125 Toolbox TALKS

SPONSORED BY aico®


125
Toolbox
TALKS
SELECT
SPONSORED BY aico
CATHERINE GILLON
Director of Employment Affairs
SAFETY HELMET

125 Toolbox TALKS
SELECT
SPONSORED BY aico

OUR EXHIBITORS

ACUTEST

aico

AURORA LIGHTING GROUP

DAIKIN

Dimplex

electrium

ehc the electric heating company

EUROPA

FLEXEL

FLUKE

Instrument Repairs and Calibration

KSR LIGHTING

LUCECO GROUP

Megger

OVIA ScolmoreGROUP

POWERQUALITY EXPERT

ROBUS

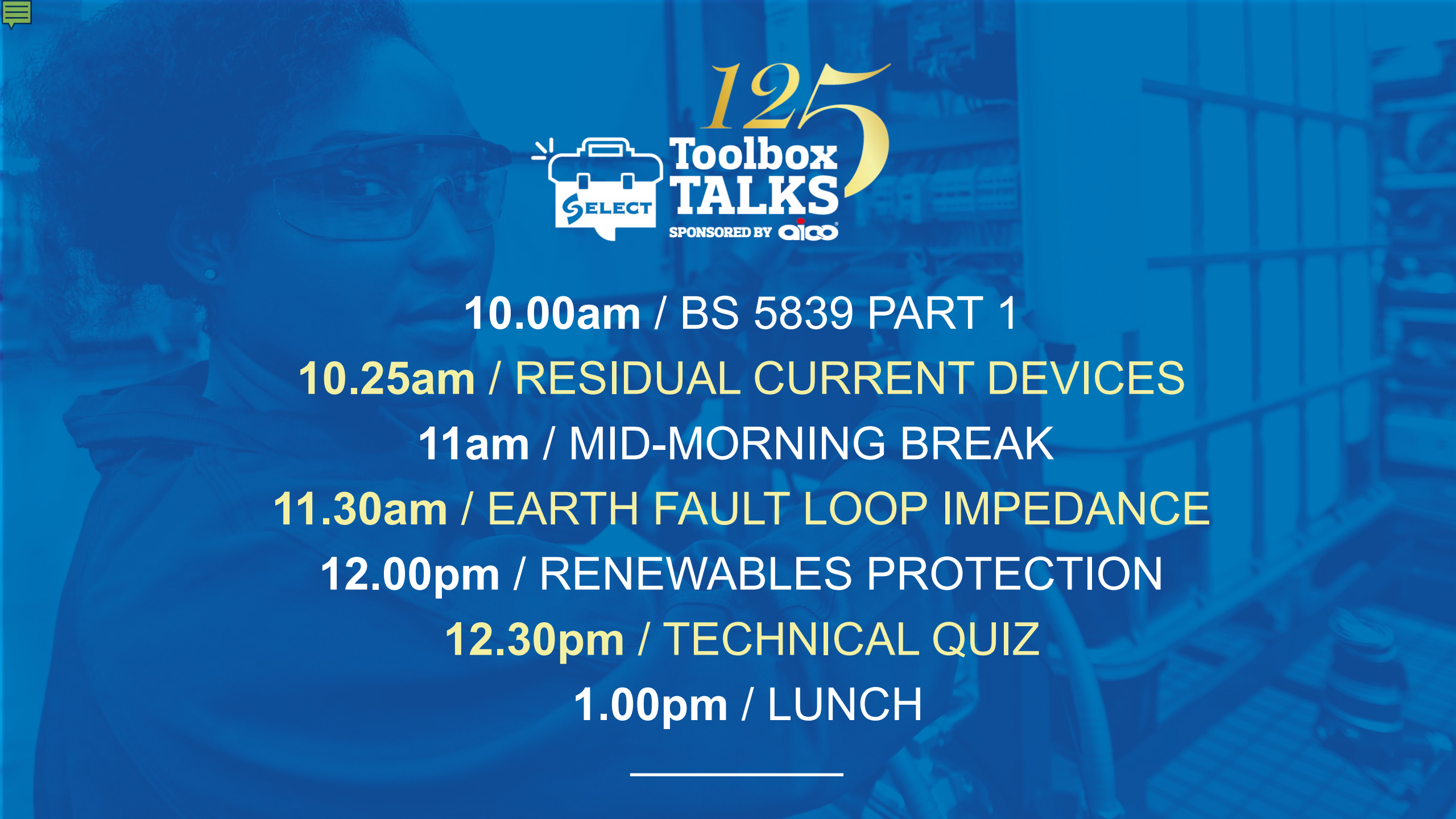
ROSS PROMOTIONAL PRODUCTS • ESTABLISHED 1984 •

Scolmore GROUP

SIMPRO

TIS

V-TAC



10.00am / BS 5839 PART 1

10.25am / RESIDUAL CURRENT DEVICES

11am / MID-MORNING BREAK

11.30am / EARTH FAULT LOOP IMPEDANCE

12.00pm / RENEWABLES PROTECTION

12.30pm / TECHNICAL QUIZ

1.00pm / LUNCH

125

SELECT Toolbox TALKS

SPONSORED BY aico

BS 5839-1:2025
AN UPDATE

MAY/JUNE 2025

WHAT IS BS 5839-1?

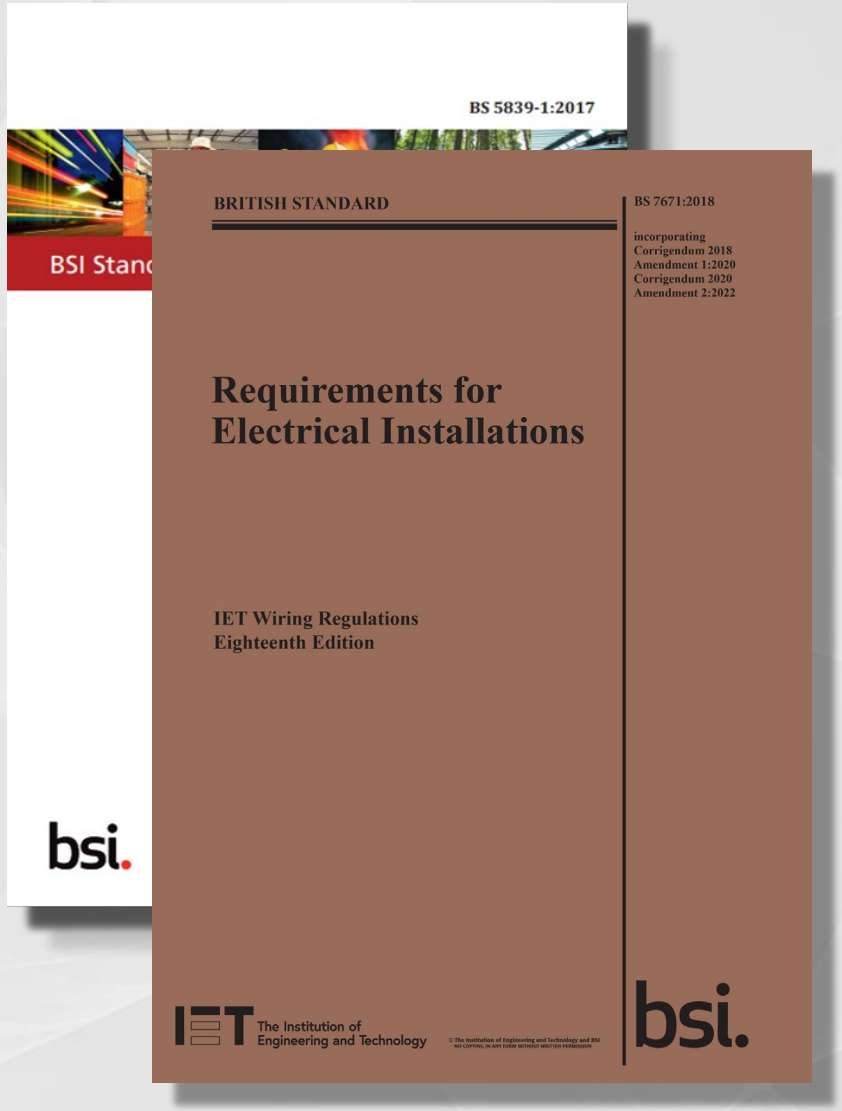
- British Standard 5839 Series covers fire detection and alarm systems for buildings.
- Part 1 is the code of practice (COP) for design, installation, commissioning and maintenance of systems in non-domestic premises.

RELATIONSHIP BETWEEN BS 5839 AND BS 7671

Regulation 110.1.3 from Part 1 of BS 7671 states:

> *"In certain circumstances the regulations may require to be supplemented by the requirements or recommendations of other British or Harmonized Standards."*

The regulation above gives ten cases for this requirement including in (v) – Fire detection and fire alarm systems for buildings – BS 5839

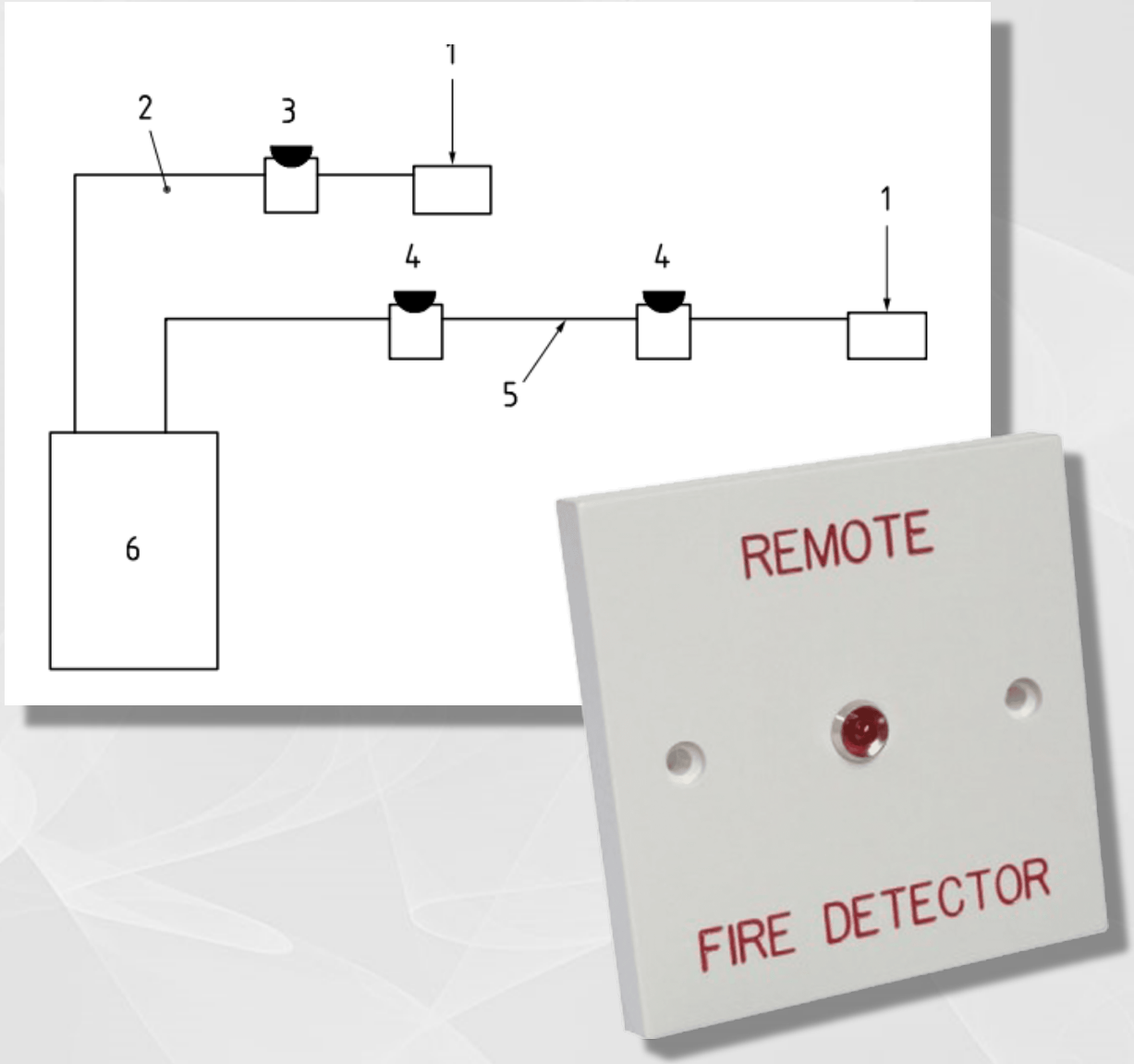


CHANGES TO BS 5839-1

- The COP has gone from seven sections to eight with the addition of a new Section 7 on **extensions and modifications.**
- The annexes have also increased with a new annex on the **calculation of false alarm rates**.

CHANGES TO BS 5839-1

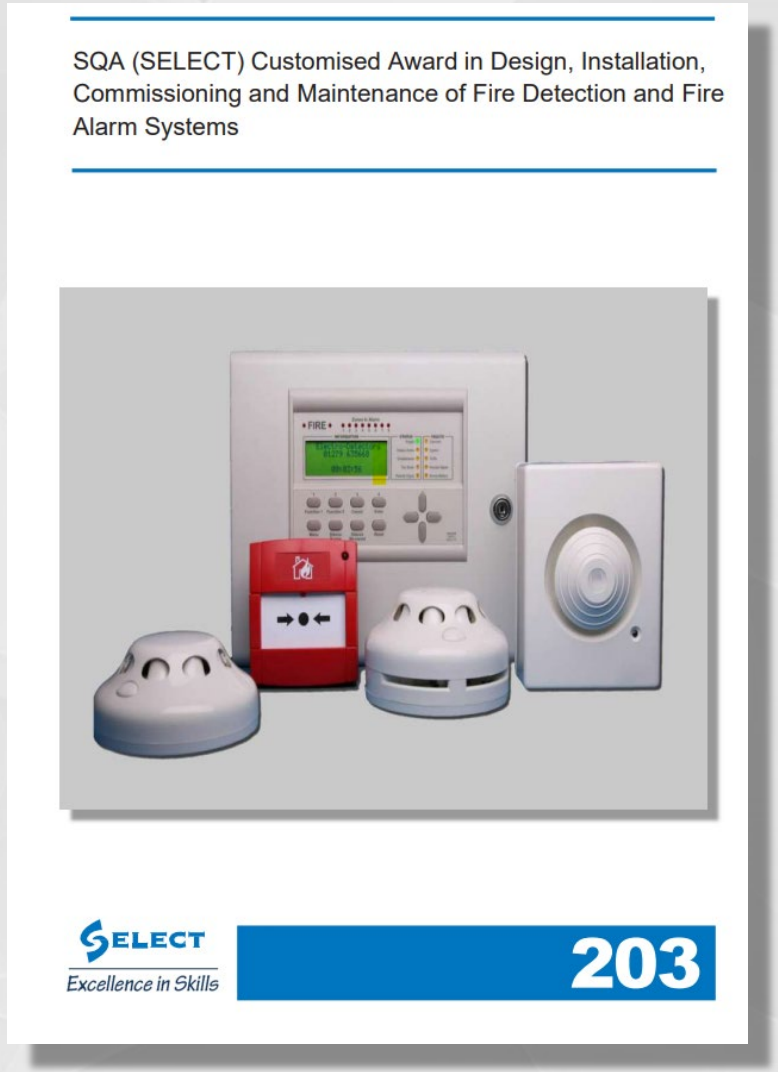
- Majority of changes are editorial, modernising and clarifying text.
- Diagrams repositioned to be more relevant to accompanying text, e.g. Figures 1, 2 & 3 in system integrity and fire detection zones.
- Colour of remote fire indicators also clarified.



CHANGES TO BS 5839-1

- The definition of a **competent person** is given as “a person, suitably trained and qualified by knowledge and practical experience, and provided with the necessary instructions, to enable the required task(s) to be carried out correctly”.
- A note has now been added:

> *“Maintenance of competence is likely to require continuing professional development (CPD).”*



CHANGES TO BS 5839-1

- As a COP, variations have always been acceptable.
- However, in the light of many fatal fires, some previously acceptable variations are now considered to be unacceptable.
- These include absence of a **zone plan** or other suitable diagrams where there is more than one zone on any floor or in premises where people sleep.

Continues >>

PROPOSED CHANGES TO BS 5839-1

- Another variation now considered unacceptable is the absence of a facility of transmission of a fire alarm signal to an alarm receiving centre (ARC) in:
  - ✗ Supported housing
  - ✗ Residential care home.

CHANGES TO BS 5839-1

- Recommendations for positioning of manual call points (MCPs) have been simplified.
- One example is height above finished floor level (FFL), which is now allowed to vary by **+200mm or -300mm**.
- Positioning of MCPs in escape routes and all storey exits has also been simplified.

CHANGES TO BS 5839-1

- In rooms in which people sleep, it is now recommended that preference is given to forms of **automatic fire detection other than heat detectors**, or sprinkler heads performing the same role as heat detectors.

CHANGES TO BS 5839-1

Examples of typical signs are given:

- When functionality is provided for automatic transmission of an alarm signal to an ARC, there should be a label with information to stop a false activation to summon the fire and rescue service.
- Likewise, when the ambient noise level exceeds 90 dB(A), visual alarm signals should be provided.

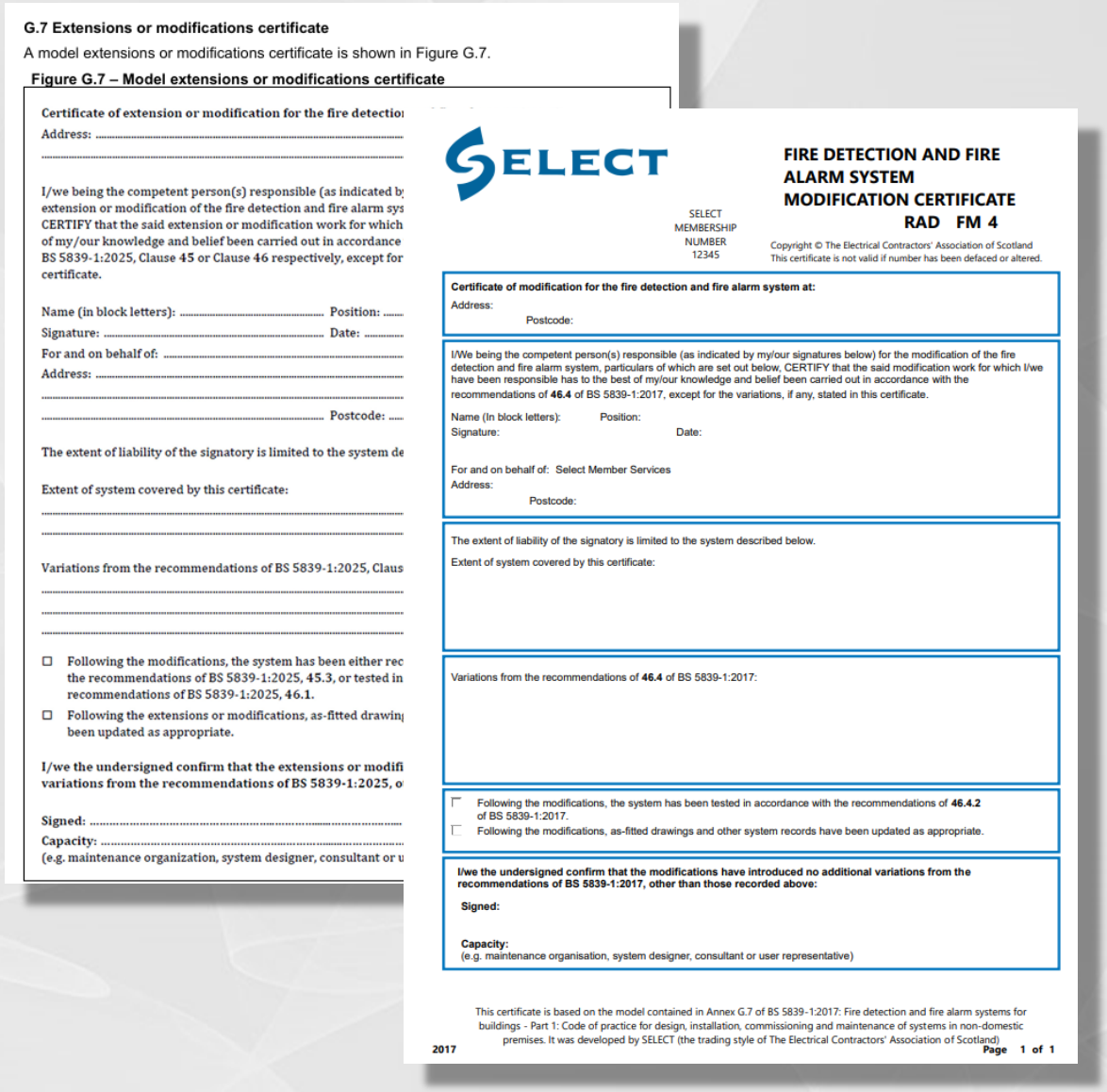
CHANGES TO BS 5839-1

Technical changes include compliance with BS 7671:2018+A3 including:

- Information on a functional earth (FE) conductor
- Additional text on complying with *521.10.202* regarding the fixing of cables.

