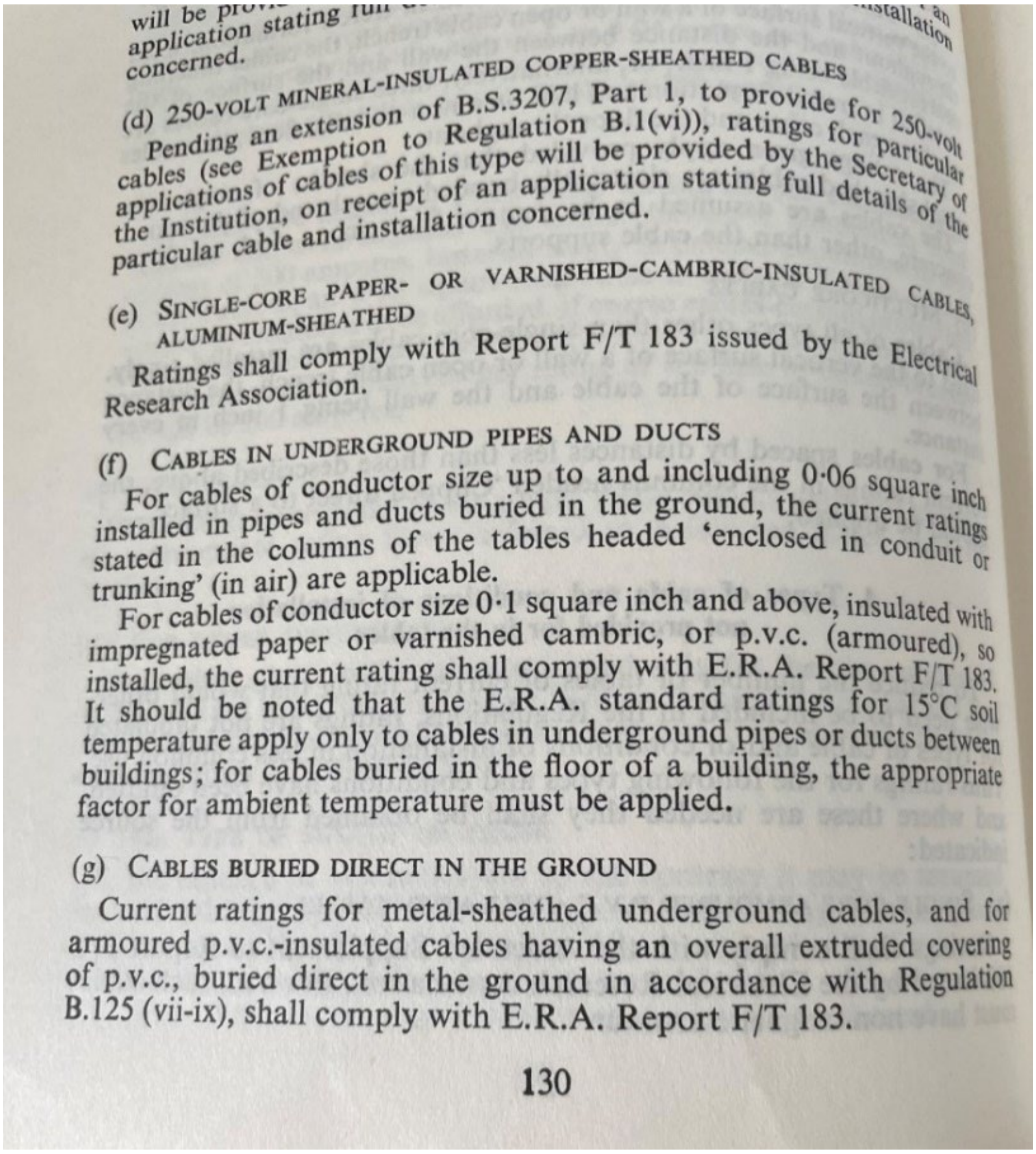
Depth of laying (from surface of soil to top of cable) .. .. 18 in
Soil temperature .. .. 15° C
Thermal resistivity of soil .. .. 120 thermal ohm-cm.

Where other depths of laying are necessary, or where the temperature or condition of the soil is abnormal or where larger numbers of cables are grouped, reference should be made to the rating factors provided in that Report.

However, the tables were not included in the next publication, the Fourteenth Edition of the IEE Wiring Regulations in 1966 but, instead, stated that current ratings shall comply with ERA report F/T 183 as seen below in Figure 3.

Figure 3: extract from the Fourteenth Edition of the IEE Wiring Regulations 1966



will be prov... application stating full ... installation concerned.

(d) 250-VOLT MINERAL-INSULATED COPPER-SHEATHED CABLES

Pending an extension of B.S.3207, Part 1, to provide for 250-volt cables (see Exemption to Regulation B.1(vi)), ratings for particular applications of cables of this type will be provided by the Secretary of the Institution, on receipt of an application stating full details of the particular cable and installation concerned.

(e) SINGLE-CORE PAPER- OR VARNISHED-CAMBRIC-INSULATED CABLES, ALUMINIUM-SHEATHED

Ratings shall comply with Report F/T 183 issued by the Electrical Research Association.

(f) CABLES IN UNDERGROUND PIPES AND DUCTS

For cables of conductor size up to and including 0·06 square inch installed in pipes and ducts buried in the ground, the current ratings stated in the columns of the tables headed 'enclosed in conduit or trunking' (in air) are applicable.

For cables of conductor size 0·1 square inch and above, insulated with impregnated paper or varnished cambric, or p.v.c. (armoured), so installed, the current rating shall comply with E.R.A. Report F/T 183. It should be noted that the E.R.A. standard ratings for 15°C soil temperature apply only to cables in underground pipes or ducts between buildings; for cables buried in the floor of a building, the appropriate factor for ambient temperature must be applied.

(g) CABLES BURIED DIRECT IN THE GROUND

Current ratings for metal-sheathed underground cables, and for armoured p.v.c.-insulated cables having an overall extruded covering of p.v.c., buried direct in the ground in accordance with Regulation B.125 (vii-ix), shall comply with E.R.A. Report F/T 183.