CHANGES TO BS 5839-1

- The new **Section 7** covers the content of the previous 46.4 with the addition of information on the extension of an existing system.
- This section also confirms the required status of the modification or extension to an existing system as well as the need for an appropriate certificate from **Annex G**.
- **Certificate G7** is now for extensions or modifications.



G.7 Extensions or modifications certificate

A model extensions or modifications certificate is shown in Figure G.7.

Figure G.7 – Model extensions or modifications certificate

Certificate of extension or modification for the fire detectio

Address: .....

I/we being the competent person(s) responsible (as indicated b
extension or modification of the fire detection and fire alarm sys
CERTIFY that the said extension or modification work for which
of my/our knowledge and belief been carried out in accordance
BS 5839-1:2025, Clause 45 or Clause 46 respectively, except for
certificate.

Name (in block letters): ..... Position: .....
Signature: ..... Date: .....
For and on behalf of: .....
Address: .....
..... Postcode: .....

The extent of liability of the signatory is limited to the system de

Extent of system covered by this certificate:

Variations from the recommendations of BS 5839-1:2025, Claus

☐ Following the modifications, the system has been either rec
the recommendations of BS 5839-1:2025, 45.3, or tested in
recommendations of BS 5839-1:2025, 46.1.

☐ Following the extensions or modifications, as-fitted drawin
been updated as appropriate.

I/we the undersigned confirm that the extensions or modifi
variations from the recommendations of BS 5839-1:2025, o

Signed: .....

Capacity: .....
(e.g. maintenance organization, system designer, consultant or u

SELECT

FIRE DETECTION AND FIRE ALARM SYSTEM MODIFICATION CERTIFICATE

RAD FM 4

SELECT MEMBERSHIP NUMBER 12345

Certificate of modification for the fire detection and fire alarm system at:

Address:

Postcode:

I/We being the competent person(s) responsible (as indicated by my/our signatures below) for the modification of the fire detection and fire alarm system, particulars of which are set out below, CERTIFY that the said modification work for which I/we have been responsible has to the best of my/our knowledge and belief been carried out in accordance with the recommendations of **46.4** of BS 5839-1:2017, except for the variations, if any, stated in this certificate.

Name (In block letters): Position:

Signature: Date:

For and on behalf of: Select Member Services

Address:

Postcode:

The extent of liability of the signatory is limited to the system described below.

Extent of system covered by this certificate:

Variations from the recommendations of **46.4** of BS 5839-1:2017:

☐ Following the modifications, the system has been tested in accordance with the recommendations of **46.4.2** of BS 5839-1:2017.

☐ Following the modifications, as-fitted drawings and other system records have been updated as appropriate.

I/we the undersigned confirm that the modifications have introduced no additional variations from the recommendations of BS 5839-1:2017, other than those recorded above:

Signed:

Capacity:
(e.g. maintenance organisation, system designer, consultant or user representative)

This certificate is based on the model contained in Annex G.7 of BS 5839-1:2017: Fire detection and fire alarm systems for buildings - Part 1: Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises. It was developed by SELECT (the trading style of The Electrical Contractors' Association of Scotland)

2017

CHANGES TO BS 5839-1

The Annex section has been reorganised with a few changes as in the previous slide regarding **Certificate G7**:

- **Annex A** has the addition of healthcare premises regarding types of category.
- **Annex D** has the addition of vapour cloud under fire phenomenon for detector selection.

Annex A (informative)
Choice of appropriate category of fire detection and fire alarm system

Table A.1 describes the category of system that is typically installed in various types of premises.

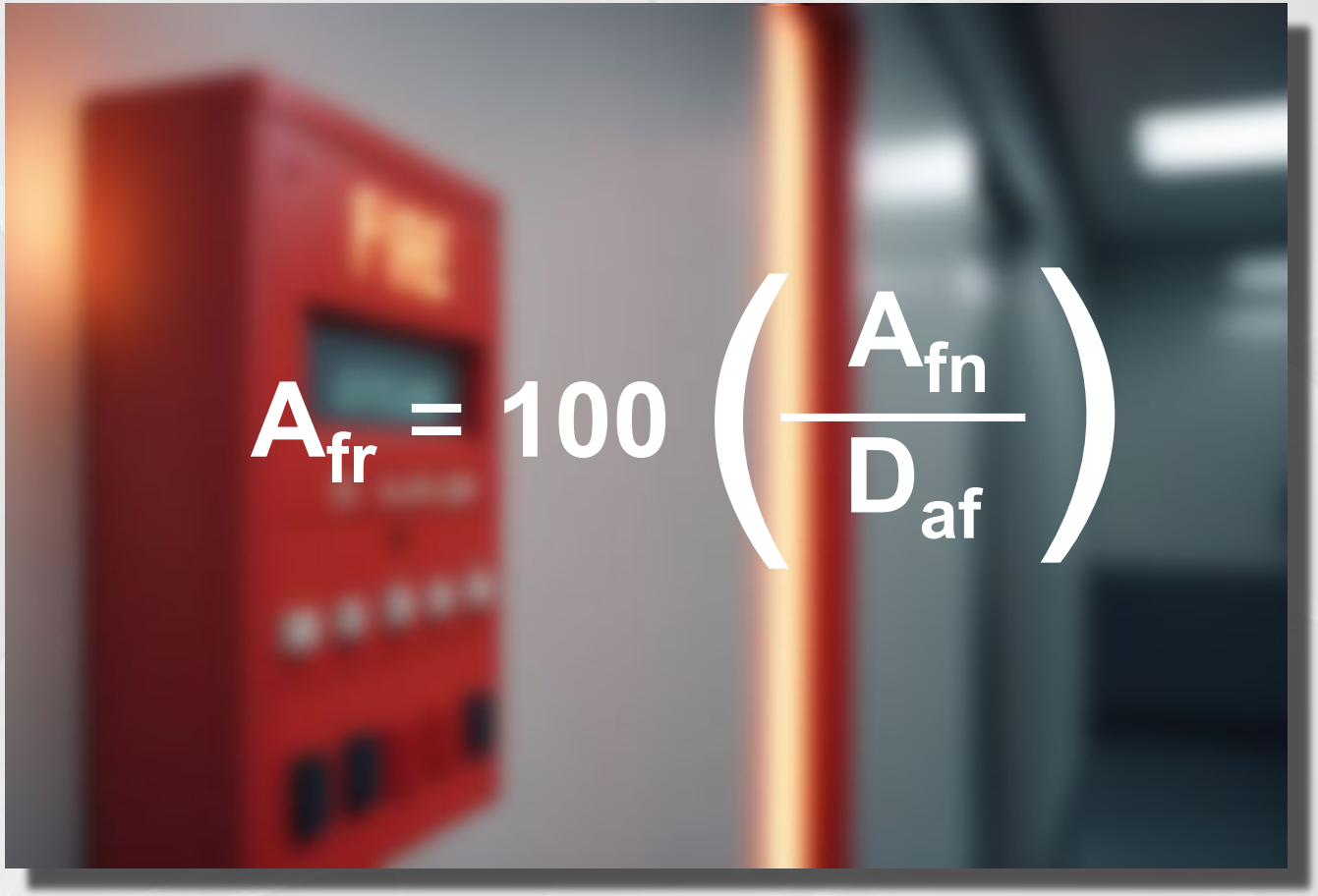
Decisions regarding the appropriate category of system for any specific building rest with the authorities responsible for enforcing legislation in the building: there can be more than one such enforcing authority.

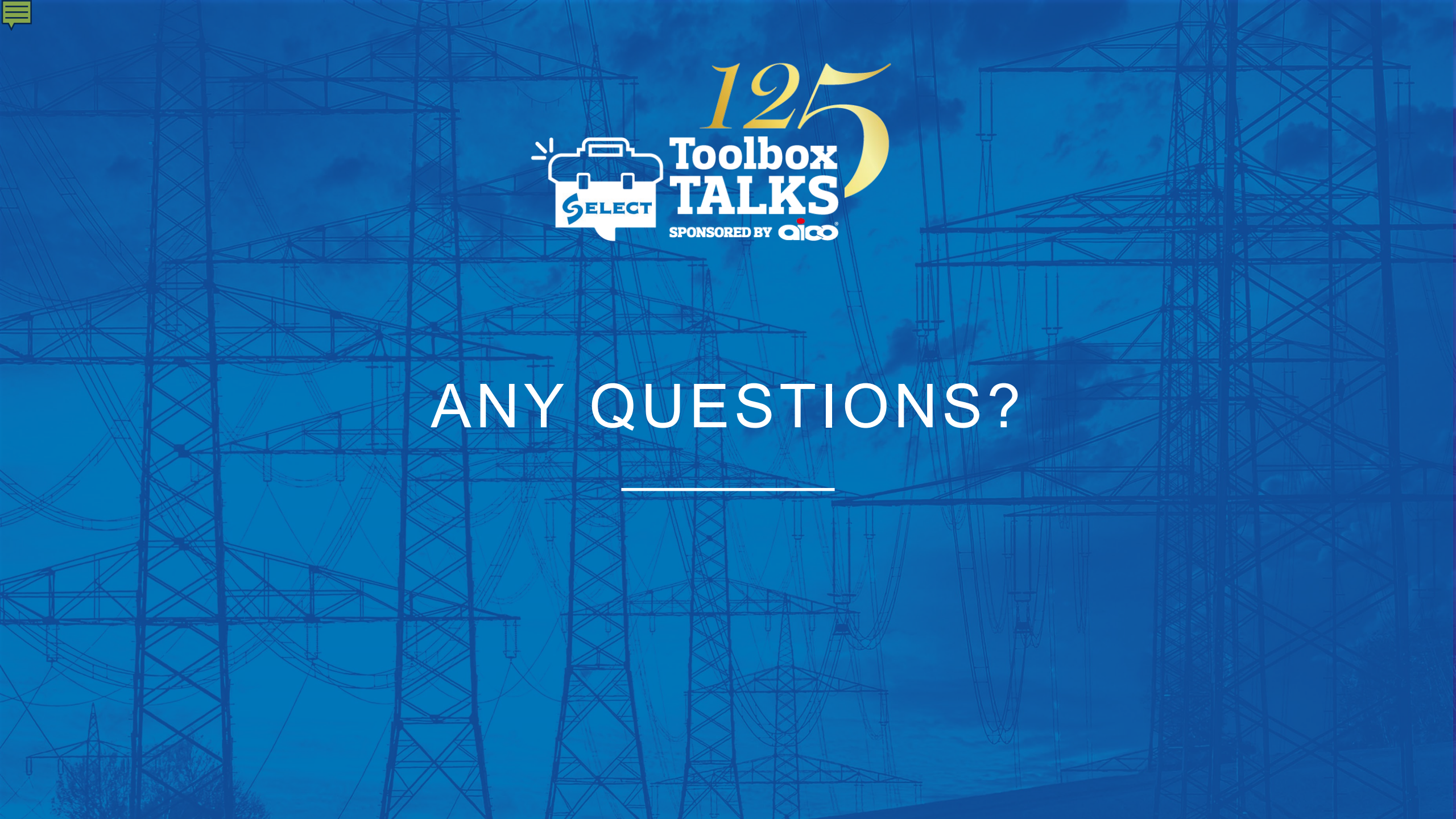
Table A.1 – Choice of appropriate category of a fire detection and fire alarm system

Type of premises	Typical category of system	Comments
Common places of work, such as offices, shops, factories, warehouses and restaurants	M or P2/M or P1/M	A Category M system can normally be expected to satisfy the requirements of legislation. It is, however, often combined with a Category P system to satisfy the requirements of insurers, as company policy for protection of assets, or to protect against business interruption.
Hotels, hostels, student accommodation, houses in multiple occupation and similar premises with sleeping accommodation	L1 or L2	In bedroom areas, the design requirements are usually based on the recommendations for a Category L3 system. Detectors are, however, typically installed in most other rooms and areas, as a fire in almost any area of the building could pose a threat to sleeping occupants; the system category is, therefore, at least L2. In practice, few, if any, areas are left unprotected and the system category is effectively L1.
Large public houses with no residential accommodation	M or M/P2	Category M/P2 is sometimes required by insurers, particularly in premises with a kitchen containing frying equipment and/or ovens.
Public houses with residential accommodation	L2	—
Schools, other than small single-storey schools with less than 160 pupils	M or M/P2 or M/P2/L4 or M/P2/L5	System category is normally based on a fire risk assessment. In many schools, a Category P system is installed to combat the hazard of arson. In schools that are partly occupied at certain times (e.g. during evening classes or community use), a Category L4 or L5 system is sometimes appropriate.
Hospitals	L1 (with possible minor variations)	Detailed guidance on areas to be protected and possible variations is given in HTM 05-03 Part B [N1] (in England and Wales) or SHTM 82 [N2] (in Scotland).
Healthcare premises without sleeping accommodation, e.g. walk-in healthcare centres	L2 or L3	Detailed guidance on areas to be protected and possible variations is given in HTM 05-03 Part B [N1] (in England and Wales) or SHTM 82 [N2] (in Scotland).

CHANGES TO BS 5839-1

- **Annex F** is a new annex on the calculation of false alarm rates.
- This includes the formula for calculating the false alarm rates, where:
  - ✓ A_{fr} = false alarm rate
  - ✓ A_{fn} = number of false alarms
  - ✓ D_{af} = number of automatic detectors.




125
Toolbox
TALKS
SELECT
SPONSORED BY aico
ANY QUESTIONS?

125

Toolbox TALKS

SELECT

SPONSORED BY aico

RESIDUAL CURRENT DEVICES (RCDs)

MAY/JUNE 2025

INTRODUCTION

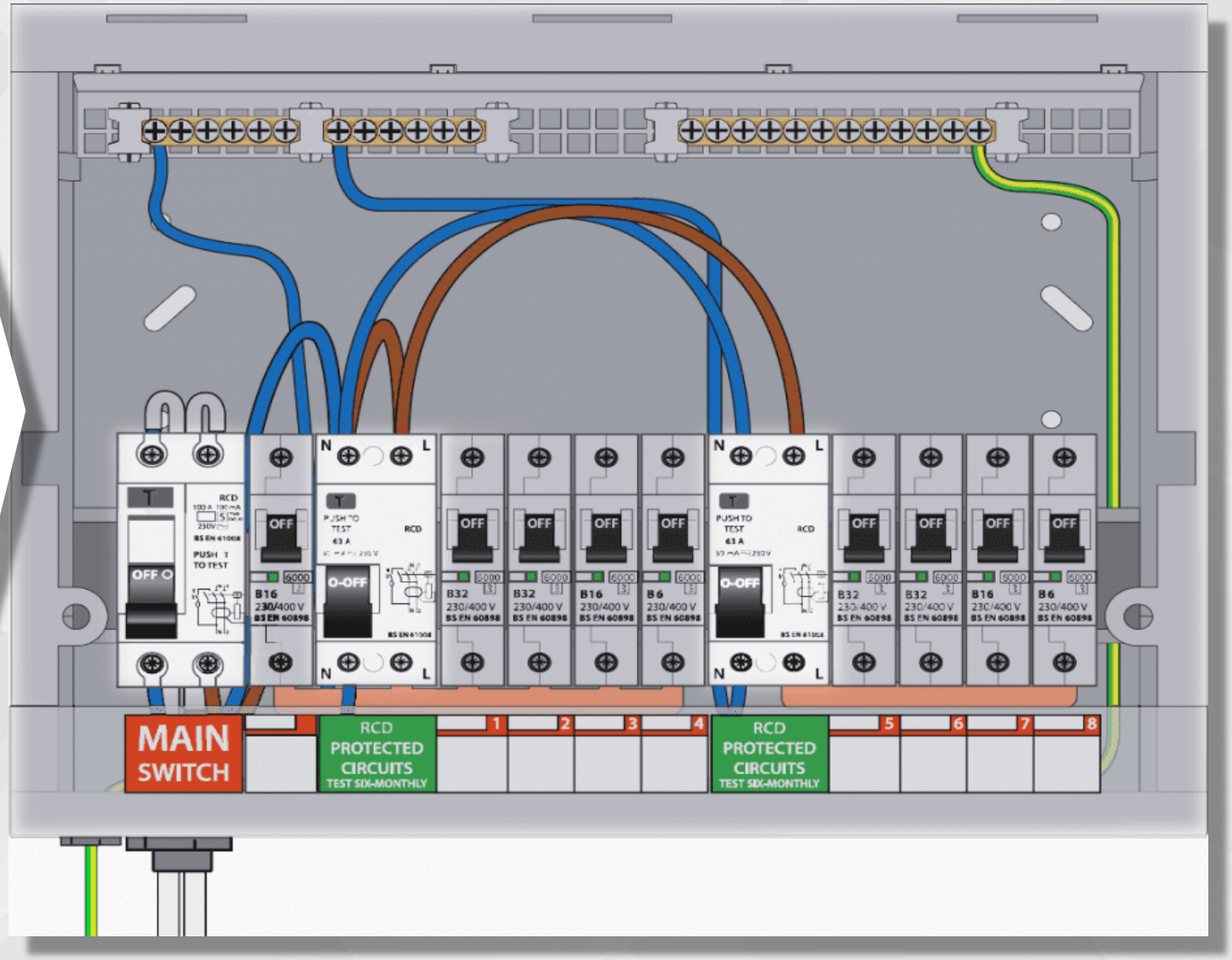
What is a Residual Current Device (RCD)?

“Mechanical switching device designed to make, carry and break currents under normal service conditions and to cause the opening of the contacts when the residual current attains a given value under specified conditions.”

DIFFERENT TYPES OF RCDs

Residual Current Circuit Breaker (RCCB) without protection against overload

- BS EN 61008
- BS 4293
- BS EN 62423



DIFFERENT TYPES OF RCDs

Residual Current Circuit-Breaker (RCBO) with protection against overload BS EN 61009

DIFFERENT TYPES OF RCDs

Residual Current Circuit-Breaker (RCBO) with protection against overload combined with BS EN 61009 and AFDD to BS EN 62606

DIFFERENT TYPES OF RCDs

Socket-Outlet incorporating a Residual Current Device (SRCD) with or without overcurrent protection BS 7288

DIFFERENT TYPES OF RCDs

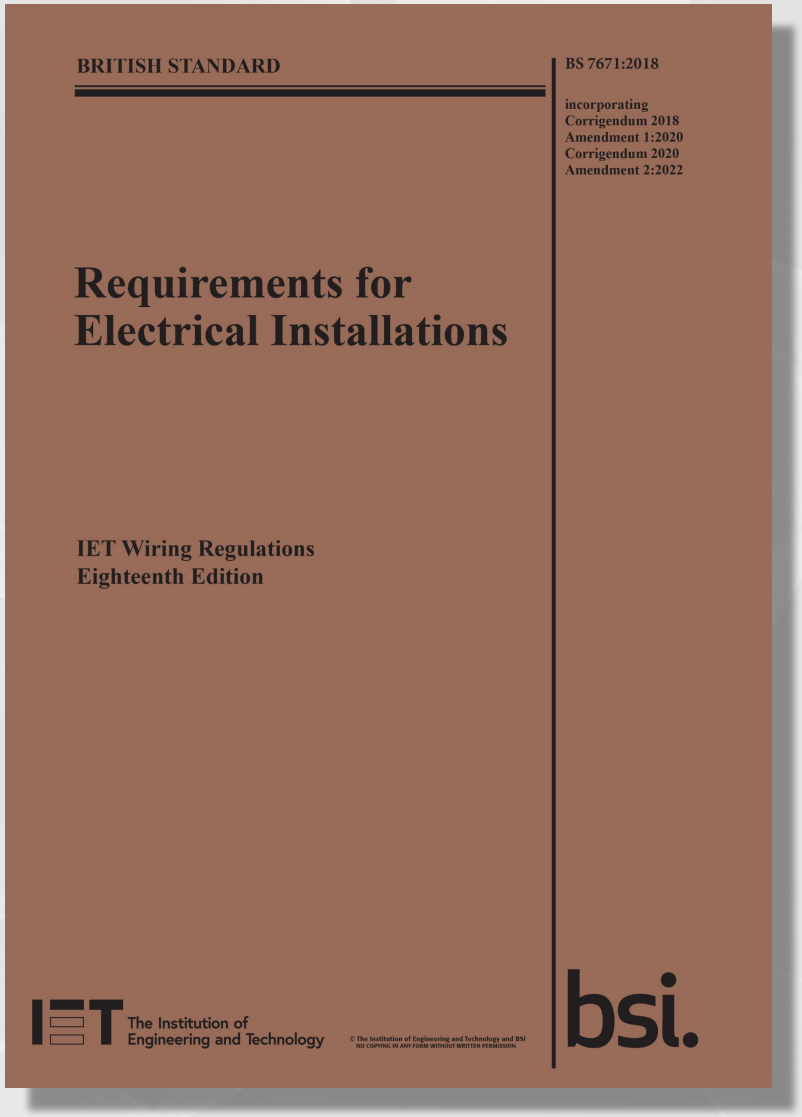
Portable Residual Current Device (PRCD) BS 7071

PURPOSE OF RCDs

- **Fault protection**
  Any tripping current dependent on the resistance of the earth path.
  Regulations 411.4.204; 411.5.2

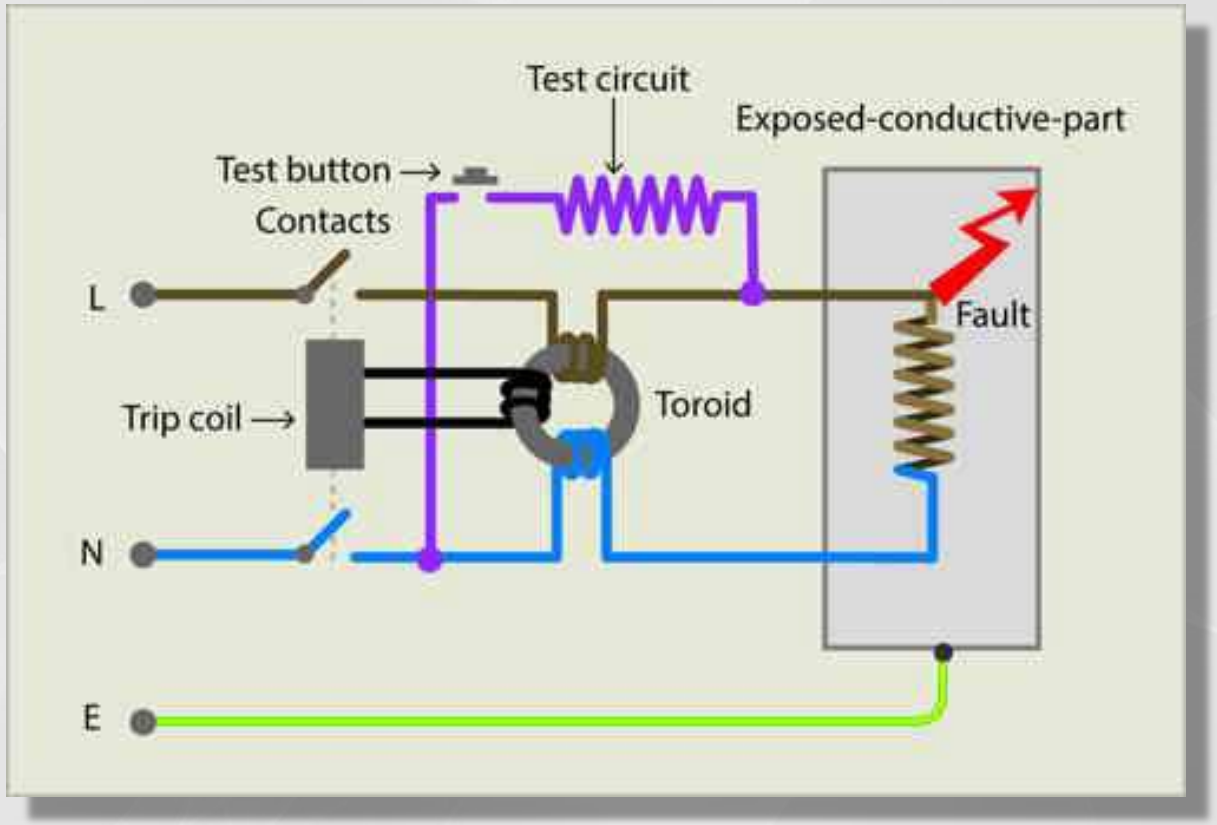
- **Additional protection**
  RCDs not exceeding 30 mA tripping current.
  415.1

- **Fire protection**
  A tripping current not exceeding 300 mA.
  422.3.9



HOW DO THEY WORK?

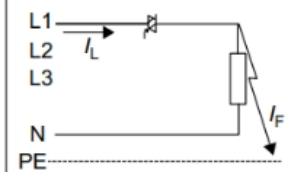
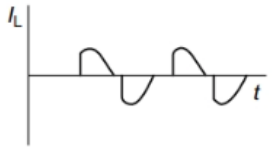
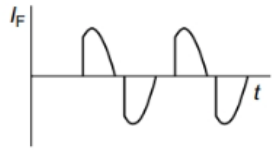
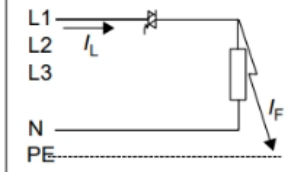
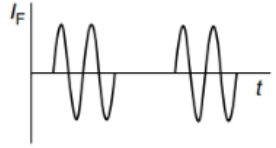
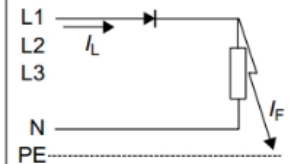
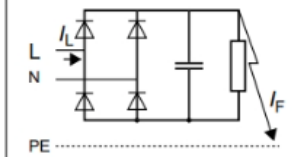
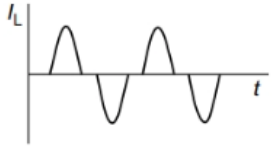
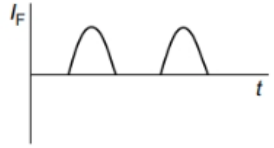
- RCDs monitor the flow of current in a circuit's live conductors.
- If the flow of current is imbalanced due to an earth leakage current of a set nominal value, the device will trip to cut off the supply to the circuit.
- While RCDs have a nominal tripping current ($I_{\Delta n}$), they may trip below the nominal value.
- For example, a 30 mA RCD is required to trip at a current between 18 mA to 28 mA.



DC RESIDUAL/FAULT CURRENT

- **BS 7671:2018 Annex 53, Figure A53.1** provides examples of possible fault currents in systems with semiconductors.
- This demonstrates how the shape of the waveform is affected on various types of circuits under load and fault conditions.

Fig A53.1 – Possible fault currents in systems with semiconductors

	Circuit diagram with fault location	Shape of load current I_L	Shape of earth fault current I_F	Protection provided by RCD tripping characteristic
1	Phase control 			AC, A, F, B
2	Burst control 			AC, A, F, B
3	Single phase 			A, F, B
4	Two-pulse bridge 			A, F, B

DC RESIDUAL LEAKAGE

- Variable-speed drives
- LED lighting
- Washing machines
- Dishwashers
- Tumble dryers
- Induction hobs

DC RESIDUAL LEAKAGE: SOLAR PV SYSTEMS

DC RESIDUAL LEAKAGE: EV CHARGING EQUIPMENT

TYPES OF RCD

RCD Type AC

RCD tripping on alternating sinusoidal residual current, suddenly applied or smoothly increasing.

RCD Type A

RCD tripping on alternating sinusoidal residual current and on residual pulsating direct current, suddenly applied or smoothly increasing.

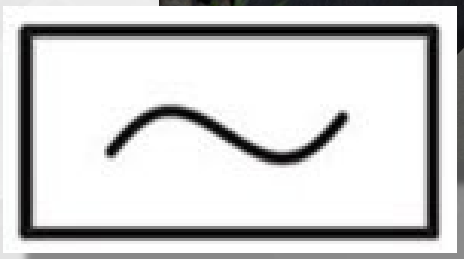
***NOTE**: For RCD Type A, tripping is achieved for residual pulsating direct currents superimposed on a smooth direct current up to 6 mA.*

TYPE AC

Examples of suitable circuits:

- Electric showers
- Oven
- Hob
- Immersion heater
- Tungsten lighting.

Type AC devices can detect and respond to AC sinusoidal wave current only.

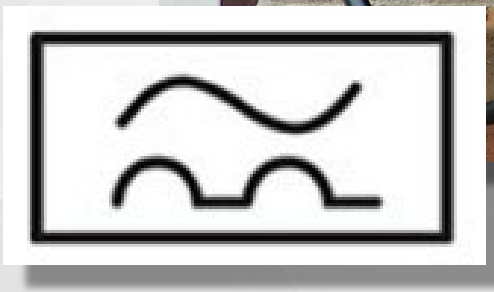


TYPE A

Examples of suitable circuits:

- Inverters
- Oven
- Induction hobs
- Electric vehicle charging equipment
- LED lighting, dimmers and drivers.

Type A devices are also suitable for Type AC applications.

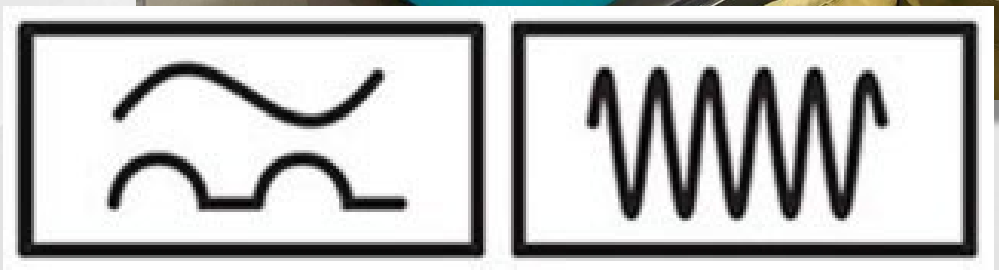


TYPE F

Examples of suitable circuits:

- Air con with speed control
- Class 1 power tools
- Industrial washing machines
- Dishwashers
- Tumble dryers with synchronous motors.

Type F devices are also suitable for Type AC and Type A applications.

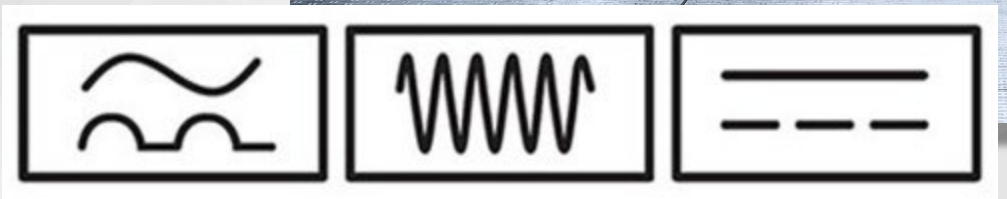


TYPE B

Examples of suitable circuits:

- PV systems
- Lifts
- Escalators
- Welding equipment
- Large scale EVCE.

Type B devices are also suitable for Type AC Type A and Type F applications.

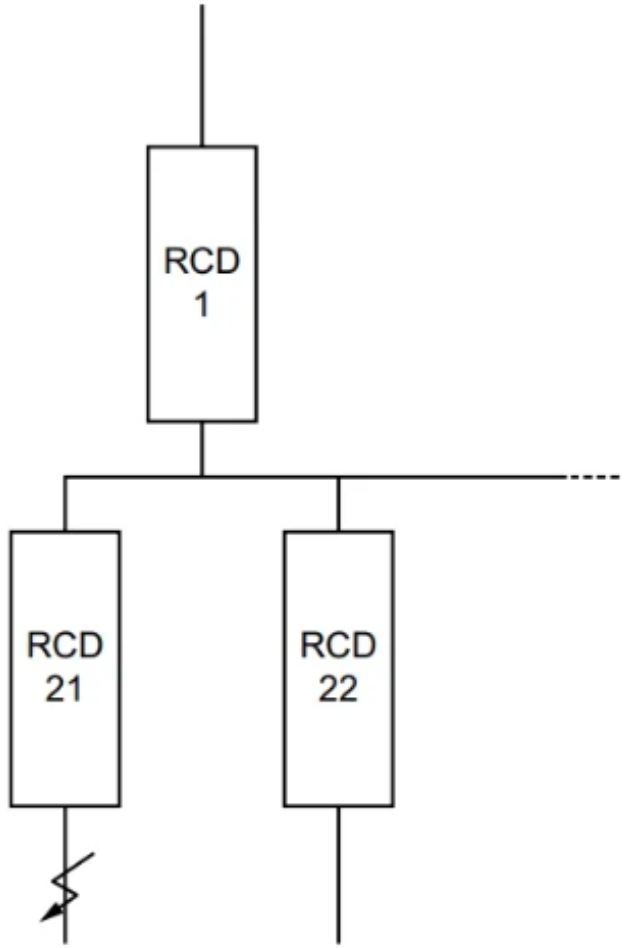


SELECTIVITY

- When the 18th Edition was published in 2018, the term **discrimination** was changed to **selectivity**.
- It is important to try and achieve selectivity when installing multiple RCDs in series.

***NOTE**: RCD 1 is Type S or time-delayed type.*

Fig 536.2 – Selectivity between RCDs in case of residual current



TYPE S (TIME DELAYED)

- A **Type S RCD** is a sinusoidal residual current device incorporating a time delay.
- It can be installed upstream from a **Type AC RCD** to provide selectivity.
- A time-delayed RCD cannot be used for additional protection because it will not operate within the required time of 300 mS at $I_{\Delta n}$.

HAZARDS AND PROBLEMS: EXISTING ELECTRICAL INSTALLATIONS

TYPES OF INSTALLATION AFFECTED

Domestic properties with modern equipment and appliances, such as LED lighting, induction hobs, IT equipment and electric vehicle charging equipment.

TYPES OF INSTALLATION AFFECTED

Commercial installations comprising LED lighting and large quantities of IT equipment which can also cause other issues, such as protective conductor current, which should also be considered.

TYPES OF INSTALLATION AFFECTED

Industrial installations using uninterruptible power supplies (UPS) and variable speed drive (VSD) frequency inverters for the speed control of motors.

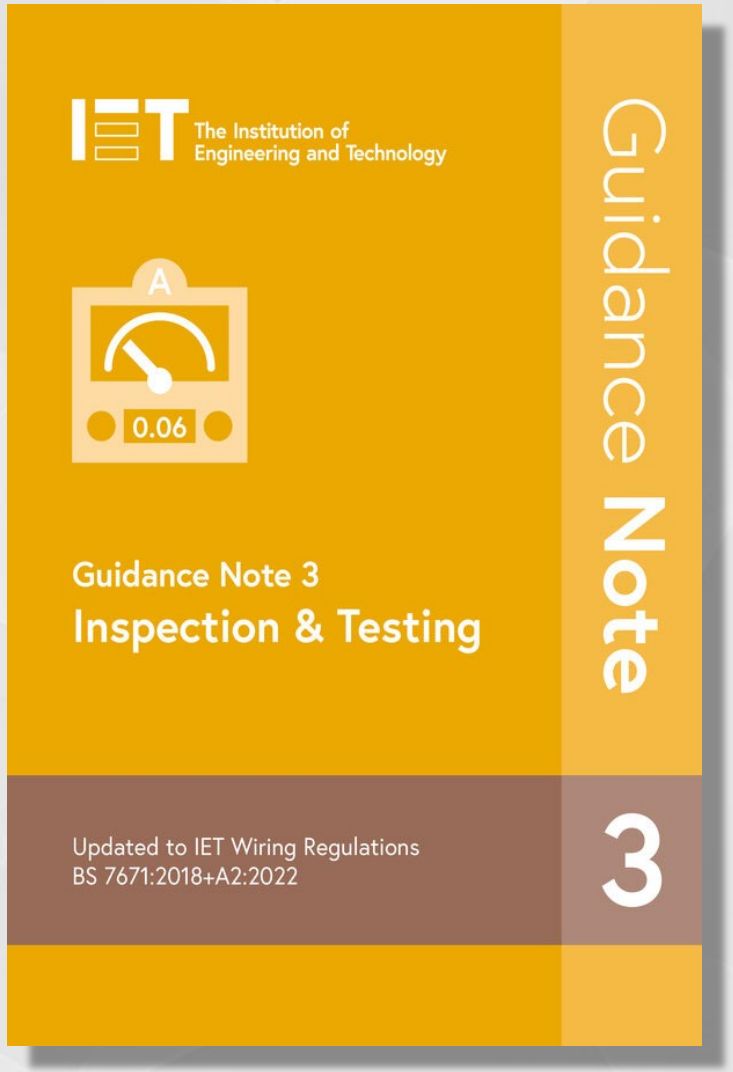
RECORDING CIRCUIT DETAILS

CIRCUIT DETAILS

	Conductor details					Overcurrent protective device					RCD			
	Type of wiring	Reference method ‡	Number of points served	Number & size		BS (EN)	Type	Rating (A)	Breaking capacity (kA)	Maximum permitted Z_s (Ω)§	BS (EN)	Type	$I\Delta_n$ (mA)	Rating (A)
				Live (mm^2)	CPC (mm^2)									
	A	101	10	2.5	1.5	60898	B	32	6	1.37	61008	A	30	100
	A	101	8	2.5	1.5	61009	B	32	6	1.37	61009	A	30	32

TESTING DIFFERENT TYPES

- Type A, B and F RCDs are tested in the same way as an AC RCD.
- Details of the test procedure and maximum disconnection times can be found in **IET Guidance Note 3**.



TESTING DIFFERENT TYPES

- Details of the test procedures where more than one RCD is installed on the same circuit can be found in **Guidance Note 3.**
- There is a new test method using an upstream/downstream test, where supported by the test equipment.

Table 2.17 Tests for RCDs

a Recommended tests

RCD Types	Instrument RCD Type setting (note 1)	Applied residual current	Maximum expected tripping time (ms)			
			RCDs to harmonized standards (note 2)		RCDs to BS 4293 or BS 7288:1990 (note 3)	
			Non-delay	S-delay	Non-delay	Time-delay
All	Type AC	$\frac{1}{2}\times I_{\Delta n}$	*RCD should not trip*		*RCD should not trip*	
All	Type AC	$1\times I_{\Delta n}$ (note 4)	300	500	200	{(0.5 to 1.0) × time delay}+200

RECORDING TEST RESULTS

TEST RESULT DETAILS

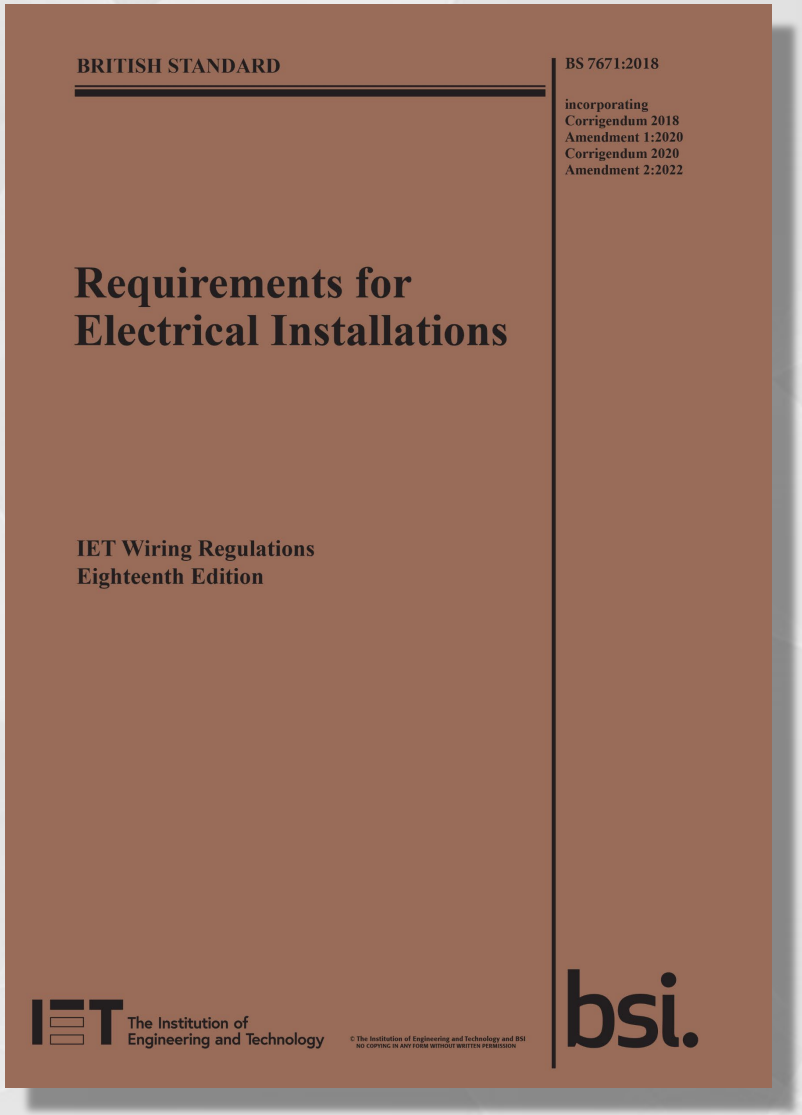
(Ω)			Insulation resistance				Z_s (Ω)		RCD		AFDD	
	$(R_1 + R_2)$ or R_2											
	$(R_1 + R_2)$	R_2	Test voltage (V)	Live - Live (MΩ)	Live - Earth (MΩ)	Polarity #	Maximum measured	Value Verified	Disconnection time (ms)**	Test button operation	Manual test button operation ††	
	0.25		500	>299	>299	✓	0.35	☑	18.2	☑	☐	
								☐		☐	☐	
	0.30		500	>299	>299	✓	0.40	☑	19.2	☑	☐	
								☐		☐	☐	
								☐		☐	☐	
								☐		☐	☐	
								☐		☐	☐	

BS 7671:2018+A3:2024

- **530.3.201** Selection and erection of equipment for protection shall take account of appropriate use of either a unidirectional protective device or bidirectional protective device.