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Later, in the reissued Fourteenth Edition of the IEE Wiring Regulations incorporating Amendments 1970, 1974 and 1976 including metric units, it was stated that current ratings shall be in accordance with ERA report 69-30 as seen below in Figure 4. It was not until the Seventeenth Edition of the IEE Wiring Regulations in 2008 that tabulated values were reintroduced as Table 4D4A (thermoplastic) and Table 4E4A (thermosetting).

Figure 4: extract from the Fourteenth Edition of the IEE Wiring Regulations 1966 incorporating Amendments 1970, 1974 and 1976

(g) CABLES IN UNDERGROUND PIPES AND DUCTS

For cables of conductor size up to and including 35 mm^2 installed in pipes and ducts buried in the ground, the current ratings stated in the columns of the tables headed 'enclosed in conduit or trunking' (in air) are applicable.

For cables of conductor size 50 mm^2 and above, insulated with impregnated paper to B.S.6480, or with p.v.c. to B.S.6346, so installed, the current ratings shall be in accordance with ERA Report 69–30†.

It should be noted that the ERA standard ratings for 15°C soil temperature apply only to cables in underground pipes or ducts between buildings; for cables buried in the floor of a building, the appropriate factor for ambient temperature must be applied.

(h) CABLES BURIED DIRECT IN THE GROUND

Current ratings for metal-sheathed underground cables, and for armoured p.v.c.-insulated cables having an overall extruded covering of p.v.c., buried direct in the ground in accordance with Regulation B.125 (vii–ix), shall be in accordance with ERA Report 69–30†.

(i) OVERHEAD LINE CONDUCTORS

For short overhead runs of sheathed cable complying with Regulation B.127(i), the normal current ratings for sheathed cables run open and clipped to a surface are applicable.

†ERA Report 69–30, Part I—'Sustained current ratings for paper-insulated lead, covered cables to B.S.6480: 1969, Part I'; Part II—'Sustained current ratings for paper-insulated aluminium-covered cables to B.S.6480: 1970, Part 2'; Part III—'Sustained current ratings for p.v.c. insulated cables to B.S.6346: 1970.' (Electrical Research Association, Cleeve Road, Leatherhead, Surrey).

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The ERA 69-30 series are still referred to in BS 7671:2018+A1:2020 today. Appendix 4 of item 7.1 reference method D states ***'if the specific installation parameters are known (thermal resistance of the ground, ground ambient temperature, cable depth), reference can be made to the cable manufacturer or the ERA 69-30 series of publications, which may result in a smaller cable size being selected.'*** as seen in Figure 5.

Figure 5

Reference Method D, for example, Installation Method 70 of Table 4A2 (multicore armoured cable in conduit or in cable ducting in the ground).

The cable is drawn into a 100 mm diameter plastic, earthenware or metallic duct laid in direct contact with soil having a thermal resistivity of 2.5 K.m/W and at a depth of 0.7 m. The values given for this method are those stated in this appendix and are based on conservative installation parameters. If the specific installation parameters are known (thermal resistance of the ground, ground ambient temperature, cable depth), reference can be made to the cable manufacturer or the ERA 69-30 series of publications, which may result in a smaller cable size being selected.

NOTE 3: The current-carrying capacity for cables laid in direct contact with soil having a thermal resistivity of 2.5 Km/W and at a depth of 0.7 m is approximately 10 % higher than the values tabulated for Reference Method D.

What are the ERA 69-30 series reports?

The ERA was commissioned to produce a series of reports on the current-carrying capacities of cables. The series of reports are called the ERA 69-30 series, previously called F/T183 and first published in 1955 have been referred to in the IEE Wiring Regulations for many years.

There are nine parts to the ERA 69-30 report series, covering different types of cables and installation methods. Part III of the ERA 69-30 provides values of current-carrying capacity and calculation methods for, '*sustained current ratings for 600/1000 V and 1900/3300 V cables with 70°C thermoplastic insulation (ac 50 Hz and dc).*' The values of current-carrying capacity tabulated in the report are in accordance with IEC 60287 *Electric cables - Calculation of the current rating.*

The ERA series of reports are still available and can be purchased from the RINA website.

An important note in the ERA 69-30 report Part III, states ***'cables installed in and around buildings subject to the provisions of the IEE Wiring Regulations, BS 7671, should be rated in accordance with those Regulations.',*** which is probably where the **'in or around buildings'** comes from in the description under reference method D in Table 4D4A as seen in Figure 6.

Figure 6

COPPER CONDUCTORS

TABLE 4D4A – Multicore armoured 70 °C thermoplastic insulated cables (COPPER CONDUCTORS)

CURRENT-CARRYING CAPACITY (amperes):

Ambient temperature: 30 °C
Ground ambient temperature: 20 °C
Conductor operating temperature: 70 °C

Conductor cross-sectional area	Reference Method C (clipped direct)		Reference Method E (in free air or on a perforated cable tray etc, horizontal or vertical)		Reference Method D (direct in ground or in ducting in ground, in or around buildings)	
	1 two-core cable, single-phase AC or DC	1 three- or four-core cable, three-phase AC	1 two-core cable, single-phase AC or DC	1 three- or four-core cable, three-phase AC	1 two-core cable, single-phase AC or DC	1 three- or four-core cable, three-phase AC
1	2	3	4	5	6	7
(mm^2)	(A)	(A)	(A)	(A)	(A)	(A)
1.5	21	18	22	19	22	18
2.5	28	25	31	26	29	24
4	38	33	41	35	37	30
6	49	42	53	45	46	38
10	67	58	72	62	60	50
16	89	77	97	83	78	64
25	118	102	128	110	99	82
35	145	125	157	135	119	98
50	175	151	190	163	140	116
70	222	192	241	207	173	143
95	269	231	291	251	204	169
120	310	267	336	290	231	192
150	356	306	386	332	261	217
185	405	348	439	378	292	243
240	476	409	516	445	336	280
300	547	469	592	510	379	316
400	621	540	683	590	-	-

What is soil thermal resistivity?

Thermal resistivity of soil is different to soil resistance. Soil resistance is the ability to pass electrical current, which is relevant to earthing systems. The thermal resistivity of soil refers to its ability to dissipate heat, which is relevant to the current-carrying capacity of cables.

Soil resistivity is affected by many factors including geographic location, soil composition and water flow and it will also change seasonally. It is important to consider that if the cables are supplying a continuous heavy load, this can cause the soil to dry out and increase the thermal resistivity.