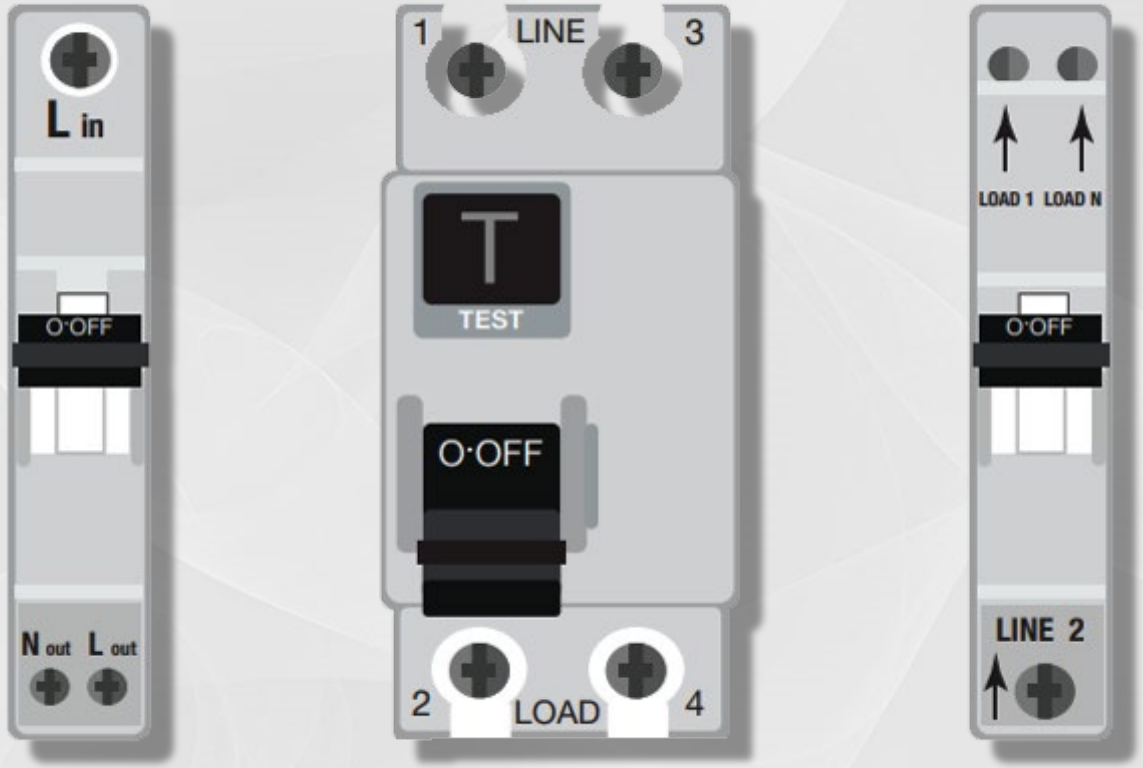
- **Unidirectional protective device:** A protective device where it is intended by the manufacturer that a source of supply is only connected to one defined set of connection terminals.

- **Bidirectional protective device:** A protective device where it is intended by the manufacturer that a source of supply is connected to either or both sets of connection terminals.



BS 7671:2018+A3:2024

- RCD and MCB product standards require that if it is necessary to distinguish between the supply and the load terminals.
- They shall be clearly marked e.g. by ‘in’ and ‘out’ or ‘line’ and ‘load’ placed near the corresponding terminals or by arrows indicating the direction of power flow.



Under no circumstances is it acceptable to connect any power supply to the load terminals of such unidirectional devices.

WRAG – ELECTRICAL SAFETY FIRST

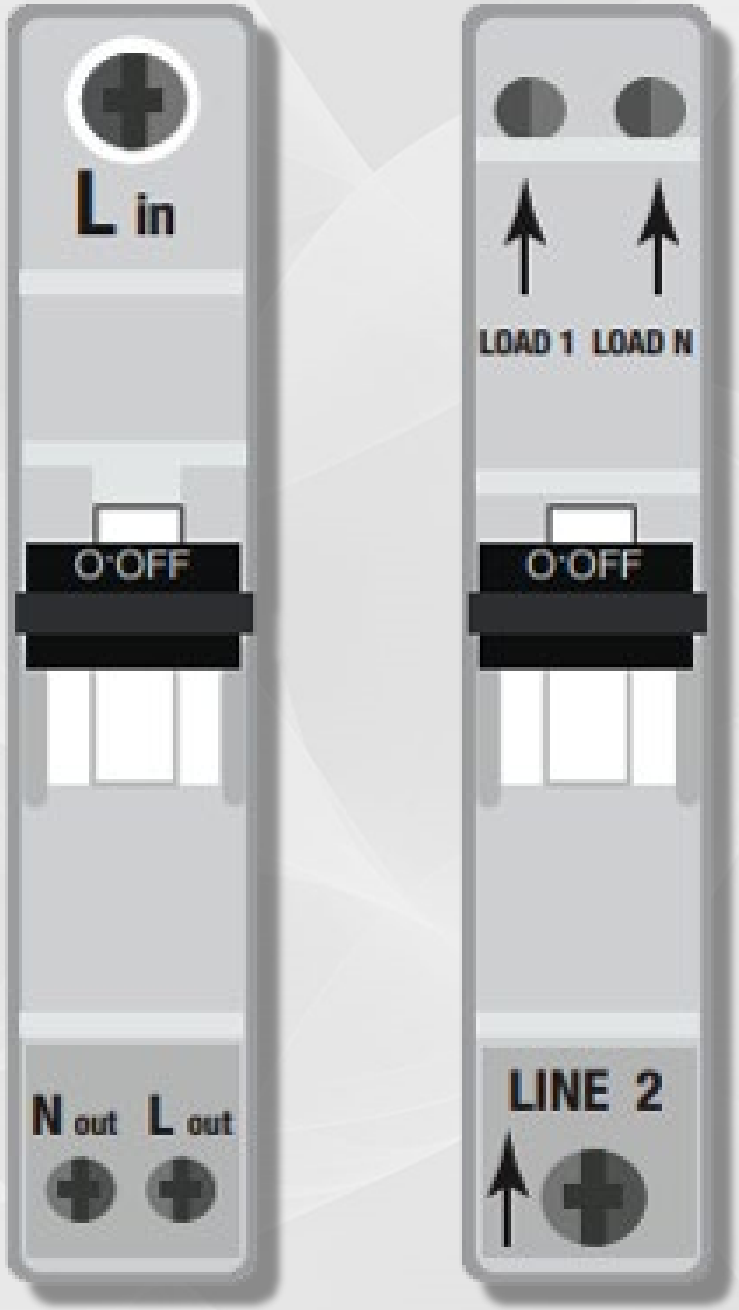
Through Electrical Safety First (ESF), the industry is constantly investigating the effects of DC current on Types of RCD.

The Wiring Regulations Advisory Group

Electrical Safety First hosts the Wiring Regulations Advisory Group, a forum comprising representatives from industry bodies, which provides guidance on the application of the requirements of BS 7671.

EICR AND REPORTING

- It is recommended that the product manufacturer is consulted to establish if the RCD is bidirectional, irrespective of the unidirectional marking.
- If the manufacturer provides a declaration of conformity that the RCD is a bidirectional device, this information should be appended to the EICR and a classification code is not required.



EICR AND REPORTING

Where the manufacturer does not provide a declaration of conformity, as above:

- If the RCD is unidirectional and is being relied upon for additional protection, but not for fault protection, then an improvement is recommended and a classification code **C3** would be appropriate, or
- If the RCD is unidirectional and is being relied upon to meet the maximum disconnection times in BS 7671 for fault protection, a classification code **C2** would be appropriate.

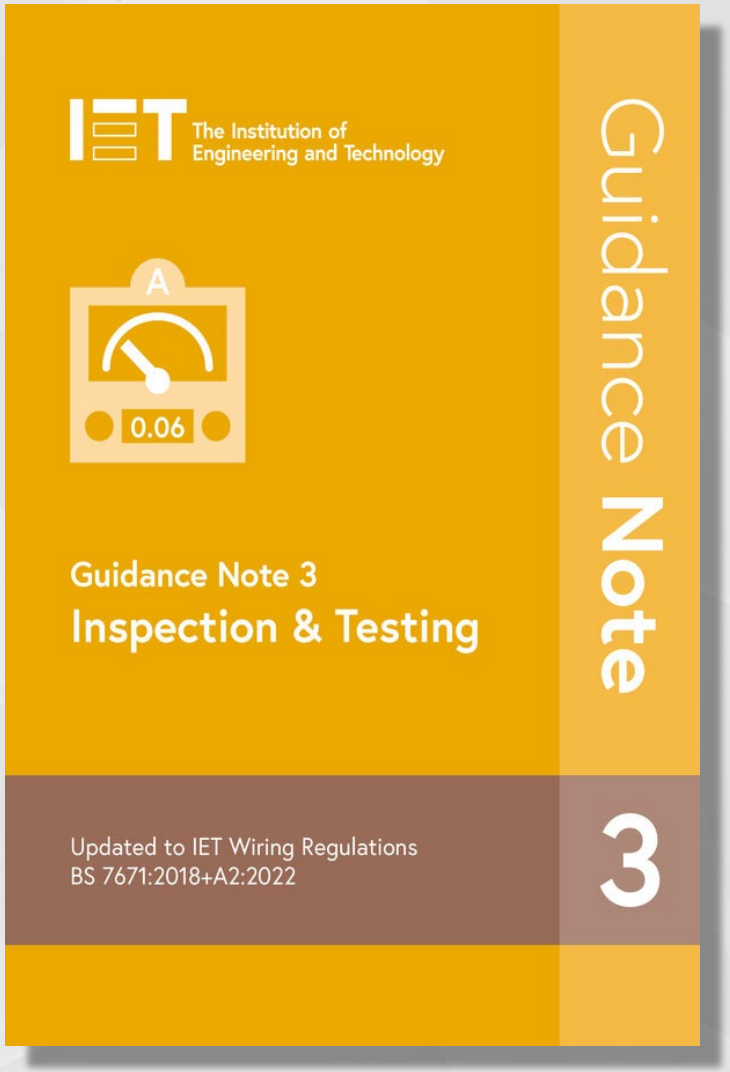
- *See Regulation numbers 134.1.1 and 510.3*

EICR AND REPORTING

- It should be noted that some appliance and equipment manufacturers now specify that a Type A, F, or B RCD is installed where fault or additional protection by RCD is required.

- Where such an appliance or equipment is encountered or could foreseeably be connected and supplied via a Type AC RCD, a classification code C3 (**improvement recommended**) would be appropriate.

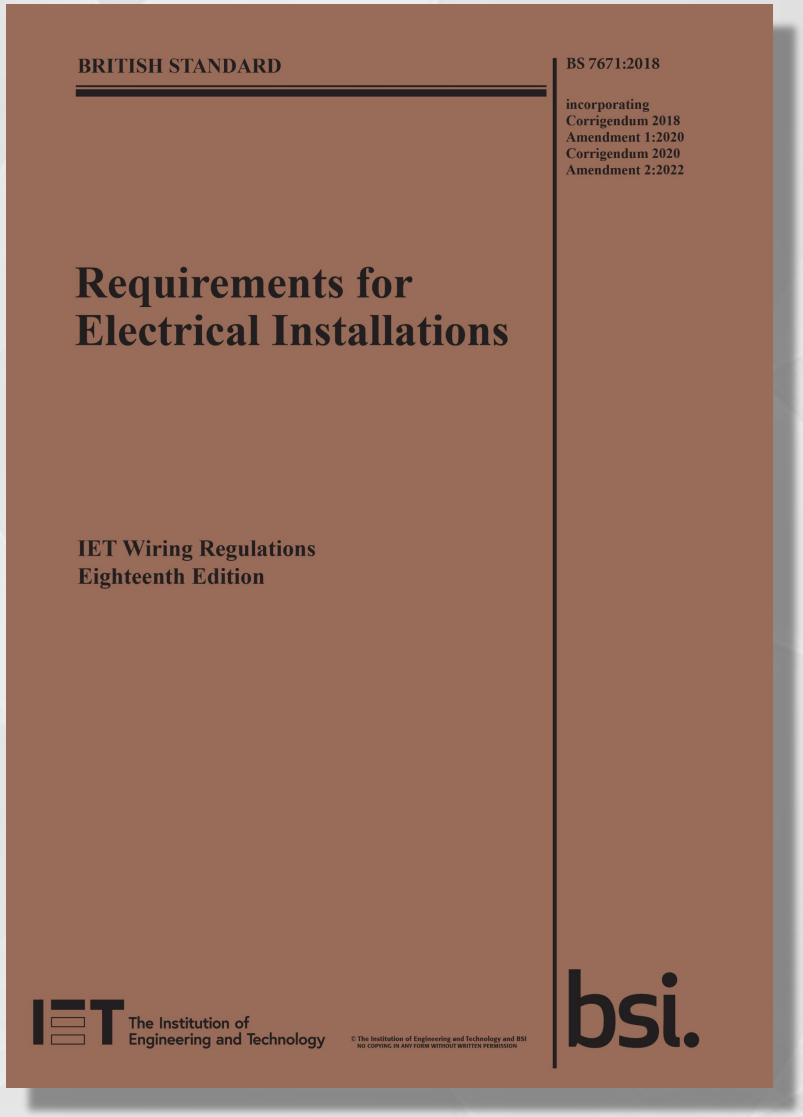
- However, if it is identified and confirmed that an RCD in the circuit does not operate correctly when tested, a classification code C2 (**potentially dangerous**) would be appropriate.

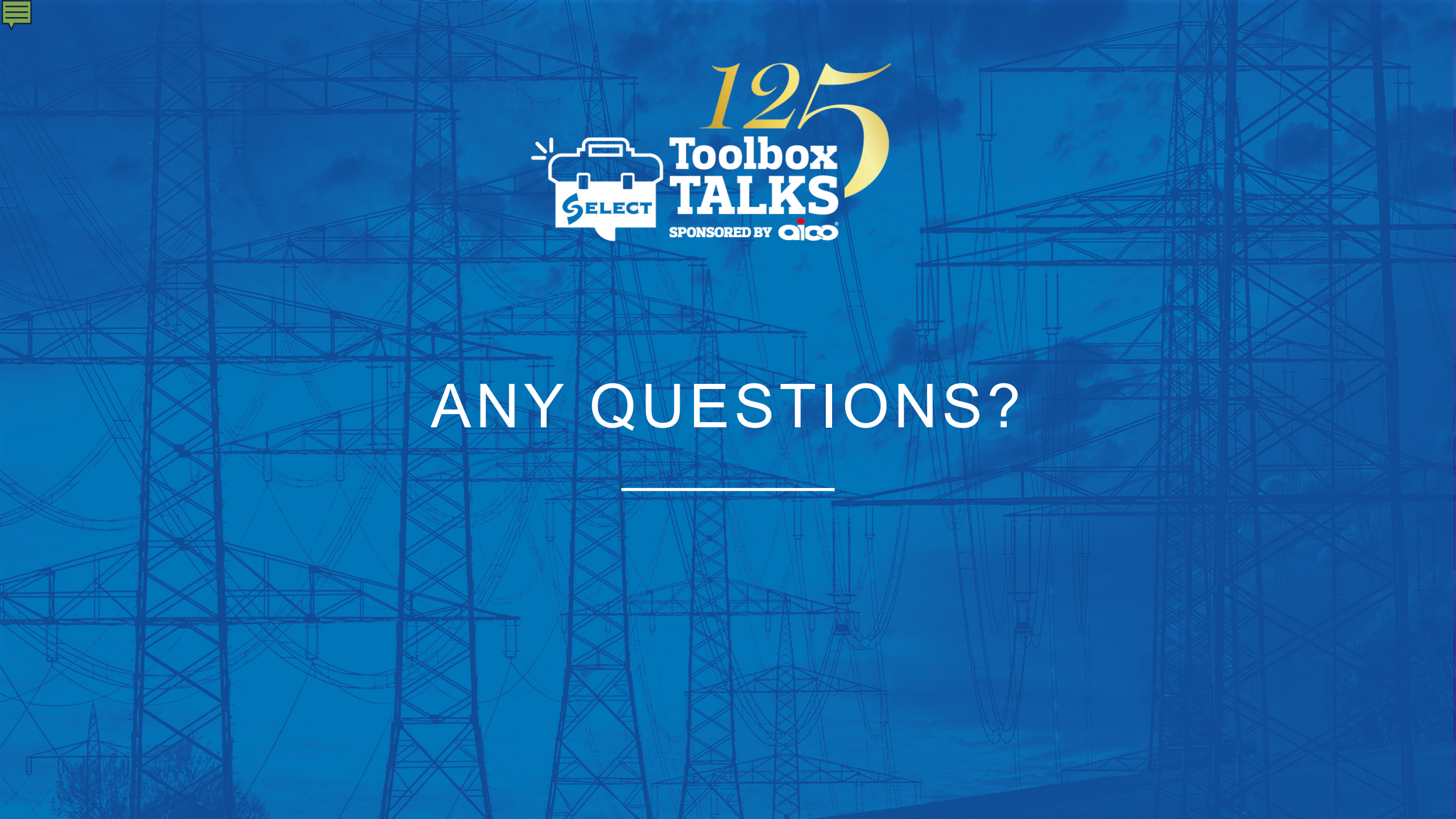


SUMMARY

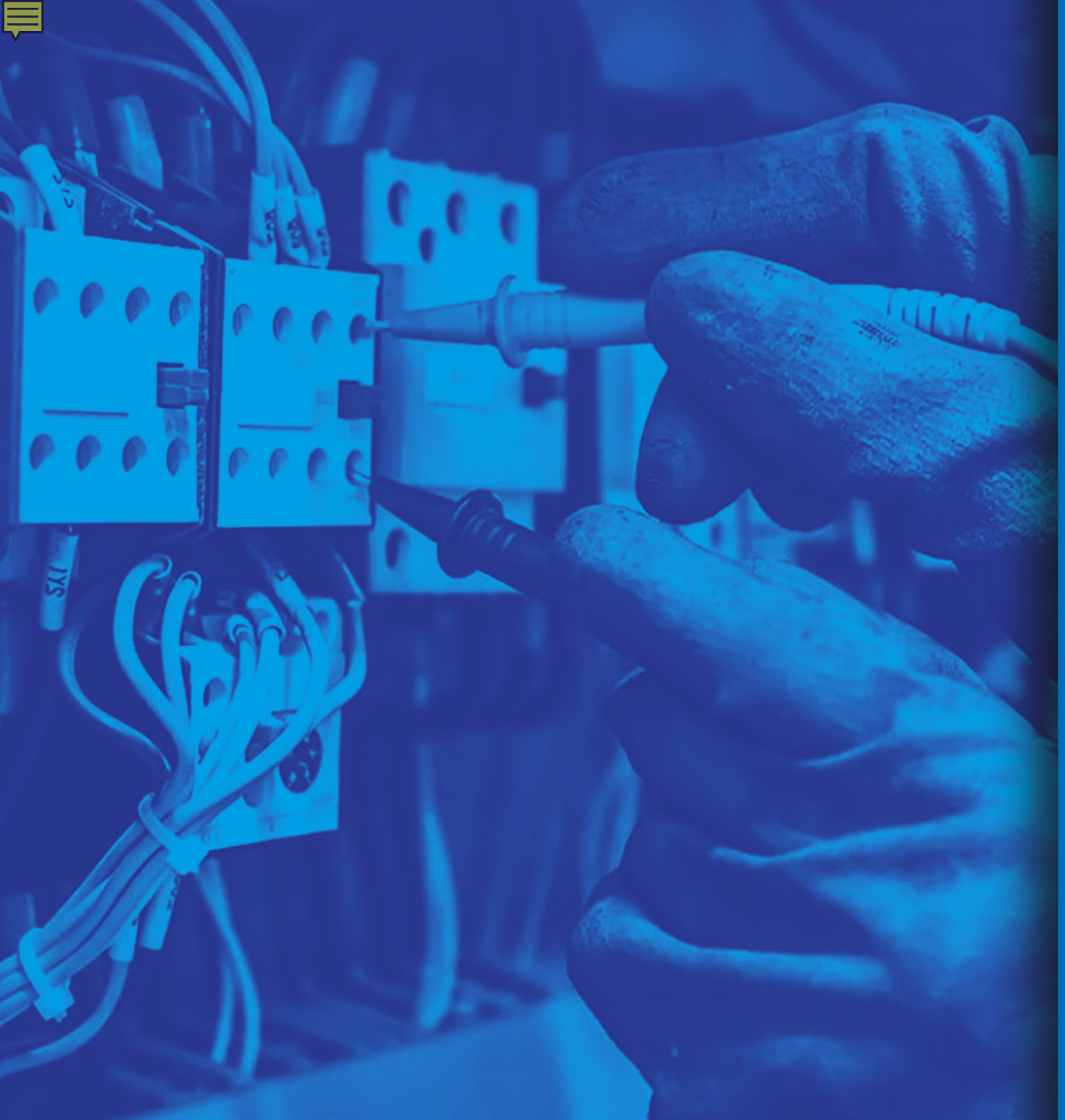
- Assuming an AC Type RCD will suit every installation is incorrect and RCDs shall be selected according to the equipment which is likely to be used within the installation.

- Type AC RCDs shall **ONLY** be selected where it can be assured that there is not, and will not be, any residual DC fault current on the circuit.




125
Toolbox
TALKS
SELECT
SPONSORED BY aico
ANY QUESTIONS?


125
Toolbox
TALKS
SELECT
SPONSORED BY aico
MID-MORNING BREAK
CHARGING POINT



125 Toolbox TALKS

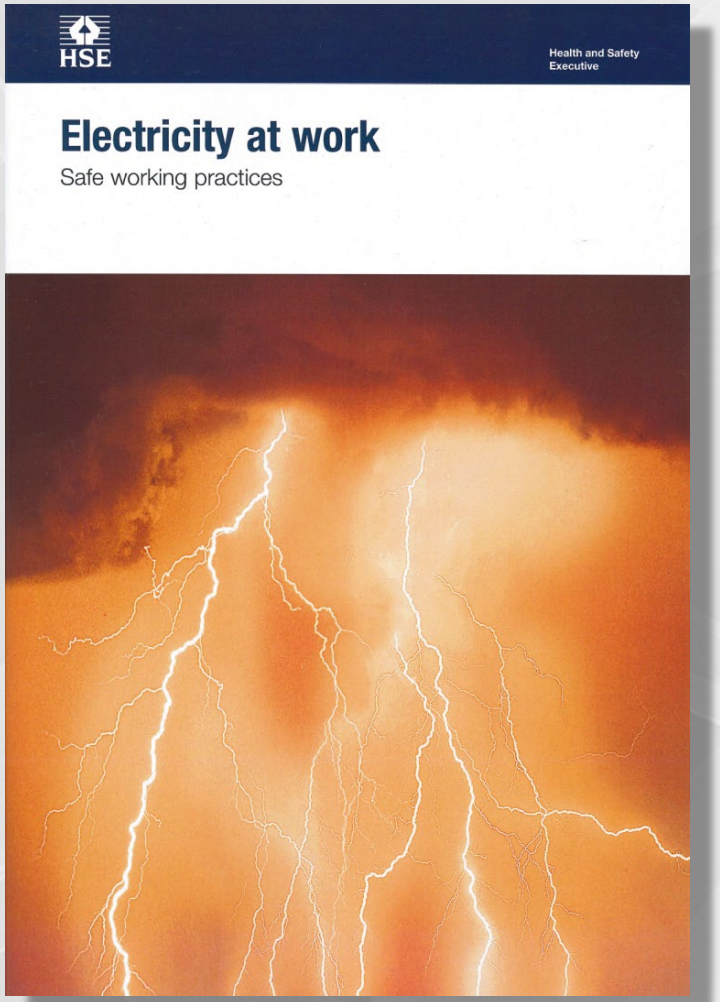
SELECT

SPONSORED BY aico

EARTH FAULT LOOP IMPEDANCE

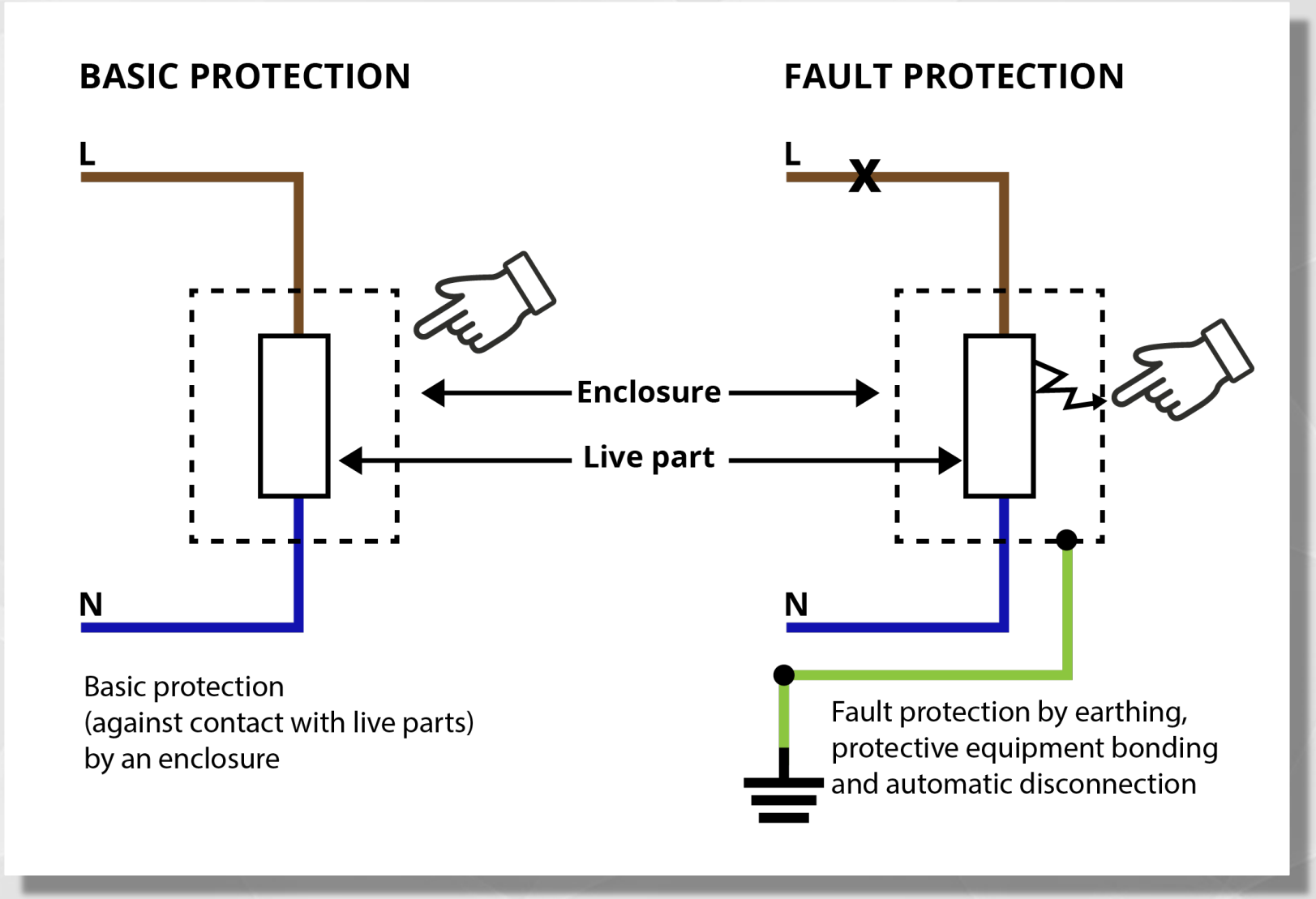
MAY/JUNE 2025

ASSESSMENT OF SAFE WORKING PRACTICES



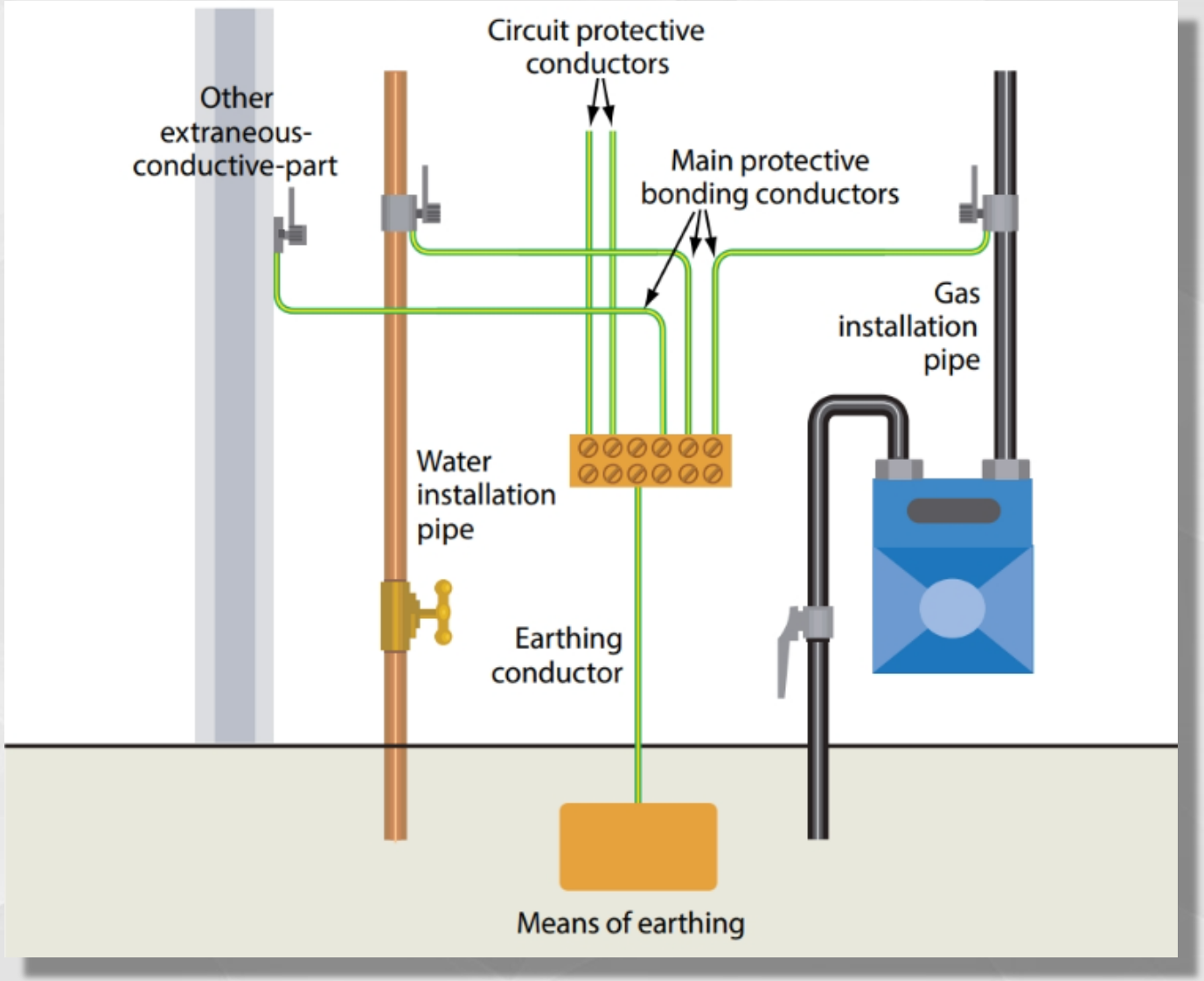
CHAPTER 41: PROTECTION AGAINST ELECTRIC SHOCK

- In most electrical installations, the most used protective measure is **automatic disconnection of supply (ADS)**
- It requires two lines of defence against electric shock.



CHAPTER 41: PROTECTION AGAINST ELECTRIC SHOCK

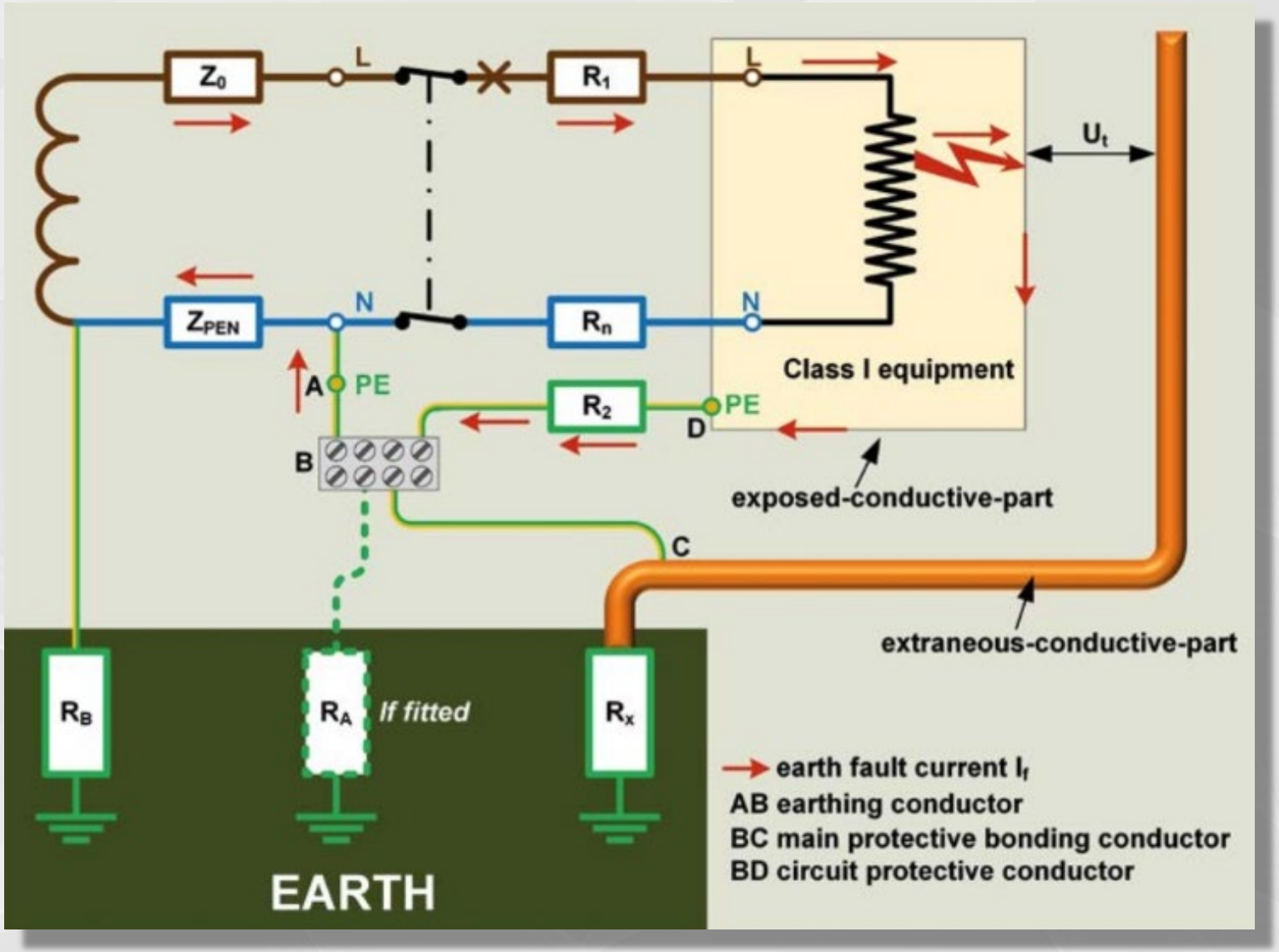
- *Regulation 411.3.1.1* Protective Earthing
- *Regulation 411.3.1.2* Protective equipotential bonding.
- All of which are connected to the **main earthing terminal (MET).**
- Connected to the means of earthing via the **earthing conductor**.



CHAPTER 41: PROTECTION AGAINST ELECTRIC SHOCK

During a fault, to prevent danger ADS limits the magnitude and duration of the voltage between:

- The exposed-conductive-parts of a circuit
- Other exposed-conductive-parts
- Extraneous-conductive-parts
- True earth.



CHAPTER 41: PROTECTION AGAINST ELECTRIC SHOCK

Regulation 411.3.2.1 states:

> *A protective device shall automatically interrupt the supply to the line conductor in the event of a fault of negligible impedance between the line conductor and an exposed-conductive-part or the protective conductor in the circuit or equipment within the disconnection time required by Regulation 411.3.2.2 to 411.3.2.4.*

CHAPTER 41: PROTECTION AGAINST ELECTRIC SHOCK

Regulation 411.3.2.2

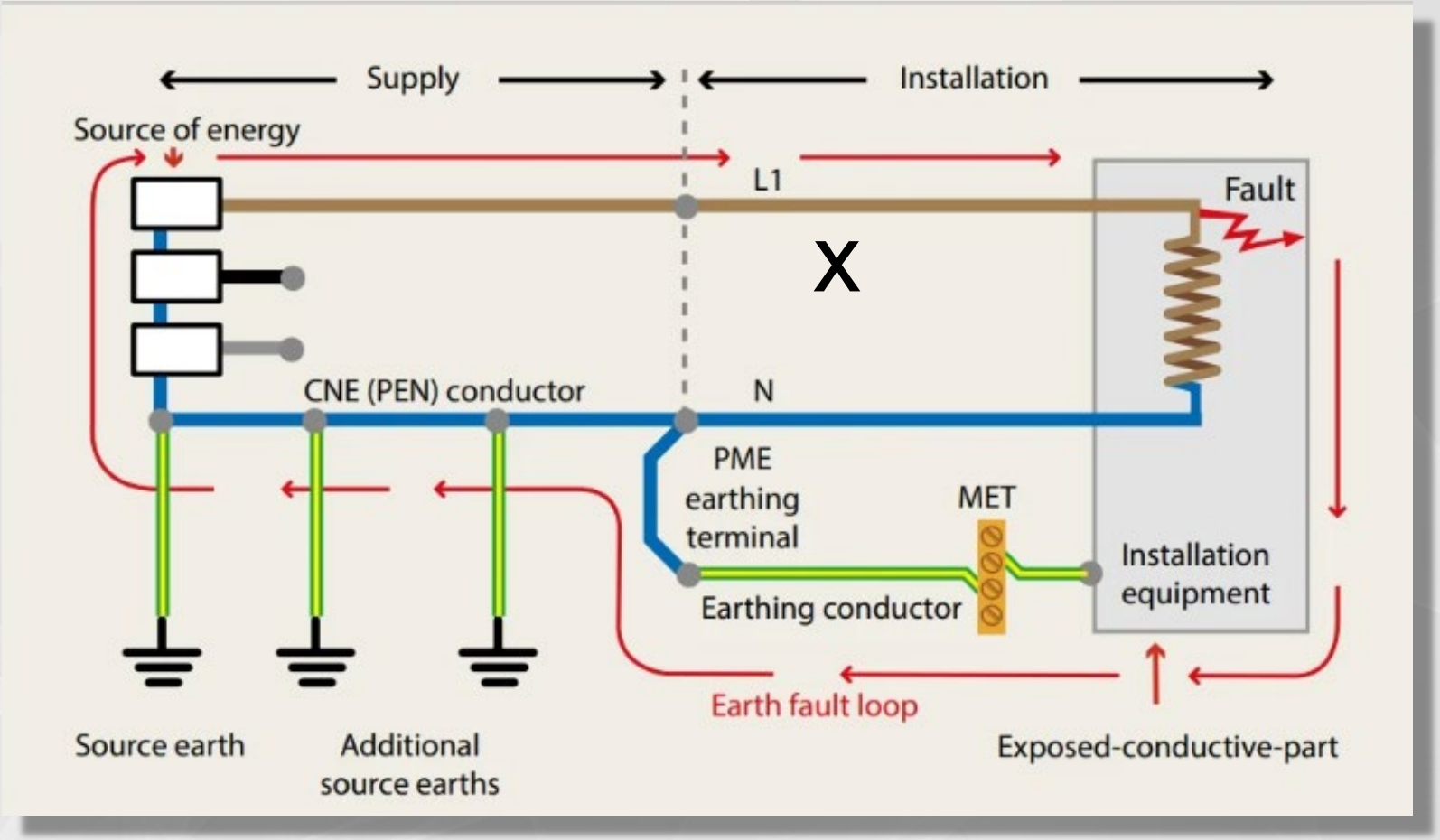
Maximum disconnection times are given in Table 41.1 and shall be applied to final circuits with a rated current not exceeding:

- 63 A with one or more socket-outlets, and
- 32 A supplying only fixed connected current using equipment.