Note the unit used for thermal resistivity of the soil in the Thirteenth Edition of the IEE Wiring Regulations was thermal ohm-cm as seen in Figure 2. Today we use K.m/W, Kelvin Metre per Watt, 120 thermal ohm-cm converts to 1.2 K.m/W (120/100 = 1.2). These values were based on the conditions identified in the supplement to Report No. F/T 183 issued by the ERA.

What are typical values of soil thermal resistivity?

By the time tabulated values for buried cables were reintroduced in the Seventeenth Edition of the IEE Wiring Regulations in 2008, the IEE Wiring Regulations had become a British Standard, BS 7671:2008, based on the European CENELEC HD 60364 series of standards. HD 60364-5-52 *Selection and erection of electrical equipment. Wiring systems*, states a general value of 2.5 K.m/W is considered necessary as a precaution for worldwide use when the soil type and geographical location are not specified.

The ERA 69-30 report assumes a soil thermal resistivity of 1.2 K.m/W, which corresponds with typical soil thermal resistivity for the UK in Annex A (A.22.2) of BS IEC 60287-3-1 *Electric cables - Calculation of the current rating: Operating conditions - Site reference conditions*, although this is considered to be a broad-brush statement.

It is important to remember that the testing carried out for the ERA 69-30 reports was under controlled conditions and using consistent backfill material, for example, in the real world it is much different.

Cement bound sand is a product which is available and can be used as backfilling material to ensure the thermal conductivity is of a known value and will remain consistent for the lifetime of the cable. However, this is unlikely to be a cost-effective option for smaller CSA cables when compared with using a more conservative cable size.

Why are cables selected smaller when using manufacturers' cable data?

Typically, electrical design software is used for cable selection on larger installations. Some electrical design software packages specifically refer to 'BICC cable data' but other manufacturer's data also exists, other software packages refer to 'ERA 69-30'. Most cable manufacturers data is based on the values used in the ERA 69-30 series but not all, so it is worth checking.

Issues can arise when [manufacturer's cable data] has been used by a consultant to complete the design, but when checked by the contractor against tables in BS 7671 directly, the sizing can appear to be inadequate. However, when the appropriate correction factors are applied, the results will be the similar as they are based on calculation methods derived from IEC 60287 *Electric cables - Calculation of the current rating*. The assumed values for each publication are identified in Table 1 below, the main influencing factor is the soil thermal resistivity.

Table 1

	BS 7671	**ERA 69-30**	**Correction factor** (Table)
C_a Ambient ground temperature	20°C	15°C	1.05 (4B2)
C_s Soil thermal resistivity	2.5 K.m/W	1.2 K.m/W	1.40 (4B3)
C_d Installation depth	0.7 m	0.5 m	1.03 (4B4)

The values used for calculation will depend on the actual ground conditions and material used for backfilling. The electrical designer must choose which is the most appropriate and apply the relevant correction factors. Unless specific values can be obtained, using the values direct from BS 7671 could be considered a safe option for the electrical designer.

When considering energy efficiency and the cost associated with a cable throughout its lifetime, it is important to remember that a smaller CSA cable will have higher energy losses (I^2R), when compared with larger CSA, this is because more heat is dissipated.

Other considerations

There are other considerations to be taken into account by the electrical designer when selecting a suitable CSA of cable, such as length, voltage drop, energy let through (I^2t) from the protective device and thus the energy withstand rating of the cable.

Summary

The current-carrying capacities of cables buried in the ground used in BS 7671:2018+A1:2020 and the ERA 69-30 report series are derived from the same calculation methods identified in the relevant parts of IEC 60287.

The current-carrying capacities published in BS 7671:2018+A1:2020 are based on tabulated values in HD 60364-5-52, whereas the current-carrying capacities used for manufacturers' data are based on the ERA 69-30 report series. The assumed values for ambient ground temperature, soil thermal resistivity and installation depth used in each publication are different which will result in a different cable size being selected. If the appropriate correction factors are applied, the results will be the same.

Unless specific details are known, the electrical designer should use the tabulated values provided in BS 7671:2018+A1:2020. Reference method D of BS 7671:2018+A1:2020 should be applied for cables buried in the ground in and around buildings.

It is the electrical designer's responsibility to apply the appropriate factors to ensure the cable is sized adequately, it would not be deemed acceptable to blame the electrical design software for any errors.

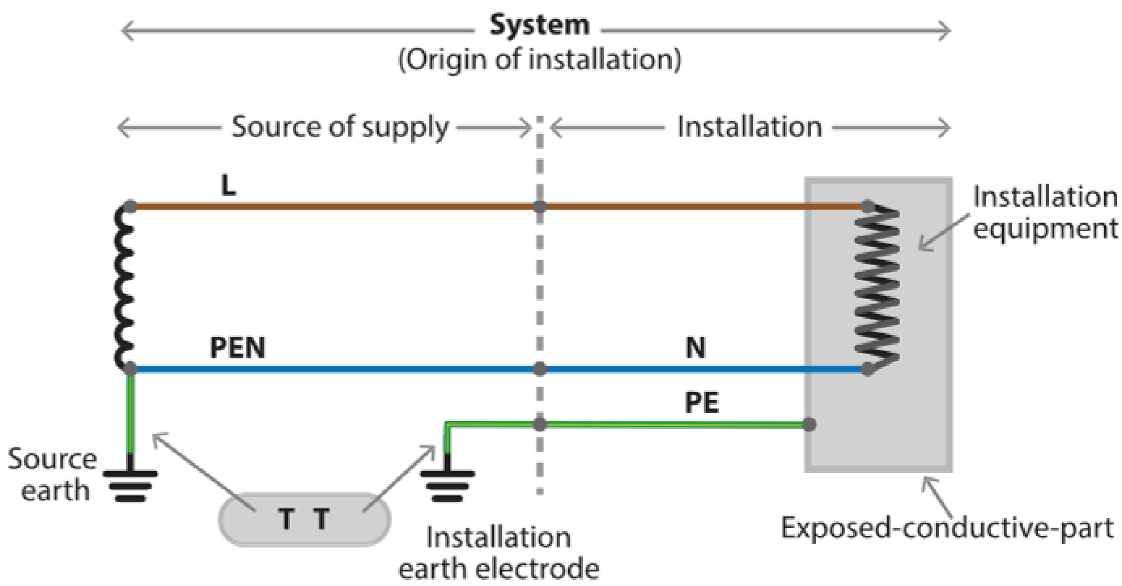
TT earthing considerations

By Michael Peace CEng MIET MCIBSE

What is a TT earthing facility?

TT earthing facilities are installed when the distributor does not provide a TN earthing system or when circumstances dictate that a TN earthing system cannot be used. 'T' is French for Terra, which translates to earth. The first 'T' of a TT earthing system relates to the earthing of the distributors transformer, the second 'T' is the earth electrode installed at the consumers installation as shown in Figure 1.

Figure 1



What is the method of protection against electric shock for TT systems?

For a TN system, automatic disconnection of supply (ADS) is the usual method of protection. The principle being that the low resistance earth loop and associated higher fault currents cause automatic disconnection within the required time. ADS can be used for TT systems providing a suitably low external loop impedance can be provided, but it is not usually the case.

Higher external earth fault loop impedances are usually associated with TT earthing systems, which don't provide sufficient fault current to operate fuses or circuit breakers within the required time and an RCD must be used for electric shock protection.

In order to fulfil the requirements of Regulation 411.5.3 of BS 7671:2018+A1:2020, the disconnection time shall be that required by Regulation 411.3.2.2 or 411.3.2.4 and $R_A \times I\Delta_n \leq$ 50 V. The requirements of this regulation are met if the earth fault loop impedance of the circuit protected by the RCD meets the requirements of Table 41.5.

Table 41.5

TABLE 41.5 –
Maximum earth fault loop impedance (Z_s) for non-delayed and time delayed 'S' Type RCDs to BS EN 61008-1 and BS EN 61009-1 for U_0 of 230 V (see Regulation 411.5.3)

Rated residual operating current (mA)	Maximum earth fault loop impedance Z_s (ohms)
30	1667*
100	500*
300	167
500	100

Disconnection shall be within the times stated in Table 41.1.

NOTE 1: Figures for Z_S result from the application of Regulation 411.5.3(i) and (ii).

NOTE 2: * The resistance of the installation earth electrode should be as low as practicable. A value exceeding 200 ohms may not be stable. Refer to Regulation 542.2.4.

What types of electrode can be used for TT earthing systems?

Any of the electrodes identified below, taken from Regulation 542.2.2 of BS 7671:2018+A1:2020, can be used for a TT earthing system.

(i) Earth rods or pipes
(ii) Earth tapes or wires
(iii) Earth plates
(iv) Underground structural metalwork embedded in foundations or other metalwork installed in the foundations
(v) Welded metal reinforcement of concrete (except pre-stressed concrete) embedded in the ground
(vi) Lead sheaths and other metal coverings of cables, where not precluded by Regulation 542.2.5
(vii) other suitable underground metalwork.

NOTE: Further information on earth electrodes can be found in BS 7430.

An earth rod is a simple and usually the most cost-effective method of providing an earth electrode. However, this may not be suitable for some installations and other types of electrodes may need to be considered.

Foundation metalwork embedded in concrete may be used as an earth electrode and can provide low earth resistance values, in some cases below 1 Ω. However, it is important to consider corrosion of the metal reinforcement, with respect to continuous leakage currents. DC earth leakage currents could cause corrosion and it may be necessary to consider cathodic protection.

See BS EN ISO 12696:2016 *Cathodic protection of steel in concrete* for further information on cathodic protection of steel in concrete.

What resistance values are required for a TT earthing system?

Table 41.5 of BS 7671:2018+A1:2020 states that 1667 ohms is the maximum earth fault loop impedance value where an RCD with a rated residual operating current of 30 mA is used. However, it is important to take into account the '*' referring to note 2, which states the resistance of the installation earth electrode should be as low as practicable and a value exceeding 200 ohms may not be stable. But what does not be stable actually mean?

Note 2 of Table 41.5 refers to Regulation 542.2.4 of BS 7671:2018+A1:2020, which states '*The type and embedded depth of an earth electrode shall be such that soil drying and freezing will not increase its resistance above the required value.*'

The main factor affecting resistance to Earth of an earth rod is the depth of installation. It is appreciated that this information is difficult to obtain, but to mitigate the effects of the soil drying out, the earth electrode should be installed at a depth sufficient to reach the water table of the soil to remain effective.

What effect does temperature have on soil resistivity?

Temperature plays a big part in soil resistivity, when the ground freezes, the resistivity increases substantially. An earth electrode which is installed during moderate weather may become ineffective during winter.

Table 1 indicates typical resistance values per metre for various temperatures for assumed conditions of 15.2% moisture content sandy loam. If the soil temperature varies from 20c to -5c, the resistivity increases 10 times, from 72 Ω/m to 790 Ω/m. This is why the note referring to 200 Ω may 'not be stable' is so important.