Type of circuit	Maximum Disconnection Time
Final circuits **not** exceeding: • 63 A with one or more socket-outlets **or** • 32 A supplying only fixed connected current-using equipment	**0.4 seconds**
Final circuits exceeding: • 63 A with one or more socket-outlets **or** • 32 A supplying only fixed connected current-using equipment **or** A distribution (sub-main) circuit	**5 seconds**

WHAT IS EARTH FAULT LOOP IMPEDANCE?

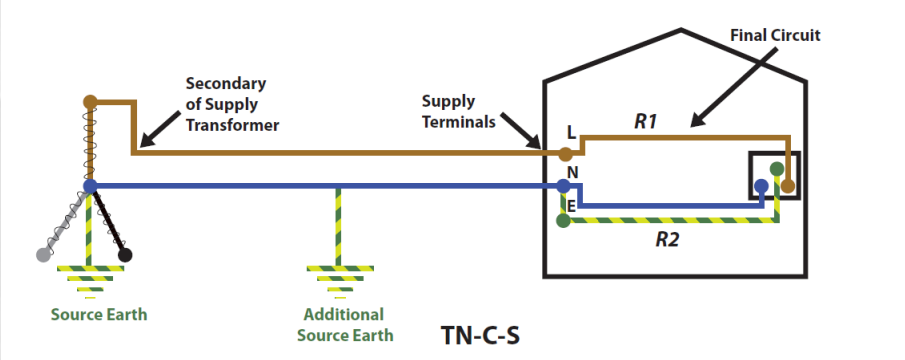
The purpose of Earth Fault Loop Impedance (Z_S) is to ensure that there is a low impedance path at the point throughout the entire loop of the circuit that will generate a high fault current, causing the protective device to operate and disconnect the electricity preventing shock, burns or fire.



THE IMPORTANCE OF EXTERNAL EFLI Z_e TN SYSTEM

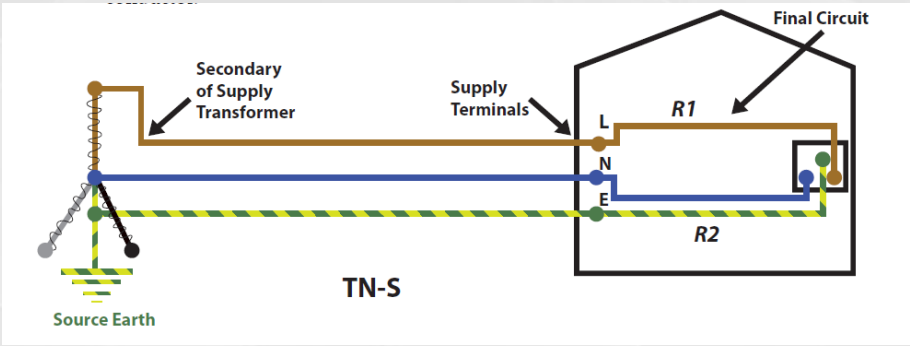
Regulation 313.1(iv)

Z_e can be determined by measurement, calculation, enquiry or inspection.



0.35 Ω

ESQCR Provision 28(b)



0.80 Ω

Nominal maximum Z_e values for typical 100 A supply

THE IMPORTANCE OF EXTERNAL EFLI Z_e TN SYSTEM

Table 1: Typical maximum earth fault loop impedance values for existing connections

System	Service capacity up to:	Typical values of EFLI at customer terminals under normal network conditions (applicable to all types of earthing system)	
		EFLI	Comments
230V single-phase Residential premises *Based on Table 1 of PD IEC/TR 60725:2012*	100 A	0.34 Ω (0.25+j0.23)	90% of premises will have an EFLI below this value.
		0.64 Ω (0.46+j0.45)	98% of premises will have an EFLI below this value.
		Over 0.64 Ω	2% of premises will have an EFLI above 0.64 Ω.
400V three-phase Large residential, commercial and light industrial premises *Based on Table 4 of PD IEC/TR 60725:2012 (20% declared voltage range)*	150 A	0.42 Ω	95% of premises will have an EFLI below these values.
	200 A	0.31 Ω	
	300 A	0.21 Ω	
	400 A	0.16 Ω	
	600 A	0.10 Ω	

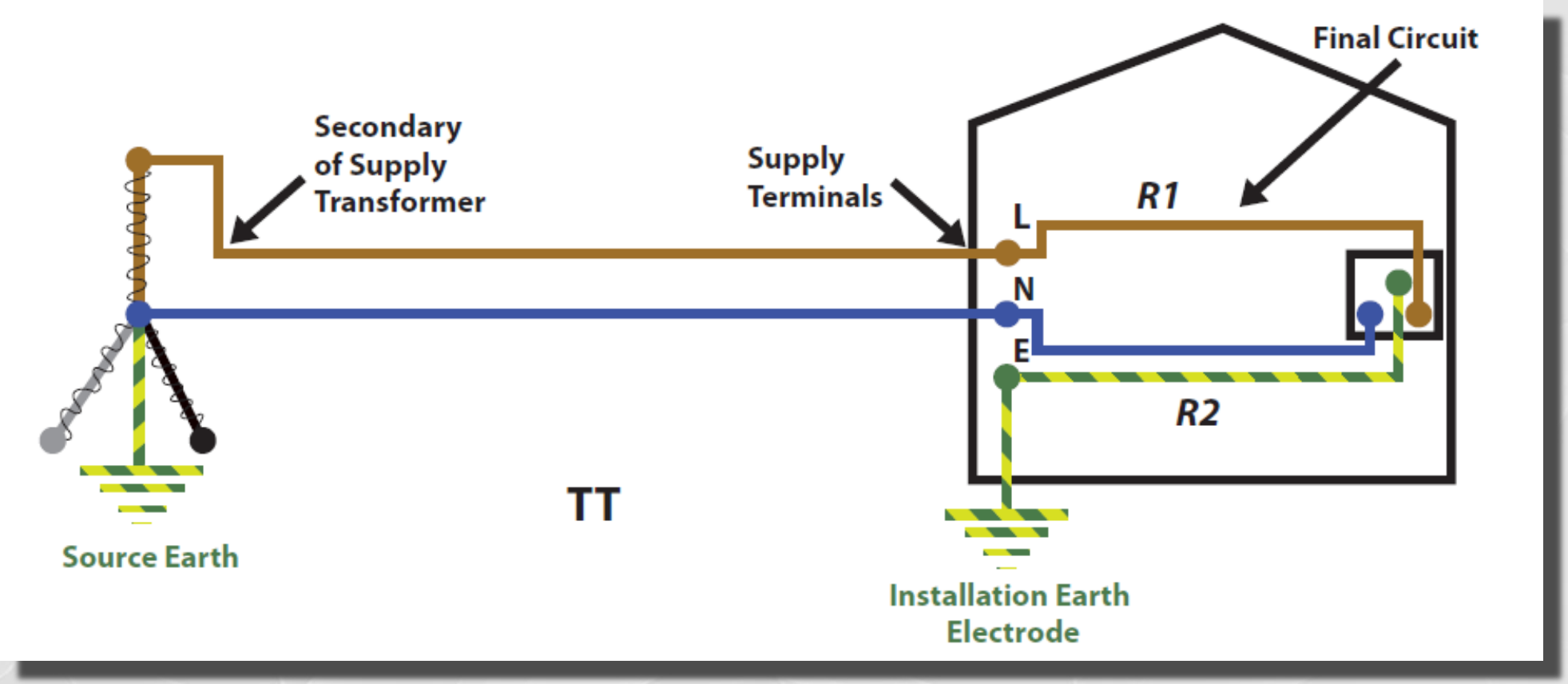
ISSUES WTH EXTERNAL EFLI Z_e TN SYSTEM

Any major concerns?

Contact the relevant DNO on emergency number **105**.

THE IMPORTANCE OF EXTERNAL EFLI Z_e TT SYSTEM

- Resistance of installation earth electrode should be as low as practicable.
- A value exceeding 200 Ω may not be stable.



ASSESSING THE MEASURED EARTH ELECTRODE RESISTANCE VALUE

- Information based on Tables 41.5 and 53.1

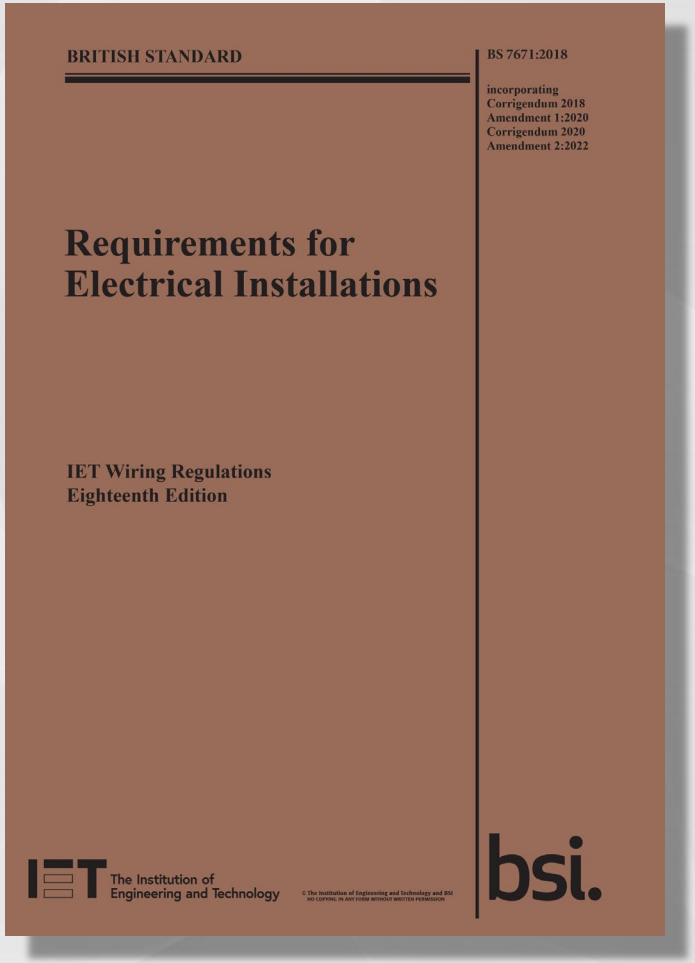
$$R_A \times I_{\Delta n} \leq 50\ V$$

NOTE: *The resistance of the installation earth electrode should be as low as practicable. A value exceeding 200 Ω may not be stable.*

RCD rated residual operating current	Maximum earth resistance R_A or earth fault loop impedance Z_e Ω
30 mA	1667*
100 mA	500*
300 mA	167
500 mA	100
1 A	50
3 A	17
5 A	10
10 A	5
20 A	2.5

EARTH FAULT LOOP IMPEDANCE Z_S

Where automatic disconnection of supply is used to give fault protection, the maximum earth fault loop impedance (Z_s) should be low enough to allow sufficient current to flow to operate the protective device within the appropriate disconnection time



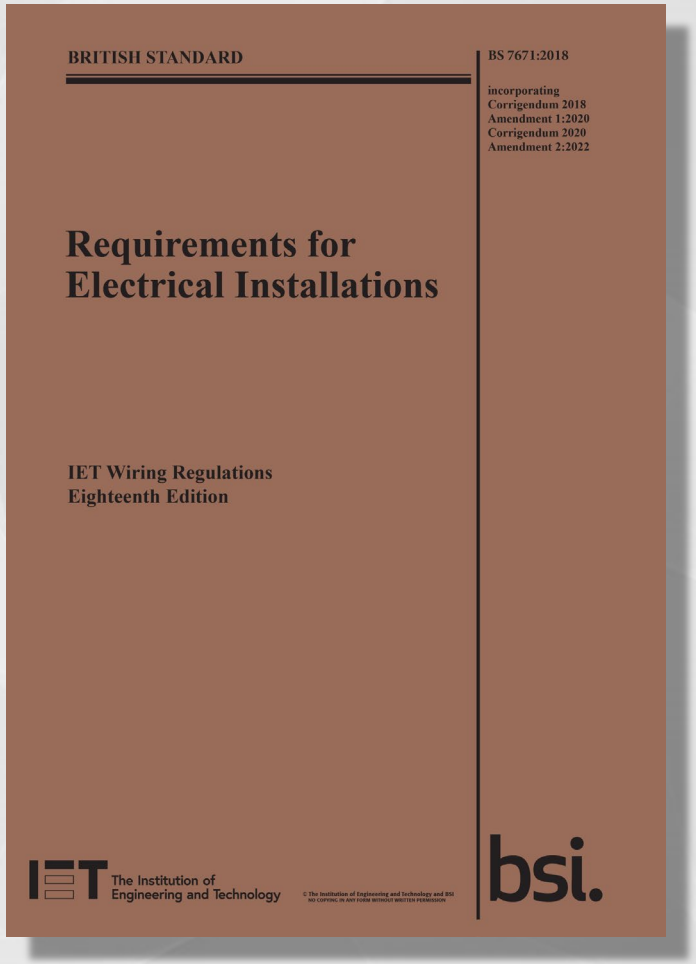
Continues >>

EARTH FAULT LOOP IMPEDANCE Z_S

Regulation 643.7.3.1

- Where protective measures are used which require a knowledge of earth fault loop impedance, the relevant impedances shall be measured or determined by an alternative method.
- An electrical continuity test shall be carried out according to *Regulation 643.2* before carrying out the earth fault loop impedance measurement.
- The measured earth fault loop impedance shall comply with Chapter 41.

$$Z_s = Z_e + (R_1 + R_2)$$



MAXUMUM EFLI Z_S FOR CIRCUIT BREAKERS

TABLE 41.3 –
Maximum earth fault loop impedance (Z_s) for circuit-breakers with U_0 of 230 V, for operation giving compliance with the 0.4 s disconnection time of Regulation 411.3.2.2 and 5 s disconnection time of Regulation 411.3.2.3 (for RCBOs see also Regulation 411.4.204)

(a) Type B circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1														
Rating (amperes)	3	6	10	16	20	25	32	40	50	63	80	100	125	I_n
Z_s (ohms)	14.57	7.28	4.37	2.73	2.19	1.75	1.37	1.09	0.87	0.69	0.55	0.44	0.35	230 x 0.95/(5I_n)
(b) Type C circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1														
Rating (amperes)		6	10	16	20	25	32	40	50	63	80	100	125	I_n
Z_s (ohms)		3.64	2.19	1.37	1.09	0.87	0.68	0.55	0.44	0.35	0.27	0.22	0.17	230 x 0.95/(10I_n)
(c) Type D circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1														
Rating (amperes)		6	10	16	20	25	32	40	50	63	80	100	125	I_n
Z_s (ohms) 0.4 sec		1.82	1.09	0.68	0.55	0.44	0.34	0.27	0.22	0.17	0.14	0.11	0.09	230 x 0.95/(20I_n)
Z_s (ohms) 5 secs		3.64	2.19	1.37	1.09	0.87	0.68	0.55	0.44	0.35	0.27	0.22	0.17	230 x 0.95/(10I_n)

NOTE 1: The circuit loop impedances have been determined using a value for factor C_{min} of 0.95.

NOTE 2: The circuit loop impedances given in the table should not be exceeded when:
(i) the line conductors are at the appropriate maximum permitted operating temperature, as given in Table 52.1, and
(ii) the circuit protective conductors are at the appropriate assumed initial temperature, as given in Tables 54.2 to 54.5.

If the conductors are at a different temperature when tested, the reading should be adjusted accordingly. See Appendix 3.

NOTE 3: Where the line conductor insulation is of a type for which Table 52.1 gives a maximum permitted operating temperature exceeding 70 °C, such as thermosetting, but the conductor has been sized in accordance with Regulation 512.1.5:
(i) the maximum permitted operating temperature for the purpose of Note 2(i) is 70 °C, and
(ii) the assumed initial temperature for the purpose of Note 2(i) is that given in Tables 54.2 to 54.4 corresponding to an insulation material of 70 °C thermoplastic.

MAXUMUM EFLI Z_S FOR CIRCUIT BREAKERS

Table B6 Circuit-breakers. Maximum measured earth fault loop impedance (in Ω) at ambient temperature where the overcurrent device is a circuit-breaker to BS 3871 or BS EN 60898 or RCBO to BS EN 61009

0.1 to 5 second disconnection times

Circuit-breaker type	Circuit-breaker rating (amperes)														
	3	5	6	10	15	16	20	25	30	32	40	45	50	63	100
1	14.57	8.74	7.29	4.37	2.92	2.74	2.19	1.75	1.46	1.37	1.10	0.98	0.88	0.70	0.44
2	8.33	5.00	4.17	2.50	1.67	1.57	1.25	1.00	0.84	0.79	0.63	0.56	0.50	0.40	0.25
B	11.66	7.00	5.83	3.50	2.34	2.19	1.75	1.40	1.17	1.10	0.88	0.78	0.70	0.56	0.35
C and 3	5.83	3.50	2.92	1.75	1.17	1.10	0.88	0.70	0.59	0.55	0.44	0.39	0.35	0.28	0.18
D (0.4 s)			1.46	0.88		0.55	0.44	0.35		0.28	-	-	-		-
D (5 s)			2.92	1.75		1.10	0.88	0.70		0.55	0.44		0.35	0.28	0.18

MAXUMUM EFLI Z_S FOR CIRCUIT BREAKERS

Further guidance on Z_s calculations and other relevant information can be found on the following SELECT training courses:

- **208** Design & Verification of Electrical Installations
- **209** Initial Verification
- **214** Periodic Inspection, Testing and Reporting

Speak to a member of SELECT staff today for further information.

MEASURED EFLI EXCEEDS MAX (Z_S) FOR PROTECTIVE DEVICES

Possible causes:

- Test instrument error
- Fault with test leads
- Supply voltage could impact Z_s readings

MEASURED EFLI EXCEEDS MAX (Z_S) FOR PROTECTIVE DEVICES

Possible causes:

- Oversized protective device rating
- Incorrect characteristics of protective device.