Table 1

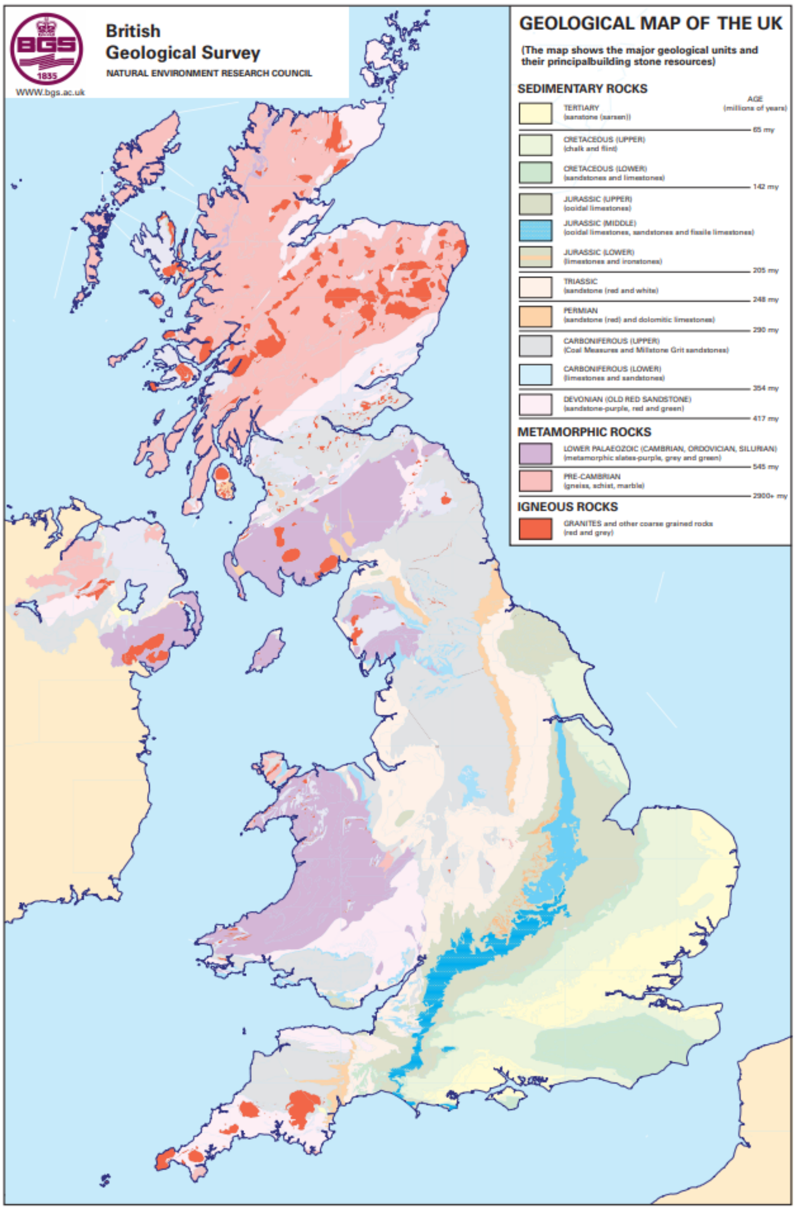
Temperature	Resistivity (Ω/m)
20	72
10	99
0 (water)	138
0 (ice)	300
-5	790
-15	3300

What other factors affect soil resistivity?

There are many factors which affect soil resistivity such as its physical composition, which is dependent on the geographical location. [Geology maps](#) can be consulted to determine what type of ground exists in different parts of the country. Table x indicates typical resistance values for different ground types. Other factors affecting soil resistivity include moisture content and chemical composition. Some minerals and salts can affect the resistance of soil and this may vary due to rainfall or presence of flowing water.

Geological map of the UK

Figure 2



Examples of soil resistivity

Table x from BS 7430:2011+A1:2015 *Code of practice for protective earthing of electrical installations*

Type of soil	Climatic condition			
	Normal and high rainfall, i.e. >500 mm/year		Low rainfall and desert conditions, i.e.<250 mm/year	Underground waters (saline)
	Probable value	Range of values encountered	Range of values encountered	Range of values encountered
1	2	3	4	5
Alluvium and lighter clays	5	A)	A)	1–5
Clays (except alluvium)	10	5–20	10–100	1–5
Marls (e.g. Keuper marl)	20	10–30	50–300	—
Porous limestone (e.g. chalk)	50	30–100	—	—
Porous sandstone (e.g. Keuper sandstone and clay shales)	100	30–300	—	—
Quartzite, compact and crystalline limestone (e.g. carboniferous sediments, marble, etc.)	300	100–1 000	—	—
Clay slates and slatey shales	1 000	300–3 000	1 000 upward	30–100
Granite	1 000	—	—	—
Fissiles shales, schists, gneiss and igneous rocks	2 000	1 000 upward	—	—

A) Depends on water level of locality.

Where should an earth electrode be installed?

There are several important factors to consider when selecting the location for an earth electrode. It is important that the earth electrode is not installed in close proximity to other earthing systems, that are above or below ground.

Where above ground, special care must be taken to avoid simultaneous contact of conductive parts connected to different earthing systems as a potential difference may exist between both systems. In some cases, it may be necessary to convert the whole installation to a TT earthing system.

Below ground, adequate separation is required from buried metallic structures and pipes connected to PME earthing systems. It is important to check this distance with the distributor as it can vary but most distributors specify a value of either 2 or 3 metres. However, the problem is understanding where these buried items are located in order to understand an adequate distance.

Earth potential rise (EPR)

EPR occurs during an earth fault, the potential of the electrode and soil in the vicinity is raised close to nominal voltage until the protective device operates.

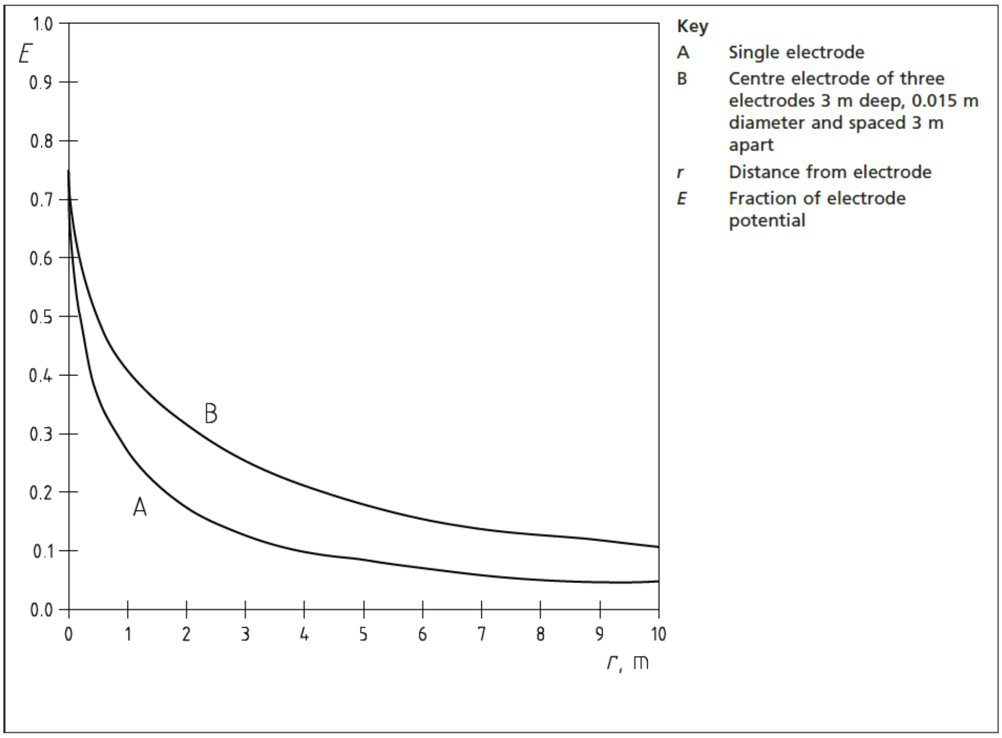
EPR in proximity to the earth electrode is an important factor which should be considered when installing TT earthing systems. It may be necessary to install a barrier to prevent contact by persons or livestock. This is especially important when wet barefoot persons or animals are in the vicinity. Animals are more susceptible to electric shock and it can only take a few volts to kill.

It might be worth considering that the distribution of ground surface potential in the vicinity of earth electrodes installed horizontally such as plates or rods are assumed to have smaller gradients than those of vertical electrodes. Further information on calculation of the fraction of earth electrode potential for horizontal electrodes can be found in BS 7430.

Two terms related to EPR are step potential and touch potential, step voltage is defined in the International Electrotechnical Vocabulary (IEV), as *'voltage between two points on the Earths surface'* a note states that *'typically, a distance of 1 m between the two points is considered to be the stride length of a human being'.*

Figure x provides fraction of ground surface potential around a single rod and three rods in a line. It can be seen that for a single electrode within a radius of 1 metre, the fraction of potential would be less than 0.3 of the earth electrode potential.

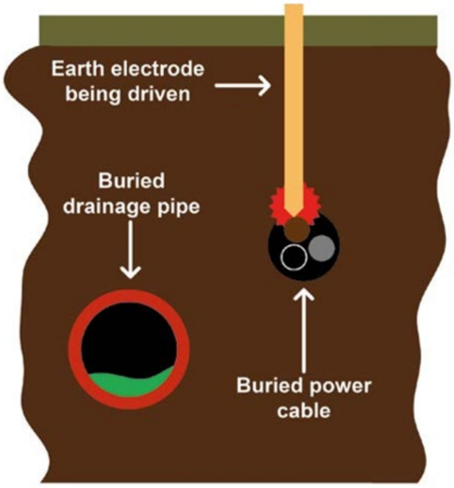
Figure 3 Ground surface potentials around a single rod and three rods in line



What precautions should be taken before installing an earth electrode?

Prior to the installation of an earth electrode, it must be ascertained what could be buried underground, striking buried services could cause serious injury or incur significant repair costs.

Figure 4



'Dial before you dig' is a free service available to anyone involved in construction and excavation, checking for utility assets in the vicinity of the proposed works. providing utility maps for cables and pipes. It is important to remember that this won't include private cable and pipes installations on private land.

Cable avoidance tools (CAT) are available to purchase or hire and can be used to detect cables and pipes underground, it is important that the user understands how to use the equipment correctly. These devices are designed to identify metallic objects and will not detect pipes made from other materials such as, plastic or clay.

What alternative earth electrodes and installation methods exist?

Where any doubt exists regarding driving earth rods, an alternative method of installing an earth electrode may be to use an earth mat or plate as it is referred to in BS 7671:2018+A1:2020. Earth plates are typically 600 mm x 600 mm x 3 mm and can be of lattice construction as seen in Figure 5.

Figure 5

A hole is required to be excavated to install an earth mat and backfilled on completion. It is important to ensure they are buried at a suitable depth to avoid drying out or freezing of the soil, this is usually at least 600 mm depth.

The benefit of this type of electrode is the hole can be hand dug using an insulated spade to minimise the risk of damage to services.

Another method is vacuum excavation, which is basically a large vacuum cleaner that uses compressed air and powerful fans to create a vacuum to remove the material from the ground, eliminating the risk of mechanical damage to services. At first this might seem like a costly option but when compared to serious injury or repair bills for services it is definitely worth consideration.

Figure 6

Does an earth electrode require maintenance?

An earth electrode doesn't require maintenance as such, but it does require periodic inspection and testing to verify it is suitable for continued use. It is good practice to plan the testing regime to take place at different times of the year to take into account seasonal variation affecting soil resistivity. It is generally accepted within the lightning protection industry for testing to take place every 11 months for this reason.

Summary

TT earthing systems are a safe and effective method of earthing and can be a good solution when the risks associated with PME earthing systems are unacceptable.

Careful consideration and planning is required when installing TT earthing systems or a hazardous situation could be created.

Engineering Networks Association (ENA) Engineering Recommendation G12/4 requires a TT earthing system for fuel filling stations, caravans, and boats.

Installing a TT earthing system is not a case of fit and forget, periodic inspection and testing is required to verify the protective measures are still effective and taking into account seasonal variations.

BS 7430:2011+A1:2015 *Code of practice for protective earthing of electrical installations* provides further information on earth electrodes.

Electrical Safety Standards in the Private Rented Sector

By Richard Giddings IEng MIET ACIBSE

Introduction

The IET's Technical Helpline continues to be inundated with queries relating to the practicalities of implementing the *Electrical Safety Standards in the Private Rented Sector (England) Regulations 2020.* (ESSPRS)

These place legal requirements on landlords to ensure that every electrical installation in a privately rented residential premise is inspected and tested at intervals of no more than 5 years, by an electrically qualified and competent person.

The Regulations apply in England to:

- All new tenancies granted (signed up to) from 1st July 2020, and
- All existing tenancies granted from 1st April 2021

This effectively means that an inspection has to be made to ascertain that the electrical installation provided in such a property is safe for continued use.

Further information about the Regulations can be found:

https://www.gov.uk/government/publications/electrical-safety-standards-in-the-private-rented-sector-guidance-for-landlords-tenants-and-local-authorities

This article addresses some of the pertinent aspects, from a practitioner perspective, although equally may serve as a useful reference to landlords, letting agents and property professionals alike.

It is intended to be read in conjunction with the recent Wiring Matters article covering Electrical Installation Condition Reports (EICRs), which may be found:

https://electrical.theiet.org/wiring-matters/years/2021/85-may-2021/eicr-myths/

Who should be doing the inspections?

One of the first hurdles encountered is the question of who can actually undertake the inspection? The simple answer is somebody who is 'competent'. Sadly, this is where things start to go wrong.