MEASURED EFLI EXCEEDS MAX (Z_S) FOR PROTECTIVE DEVICES

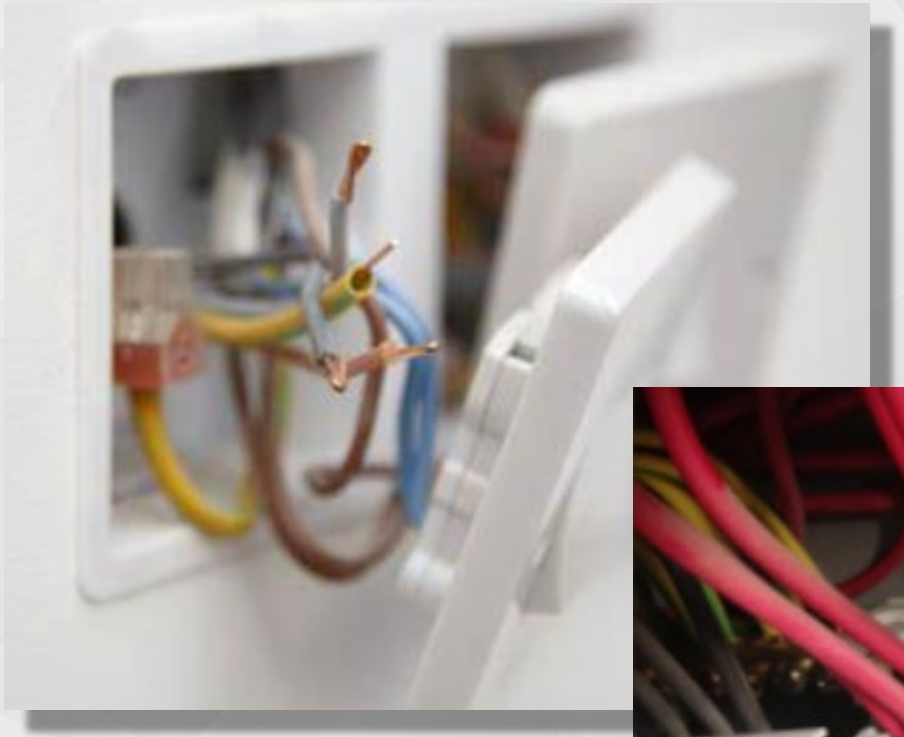
Possible causes:

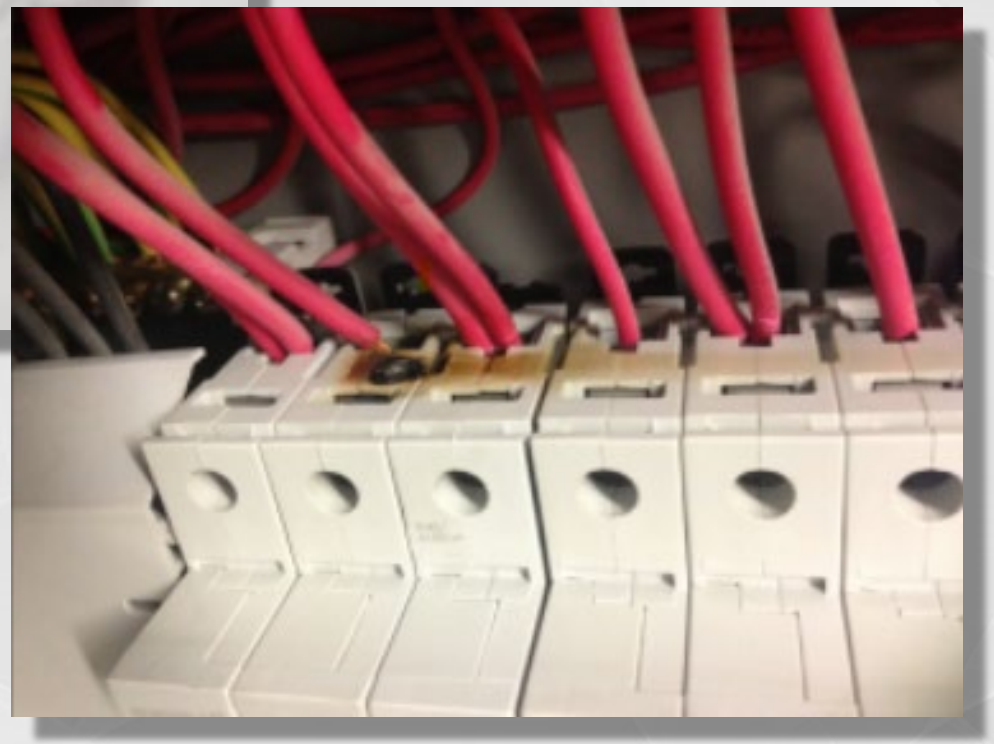
- Excessive circuit length
- poorly designed circuit
- Undersized CSA.

MEASURED EFLI EXCEEDS MAX (Z_S) FOR PROTECTIVE DEVICES

Possible causes:

- Poor connections in equipment
- Accessories
- Overloading.

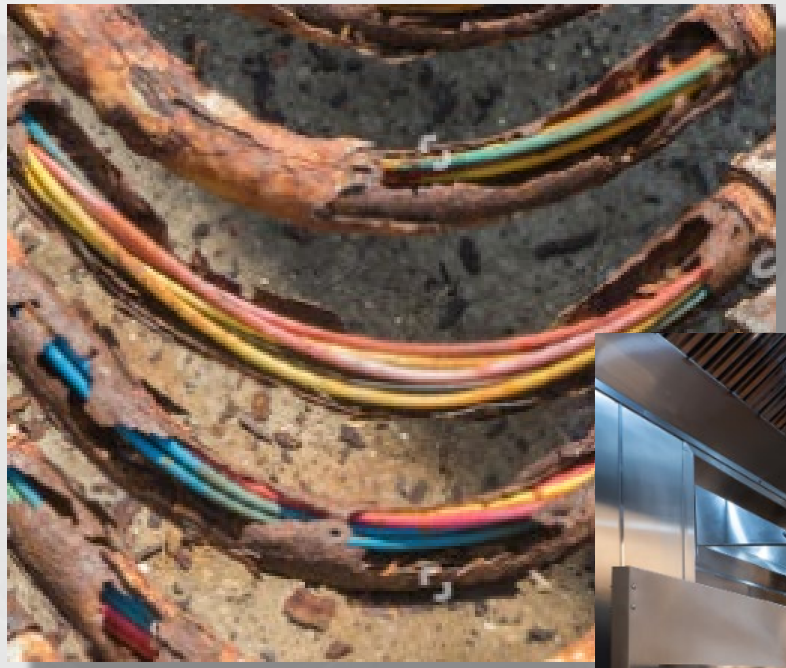


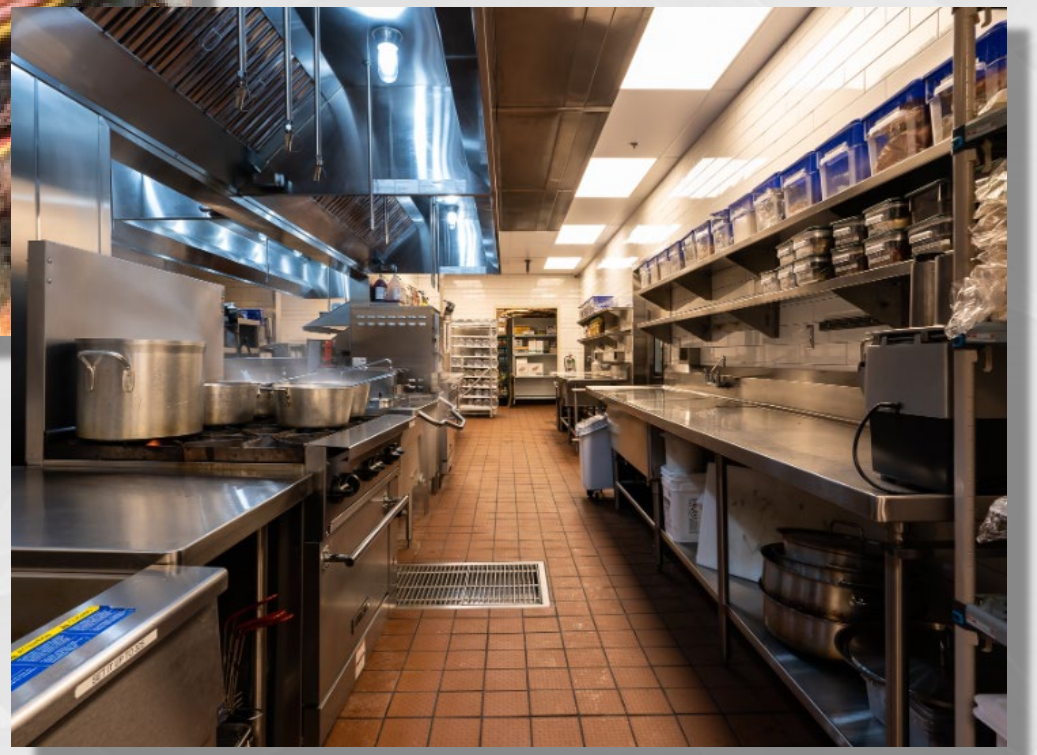


MEASURED EFLI EXCEEDS MAX (Z_S) FOR PROTECTIVE DEVICES

Possible causes:

- Corrosion
- Environment with a high ambient temperature.

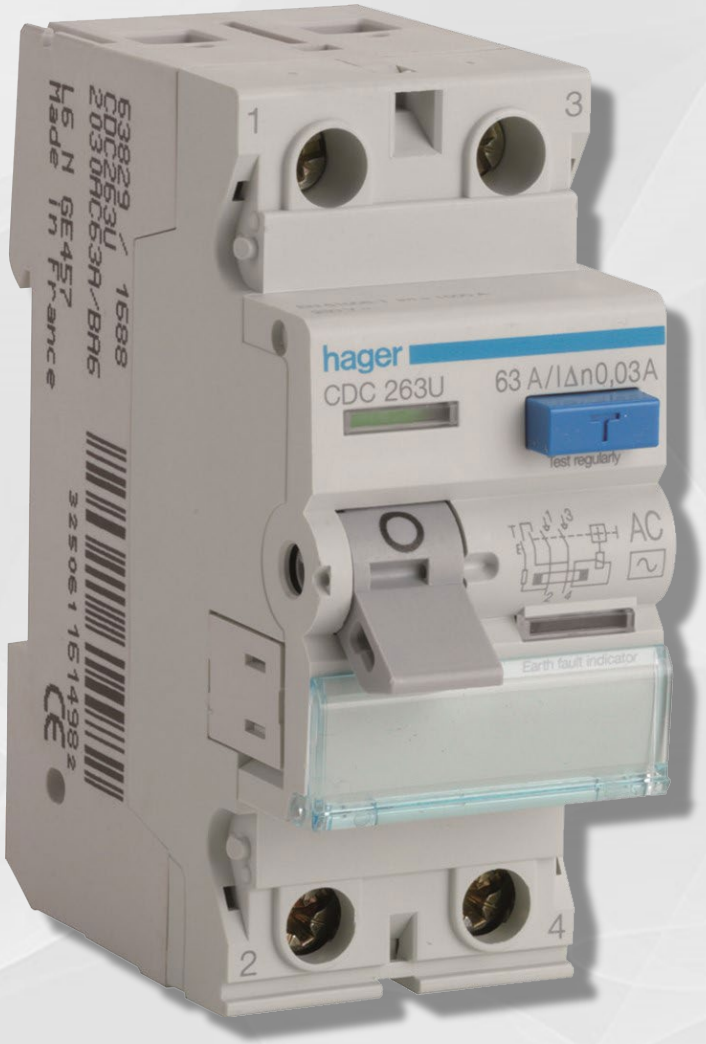




MEASURED EFLI EXCEEDS MAX (Z_s) FOR PROTECTIVE DEVICES

Possible causes:

- Testing through RCD low trip setting
- RCD uplift.



MEASURED EFLI EXCEEDS MAX (Z_S) FOR PROTECTIVE DEVICES

Possible causes:

- **Electrical noise** – are the circuits that contain electronic components, semi conductors being tested when under load as this can create noise which may increase values.
- **Harmonics** – electrical equipment operating at different frequency could alter the AC waveform affecting voltage which could impact impedance.

AUTOMATIC DISCONNECTION OF SUPPLY CANNOT BE ACHEIVED

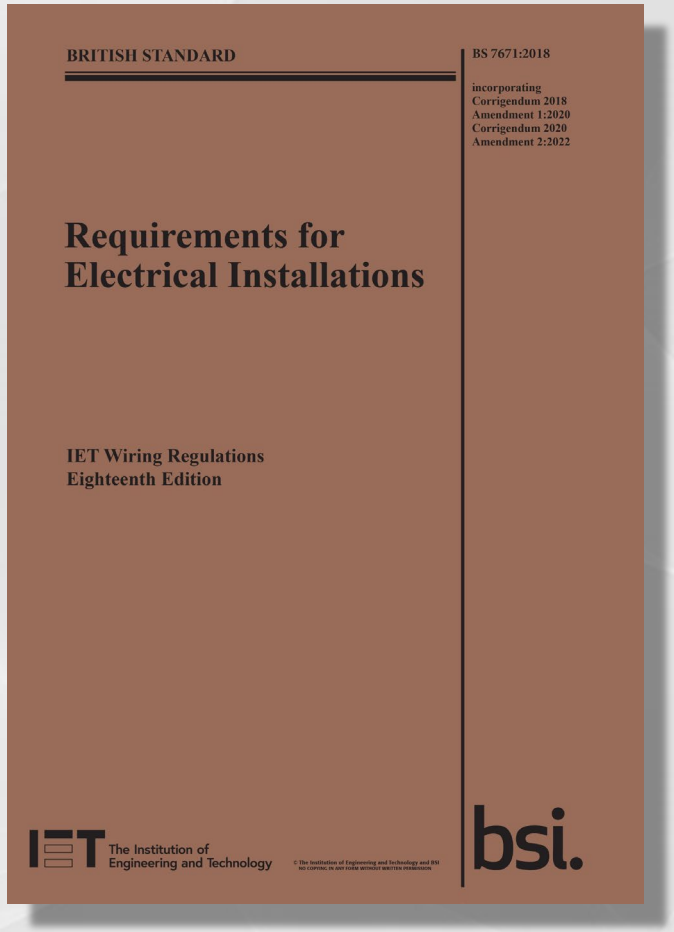
Section 419: Provisions where Automatic Disconnection according to Regulation 411.3.2 is not feasible

Provides the requirements where ADS is not feasible in certain circumstances:

i. Where electronic equipment with limited short-circuit current is installed e.g. uninterrupted power supply (UPS), electrical energy storage system (EESS) on island mode, or

ii. The required disconnection times cannot be achieved by a protective device e.g. Z_S of protective device exceeded.

Regulation 419.3 refers to *Regulation 415.2* Additional protection: supplementary protective equipotential bonding, when considering item (ii).

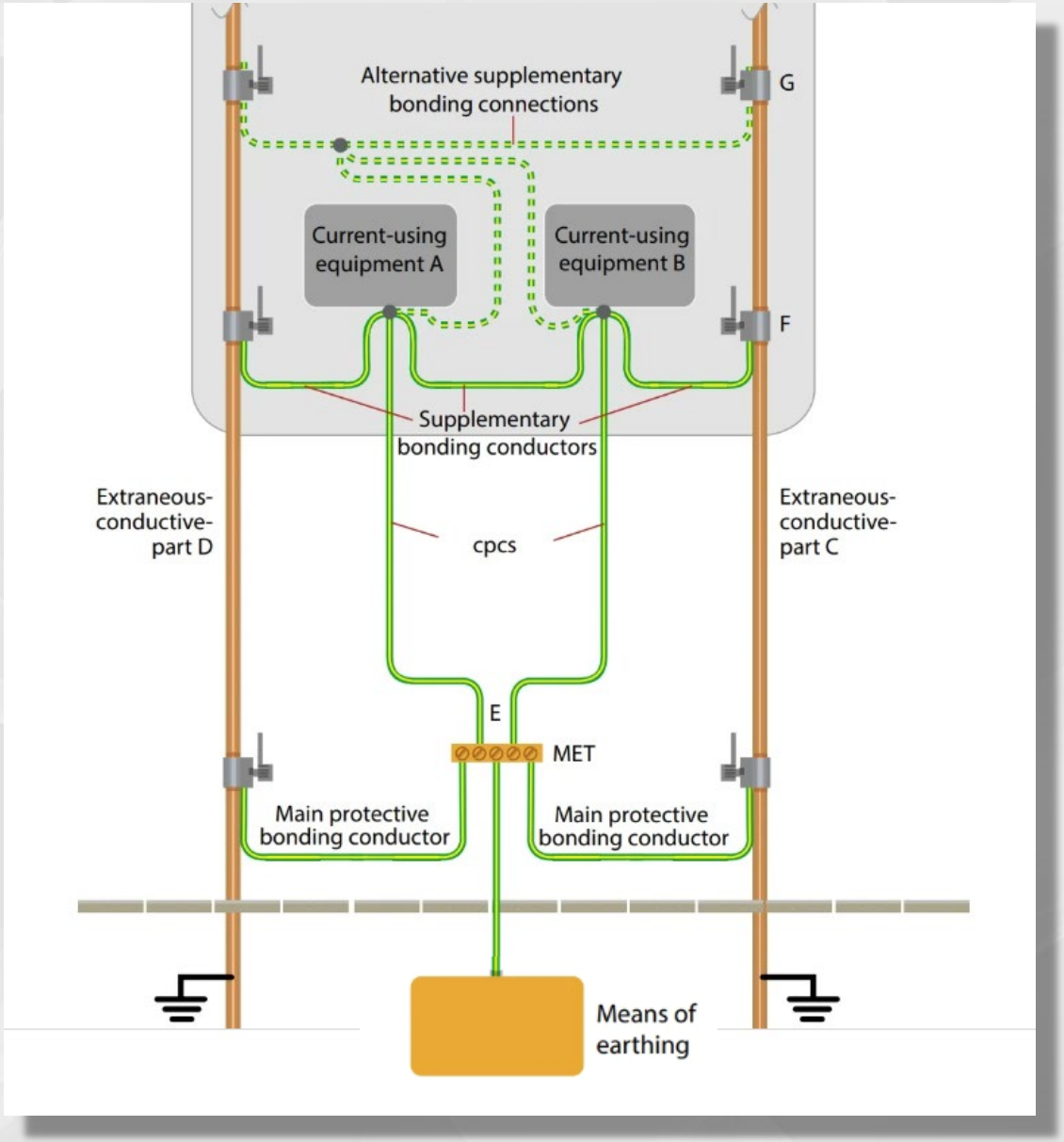


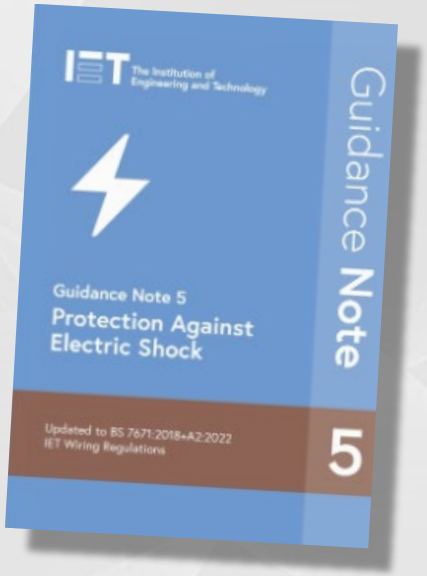
SUPPLEMENATRY PROTECTIVE EQUIPOTENTIAL BONDING

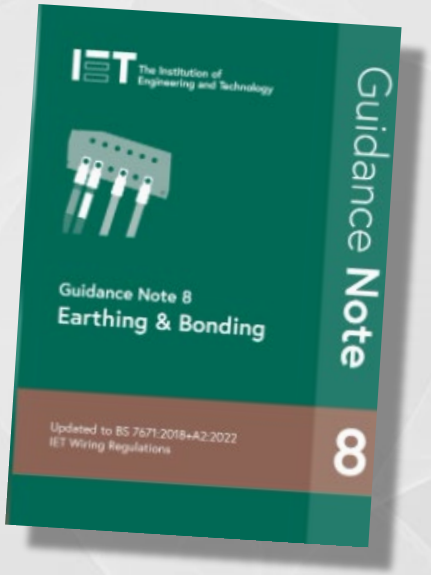
Regulation 415.2

Supplementary Equipotential Bonding to be an addition to fault protection. It can be applied to:

- The whole or part of an installation
- An item of equipment
- A location.