Unfortunately, there is no magic formula prescribed for demonstrating 'competence' in this field, although certainly experience and formal qualifications, particularly in the field of BS 7671 related electrical testing and inspection work, would feature strongly in the mix.

A property owner, landlord or letting agency, if undertaking due diligence in sourcing a suitable practitioner can often end up with conflicting guidance and opinion, especially as the majority of practitioners out there, if asked, would of course deem themselves competent!

Electrical Safety First's long-standing and industry-endorsed 'Best Practice Guide 4' covers electrical installation condition reporting (EICRs). It recommends that the person carrying out the inspection and testing must be electrically skilled to do so and also as a minimum:

- *Have adequate knowledge and experience of electrical installations to carry out such inspections safely*
- *Be well-versed and have full understanding of the current edition of BS 7671 – particularly the aspects relating to periodic inspecting, testing, and reporting*
- *Be adequately skilled in testing procedures and safe use of test equipment*
- *Have in-depth knowledge of the particular type of installation being tested*

The Electrical Safety Roundtable, an industry forum founded in 2012 by the Ministry of Housing, Communities & Local Government, provides further specific guidance in its publication:

http://www.electricalsafetyroundtable.co.uk/downloads/Electrical-Safety-Standards-in-the-Private-Rented-Sector-Regulation-ESR-Guidance.pdf

which suggests that the inspector holds:

- *Adequate insurance – including at least £2 million public liability and £250,000 of professional indemnity*
- *A qualification covering the current edition of BS 7671*
- *A qualification covering periodic inspection, testing and certification of electrical installations*
- *At least two years' experience in undertaking periodic inspections*

Attention is additionally drawn to another website, updated weekly, which lists organisations or individuals who have voluntarily put themselves forward for assessment and registration by a Government-approved Competent Person Scheme Operator, to demonstrate their competence in undertaking such reports:

https://www.electricalcompetentperson.co.uk/

Clearly, therefore, an electrical practitioner wishing to develop business opportunities in this field may want to consider gaining inclusion on this database if not already having done so. This would be instigated via membership of a relevant Government-approved Part P Competent Person Scheme. From a landlord's or property owner's perspective, clearly this should be the first place to look, if trying to locate a local suitable electrically 'competent' person.

It should be noted that the database in its search parameters differentiates between parties suitable for installation work only and for carrying out inspections, as there are significant differences in the skill sets needed.

Electrical installation condition reports (EICRs)

With an EICR, concluding a 'satisfactory' outcome is the target to aim for to satisfy the ESSPRS Regulations, and although a new concept to many parties and professionals in the rental sector, should certainly not be new to practitioners familiar with BS 7671.

However, EICRs, the manner in which they are conducted, concluded, and followed up, continues to generate much controversy and often unnecessary dispute, which can sometimes end up involving litigation.

Although the separate EICR Wiring Matters article covers the process of these reports and some of the many myths associated with them in more depth, specific topics relevant to EICRs in residential premises are however worth a mention here:

Sampling

Whilst this concept may be more relevant to larger or complex installations it often causes contention and can lead to liability issues if incorrectly applied to smaller installations such as residential properties.

Guidance given by the Electrical Safety Roundtable suggests that 100% of a residential installation should be tested to ensure it is safe for continued use, with a further recommendation for at least 20% of all wiring accessories to be opened up for a detailed internal examination.

Fig 1 At least 20% of wiring accessories should be examined

Whilst a full examination of all accessible parts of an installation would be considered to be best practice, in reality this may sometimes be impractical.

Where limits apply to what can be/will be inspected, right at the outset these need to be formally agreed with the person ordering the work. As a practitioner undertaking such inspections, it will be essential to fully detail these on the report, together with the name of the person with which it has been agreed.

Finally remember – **the more exclusions or limitations a report contains, the less use it will be!**

Think of EICRs very like MOT inspections on a motor vehicle. What use would a vehicle MOT inspection be if it were perhaps to be cut back due to cost considerations, and riddled with exclusions and unexamined areas? Would you feel safe driving such a car?

Fig 2 Agree the scope and extent of the inspection carefully, particularly 'sampling' and any excluded areas or items

Frequency of inspections

This is another area that causes contention.

The ESSPRS regulations require as a minimum that such inspections be undertaken at least every five years.

Other guidance, notably in the IET's Guidance Note 3 (to BS 7671), suggests that in the case of an existing installation, the duration until the next periodic inspection is to be determined solely by the competent person undertaking the inspection, based on their engineering judgement. A recommendation is also made in Guidance Note 3 for such inspections in domestic accommodation, rented houses and flats to also be undertaken at changes in occupancy.

https://shop.theiet.org/guidance-note-3-inspection-testing-8th-edition

Also consider the fact that many tenancies are often less than five years in duration, and consequently there may be changes of occupancy within such a five year period.

It is not unheard of for an electrical installation to be damaged or rendered unsafe during a tenancy, after an initial inspection, and then a subsequent tenancy change occurs. Consider therefore very carefully the potential legal liabilities and ramifications if this subsequent new tenant were to be injured or worse by an unsafe electrical installation.

Remedial work following an EICR

Assuming that the EICR has been undertaken correctly, the report may have flagged up some Code C1 or C2 deficiencies, that will have resulted in an 'unsatisfactory' outcome being recorded. Additionally, there may be a need for further investigative work (coded 'FI').

All of these scenarios will need further work undertaken, time committed and money spent before a satisfactory outcome can be arrived at and the rented premises considered electrically safe.

The ESSPRS requires that this remedial work is carried out by a competent person within a maximum of 28 days, or the period specified in the report if less than 28 days.

Best practice, for any item that is considered as presenting immediate danger (and perhaps allocated a C1 code by the inspector) is for it to be dealt with immediately, particularly if the property is occupied and the electrical installation energised and in use.

Upon completion of the necessary work, BS 7671:2018+Amd1:2020 will often require appropriate verification and certification (Electrical Installation Certificate and/or Minor Electrical Installation Works Certificate) to be completed covering the extent of the remedial work undertaken.

Such follow up certification can then accompany the original 'unsatisfactory' EICR to prove the remedial work is complete, and the installation this considered safe. Alternatively, it may be agreed between parties that a new EICR is to be issued concluding 'satisfactory'.

Existing certification or reports

In some instances, existing BS 7671 certification or an EICR report may be available, which leads to the inevitable question of whether they will suffice in lieu of having to undertake a new EICR.

In all cases, very careful study will need to be made, to establish what the existing report or certificate actually covers.

In many instances, it will be apparent that the extent of the work previously certificated or reported on may not extend to fully cover the overall condition of the whole installation. A good example here would be an Electrical Installation Certificate - covering perhaps only a replacement consumer unit or a kitchen extension. Understandably, such certification may not have covered the same scope that a full EICR would have to cover to satisfy the ESSPRS Regulations.

In the case of an existing EICR (or perhaps an Electrical Installation Certification if less than 5 years old) covering the whole installation, guidance suggests that such documentation may be considered. A very careful review should be made, addressing factors such as how long ago the report or certification was produced, if the property has been let since, if there has been a high turnover of tenants, or any other factors such as alterations or damage to the installation.

Where any doubt exists, best practice to safeguard all parties' long-term legal liabilities would be to undertake a new inspection, to draw another motoring parallel would be selling a secondhand car with a new MOT.

Electrical appliances

The ESSPRS Regulations do not define any requirements relating to built-in, fixed, or portable appliances provided by a landlord. Typically, these might include things such as central heating boilers, water heaters, showers, laundry equipment, immersion heaters and other appliances or white goods.

However, such equipment itself can (and often does) pose hazards of fire and electric shock, suggesting that best practice would of course be to somehow inspect and test them.

It is common practice by practitioners for these to be excluded from the scope of an EICR as, clearly, they are not considered BS 7671-related.

In many instances, the testing regime applicable to appliances (often still colloquially known as 'PAT testing') would be applicable, with proof of such being undertaken being an ideal.

The IET's 5th edition of its 'Code of Practice for In-service Inspection and Testing of Electrical Equipment' provides definitive guidance in this respect, focussing now very much on a risk-based approach rather than defined testing at fixed intervals.

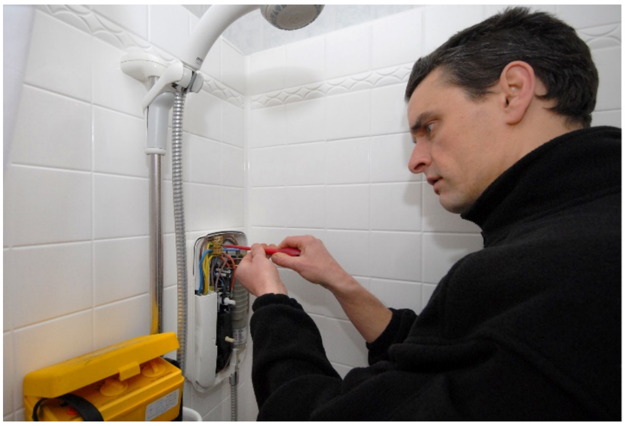
https://electrical.theiet.org/wiring-matters/years/2020/81-july-2020/the-all-new-5th-edition-of-the-iet-code-of-practice-for-in-service-inspection-and-testing-of-electrical-equipment/

It is also considered best practice, to check if any appliances have been subject to any manufacturer's safety recalls.

A good source for following this up can be found here:

https://www.electricalsafetyfirst.org.uk/product-recalls/?gclid=EAIaIQobChMI2br21Zyr8gIVDz5gCh3y-AYMEAAYASAAEgJGkfD_BwE

Fig 3 Consider how fixed electrical appliances forming part of the electrical installation are to be included, and if they have been subject to a manufacturer's safety recall



Smoke detection & fire alarms

The Smoke and Carbon Monoxide Alarm (England) Regulations have been in force since 1 October 2015.

They require private sector landlords to have at least one smoke alarm installed on every storey of their property and a carbon monoxide alarm in any room containing a solid fuel burning appliance. Such alarms need to be proven as functional at the start of each tenancy.

https://www.gov.uk/government/publications/smoke-and-carbon-monoxide-alarms-explanatory-booklet-for-landlords/the-smoke-and-carbon-monoxide-alarm-england-regulations-2015-qa-booklet-for-the-private-rented-sector-landlords-and-tenants

The Regulations do not however specify type of alarms, i.e., battery or mains-powered and not surprisingly this is another area in which much controversy abounds.

Definitive guidance in this respect can be found in Table 1 of BS 5839-6:2019 *Code of practice for the design, installation, commissioning and maintenance of fire detection and fire alarm systems in domestic premises.*

Of note is the fact that BS 5839-6:2019 **no longer recognizes detection powered by battery power alone as now suitable for rented dwellings.**

Smoke detection issues (other than related wiring) is not covered under BS 7671 and therefore should not be attributed any coding under an EICR. Its absence or inappropriateness should not contribute to an 'unsatisfactory' conclusion on such a report.

Industry best practice, however, suggests that any noted deficiencies in these respects are formally brought to the landlord's attention, with suitable factual recommendations being made where necessary.

Access and escape routes

Very often, a rental property may only be accessible through other common parts of a building, which will form the vital fire escape route. It is common for these areas to be under the ownership, control, and jurisdiction of other parties.

Consideration must be given to electrical safety aspects in these areas since they will form the safe access and egress to the rental property concerned. In many cases they may also be a 'protected escape route', which is subject to even higher fire safety considerations under the Building Regulations.

In particular as a minimum, the following points need consideration:

- Lighting
- Emergency lighting
- Fire alarm coverage

In all cases, it should be established:

- if these safety services are needed?
- if so, are they provided?
- are they adequate?
- together with who is responsible for their upkeep?

Where any doubt exists, this should be formally brought to the attention of the landlord and, if separate, the building owner.

Fig 4 Access & egress routes – who is responsible? Very often a grey area, and often inadequately served

Conclusion

The work associated with ensuring overall electrical safety in private rental properties can provide a good business opportunity for suitably skilled, experienced, and qualified practitioners.

Equally it can also be a minefield for landlords or property professionals.

In all cases, it will be essential to recognize what standards apply, and what is required by those standards before undertaking inspections, giving any advice or recommendation for any remedial work.

Whilst it has sadly been the case that the IET Technical Helpline has received many calls from landlords and property professionals, who have received incorrect advice as well as sometimes having been mis-sold unnecessary work, it is hoped that this article will provide a useful source of reference and help drive up standards.