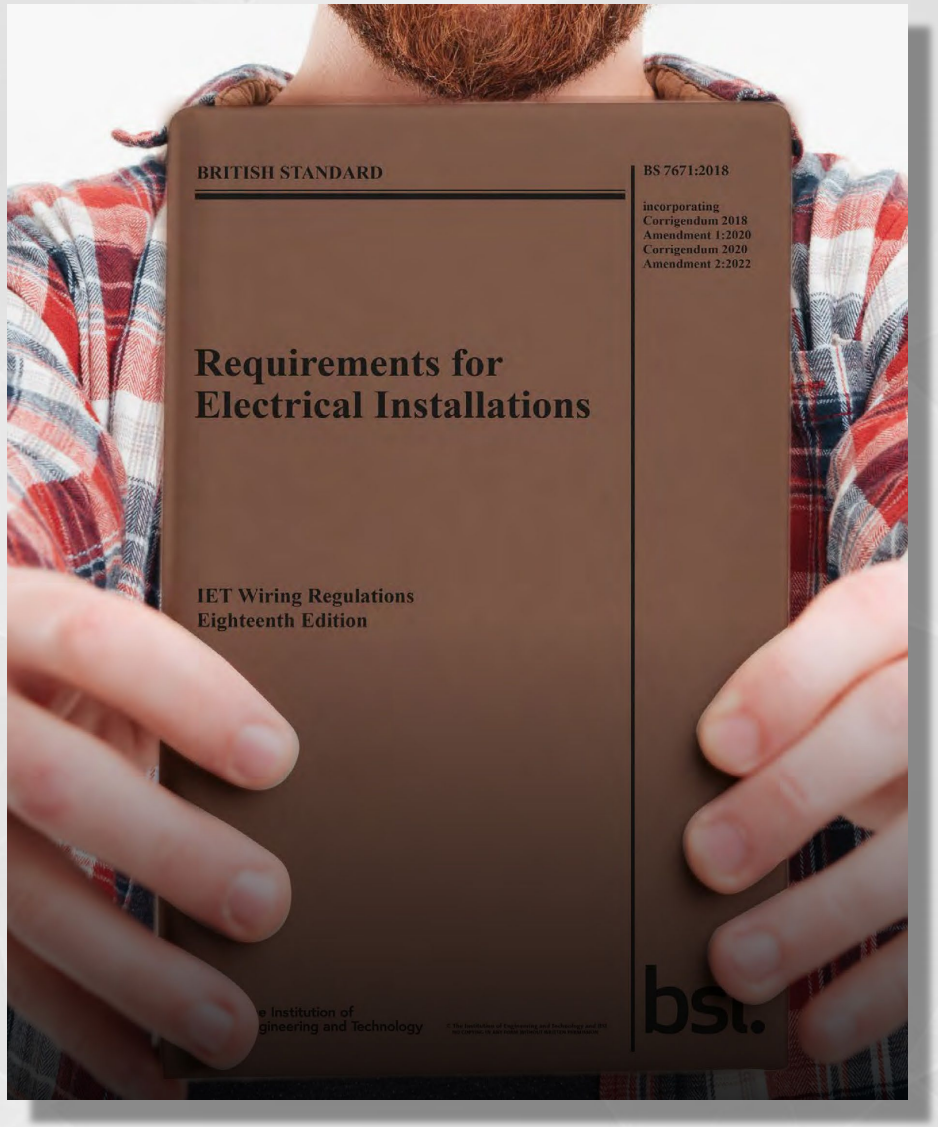






EXISTING INSTALLATIONS: REGULATION 132.16

*"No addition or alteration, temporary or permanent, shall be made to an existing installation, unless it has been ascertained that the rating and condition of any existing equipment, including that of the distributor will be adequate for the altered circumstance. Furthermore, the earthing and bonding arrangements, if necessary for the protective measure applied for the safety of the addition or alteration, **shall** be adequate."*



DOCUMENTATION FOR INTIAL VERIFICATION Z_S EXCEEDED

SCHEDULE OF INSPECTIONS

Item No.	Description	Outcome ✓ / N/A	Item No.	Description	Outcome ✓ / N/A
1.0	Condition of consumer's intake equipment (Visual inspection only)		8.0	Circuits (Distribution and Final)	
			9.0	Isolation and switching	
2.0	Parallel or switched alternative sources of supply		10.0	Current-using equipment (permanently connected)	
3.0	Methods of protection	✓	11.0	Identification and notices	
4.0	Basic protection		12.0	Location(s) containing a bath or shower	
5.0	Protective measures other than ADS		13.0	Other special installations or locations	
6.0	Additional protection		14.0	Prosumer's low voltage electrical installation(s)	
7.0	Distribution Equipment				

DOCUMENTATION FOR INTIAL VERIFICATION Z_S EXCEEDED

Overcurrent protective device					RCD			
BS (EN)	Type	Rating (A)	Breaking capacity (kA)	Maximum permitted Z_s (Ω) ss	BS (EN)	Type	$I\Delta_n$ (mA)	Rating (A)
60898 (0.4s)	B	32	6	1.37	61008	A	100	100
61009 (0.4s)	C	32	10	0.68	61009	A	30	32
61009 (0.4s)	D	32	10	0.34	61009	A	30	32

DOCUMENTATION FOR INTIAL VERIFICATION Z_S EXCEEDED

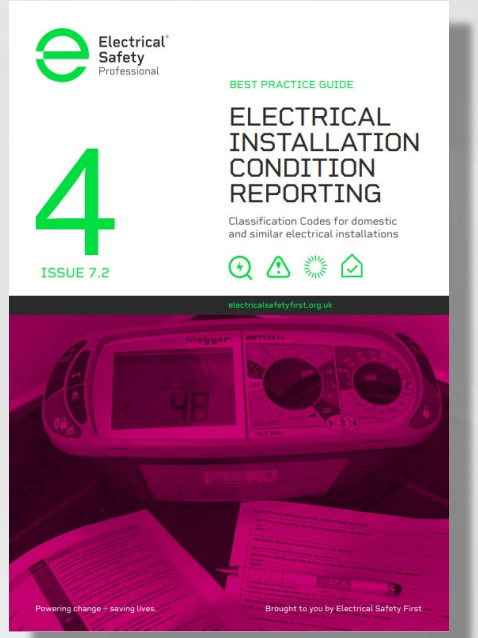
		Insulation resistance				Zs (Ω)		RCD		AFDD	
$(R_1 + R_2)$ or R_2											
$(R_1 + R_2)$	R_2	Test Voltage (V)	Live-Live (MΩ)	Live-Earth (MΩ)	Polarity	Maximum measured	Value verified	Disconnection time (ms)	Test button operation	Manual test button operation	Remarks
1.4						2.42	☑	123	☑	☐	RCD provides Fault Protection
0.45						3.33	☑	39	☑	☐	RCD provides Fault Protection
0.75						4.1	☑	33	☑	☐	RCD provides Fault Protection

PI&T DOCUMENTATION MAX Z_S EXCEEDED

ITEM NO.	DESCRIPTION	OUTCOME (Use codes above. Provide additional comment where appropriate. C1, C2, C3 and FI coded items to be recorded in Section K of the Condition Report)
1.0	INTAKE EQUIPMENT (VISUAL INSPECTION ONLY)	
	Note 1: Where inadequacies in the intake equipment are encountered, which may result in a dangerous situation, the person ordering the work and/or dutyholder must be informed. It is strongly recommended that the person ordering the work informs the appropriate authority. **Note 2:** For this section only, where inadequacies are found, an 'X' should be put against the appropriate item and comment made in Section K.	
1.1	Distributor/supplier intake equipment	
	• Service cable	
	• Service head	
	• Earthing arrangement	X
	• Meter tails	
	• Metering equipment	
	• Isolator (where present)	
	Person ordering work /Duty holder notified (Delete as appropriate)	Y
1.2	Consumer's isolator (where present)	
1.3	Consumer's meter tails	

PI&T DOCUMENTATION MAX Z_s EXCEEDED

5.0	FINAL CIRCUITS	
5.1	Identification of conductors (514.3.1)	
5.2	Cables correctly supported throughout their run (521.10.202; 522.8.5)	
5.3	Condition of insulation of live parts (416.1)	
5.4	Non-sheathed cables protected by enclosure in conduit, ducting or trunking (521.10.1)	
	• To include the integrity of conduit and trunking systems (metallic and plastic)	
5.5	Adequacy of cables for current-carrying capacity with regard for the type and nature of installation (Section 523)	
5.6	Coordination between conductors and overload protective devices (433.1; 533.2.1)	
5.7	Adequacy of protective devices: type and rated current for fault protection (411.3)	C2
5.8	Presence and adequacy of circuit protective conductors (411.3.1; Section 543)	
5.9	Wiring system(s) appropriate for the type and nature of the installation and external influences (Section 522)	
5.10	Concealed cables installed in prescribed zones (see Section D. Extent and limitations) (522.6.202)	
5.11	Cables concealed under floors, above ceilings or in walls/partitions, adequately protected against damage (see Section D. Extent and limitations) (522.6.204)	
5.12	Provision of additional requirements for protection by RCD not exceeding 30 mA:	
	• for all socket-outlets of rating 32A or less, unless an exception is permitted (411.3.3)	
	• for the supply of mobile equipment not exceeding 32A rating for use outdoors (411.3.3)	
	• for cables concealed in walls at a depth of less than 50 mm (522.6.202; 522.6.203)	
	• for cables concealed in walls/partitions containing metal parts regardless of depth (522.6.203)	
	• Final circuits supplying luminaires within domestic (household) premises (411.3.4)	
5.13	Provision of fire barriers, sealing arrangements and protection against thermal effects (Section 527)	
5.14	Band II cables segregated/separated from Band I cables (528.1)	
5.15	Cables segregated/separated from communications cabling (528.2)	
5.16	Cables segregated/separated from non-electrical services (528.3)	
5.17	Termination of cables at enclosures - indicate extent of sampling in Section D of the report (Section 526)	
	• Connections soundly made and under no undue strain (526.6)	
	• No basic insulation of a conductor visible outside enclosure (526.8)	
	• Connections of live conductors adequately enclosed (526.5)	
	• Adequately connected at point of entry to enclosure (glands, bushes etc.) (522.8.5)	
5.18	Condition of accessories including socket-outlets, switches and joint boxes (651.2(v))	
5.19	Suitability of accessories for external influences (512.2)	
5.20	Adequacy of working space/accessibility to equipment (132.12; 513.1)	
5.21	Single-pole switching or protective devices in line conductors only (132.14.1; 530.3.3)	



PI&T DOCUMENTATION MAX Z_S EXCEEDED

4.0	CONSUMER UNIT(S) / DISTRIBUTION BOARD(S)	
4.1	Adequacy of working space/accessibility to consumer unit/distribution board (132.12; 513.1)	
4.2	Security of fixing (134.1.1)	
4.3	Condition of enclosure(s) in terms of IP rating etc (416.2)	
4.4	Condition of enclosure(s) in terms of fire rating etc (421.1.201; 526.5)	
4.5	Enclosure not damaged/deteriorated so as to impair safety (651.2)	
4.6	Presence of main linked switch (as required by 462.1.201)	
4.7	Operation of main switch (functional check) (643.10)	
4.8	Manual operation of circuit-breakers and RCDs to prove disconnection (643.10)	
4.9	Correct identification of circuit details and protective devices (514.8.1; 514.9.1)	
4.10	Presence of RCD six-monthly test notice, where required (514.12.2)	
4.11	Presence of alternative supply warning notice at or near consumer unit/distribution board (514.15)	
4.12	Presence of other required labelling (please specify) (Section 514)	
4.13	Compatibility of protective devices, bases and other components; correct type and rating (No signs of unacceptable thermal damage, arcing or overheating) (411.3.2; 411.4; 411.5; 411.6; Sections 432, 433)	
4.14	Single-pole switching or protective devices in line conductor only (132.14.1; 530.3.3)	
4.15	Protection against mechanical damage where cables enter consumer unit/distribution board 522.8.1; 522.8.5; 522.8.11)	
4.16	Protection against electromagnetic effects where cables enter consumer unit/distribution board/enclosures	
4.17	RCD(s) provided for fault protection - includes RCBOs (411.4.204; 411.5.2; 531.2)	✓
4.19	Confirmation of indication that SPD is functional (651.4)	
4.20	Confirmation that ALL conductor connections, including connections to busbars, are correctly located in terminals and are tight and secure (526.1)	
4.21	Adequate arrangements where a generating set operates as a switched alternative to the public supply (551.6)	
4.22	Adequate arrangements where a generating set operates in parallel with the public supply (551.7)	

PI&T DOCUMENTATION MAX Z_S EXCEEDED

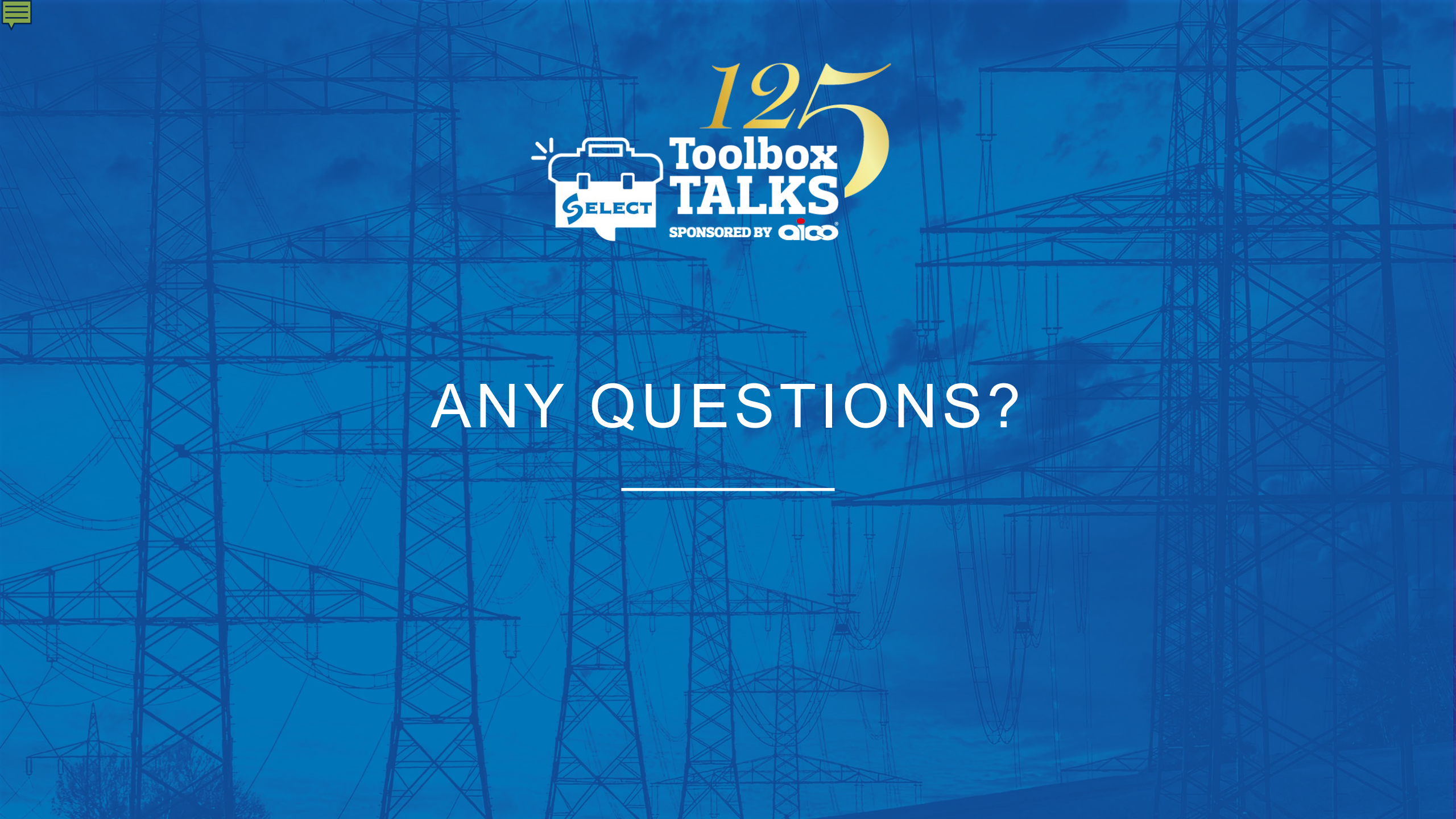
SECTION K. OBSERVATIONS

Referring to the attached Schedules of Inspection and Test Results, and subject to the limitations specified at Section D, Extent and Limitations of the Inspection and Testing: ☐ No remedial action is required ☐ The following observations are made:

Inspection Schedule Item No. or 'Test'	OBSERVATIONS	Classification Code C1, C2, C3 or FI (see below)
Test	The kitchen socket-outlet circuit protective device will not operate in the required time in the event of a fault (Zs exceeded) and an RCD for fault protection has not been provided.	C2

One of the adjacent Codes, as appropriate, has been allocated to each of the observations made above to indicate to the person(s) responsible for the installation the degree of urgency for remedial action.	**Danger present. Risk of injury. Immediate action required.**	**C1**
	Potentially dangerous – urgent remedial action required.	**C2**
	Improvement recommended.	**C3**
	Further investigation required without delay.	**FI**

☐ **Additional observations are recorded on the following number of continuation sheet(s) .....**


125
Toolbox
TALKS
SELECT
SPONSORED BY aico
ANY QUESTIONS?

Fire Safety and Renewables

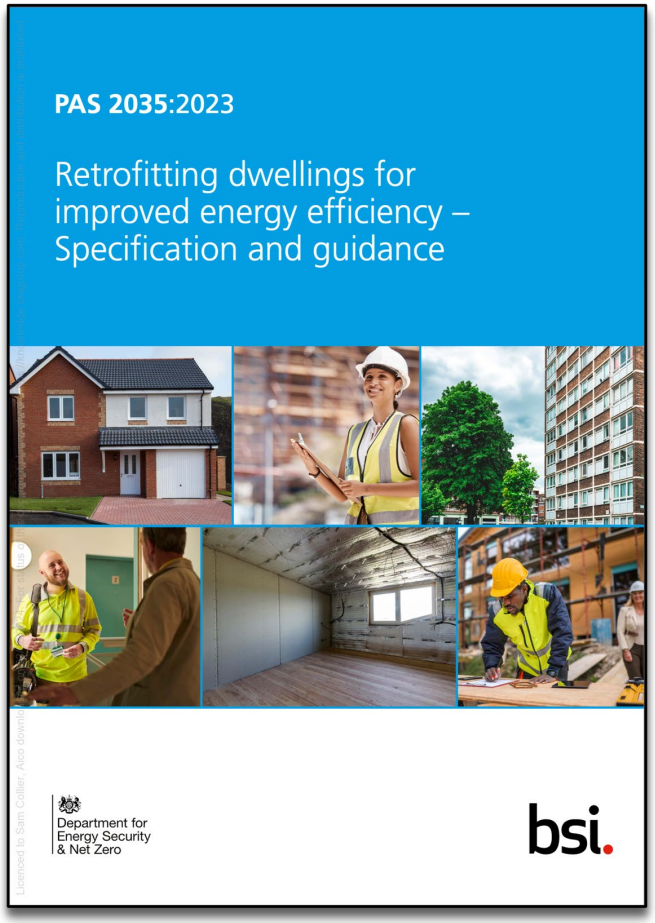
SELECT Toolbox Talk

an Ei Company

Good Quality Retrofit

PAS 2035:2023

Clause 6



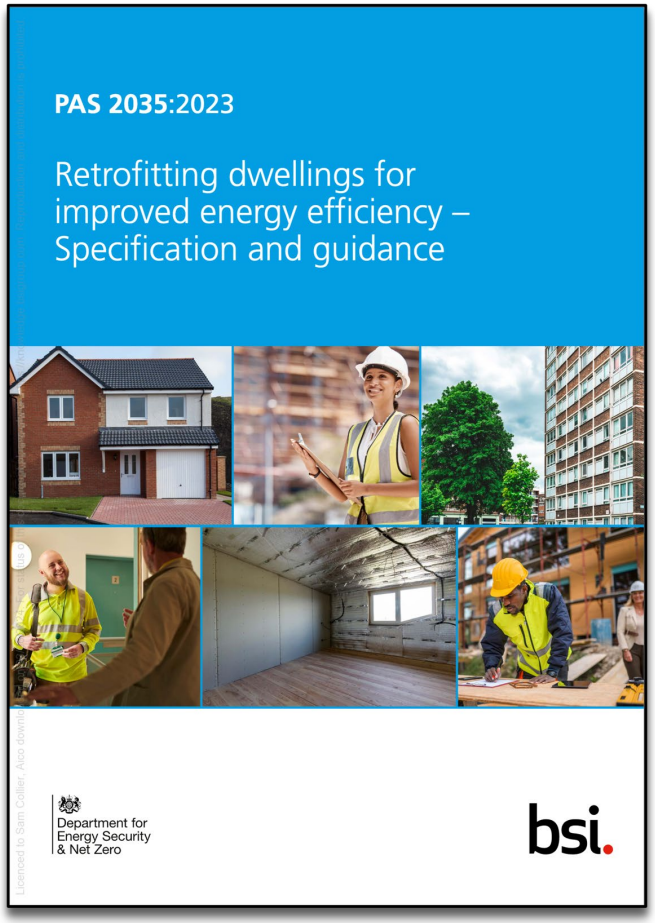
Clause 6.2 defines outcomes that should be considered when undertaking retrofit, these include but are not limited to:

- Reductions in energy costs and/or alleviation of fuel poverty
- Improvement of IAQ (internal air quality)
- Elimination of condensation, damp & mould
- Improving the management of moisture within the building

Good Quality Retrofit

PAS 2035:2023

Clause 13



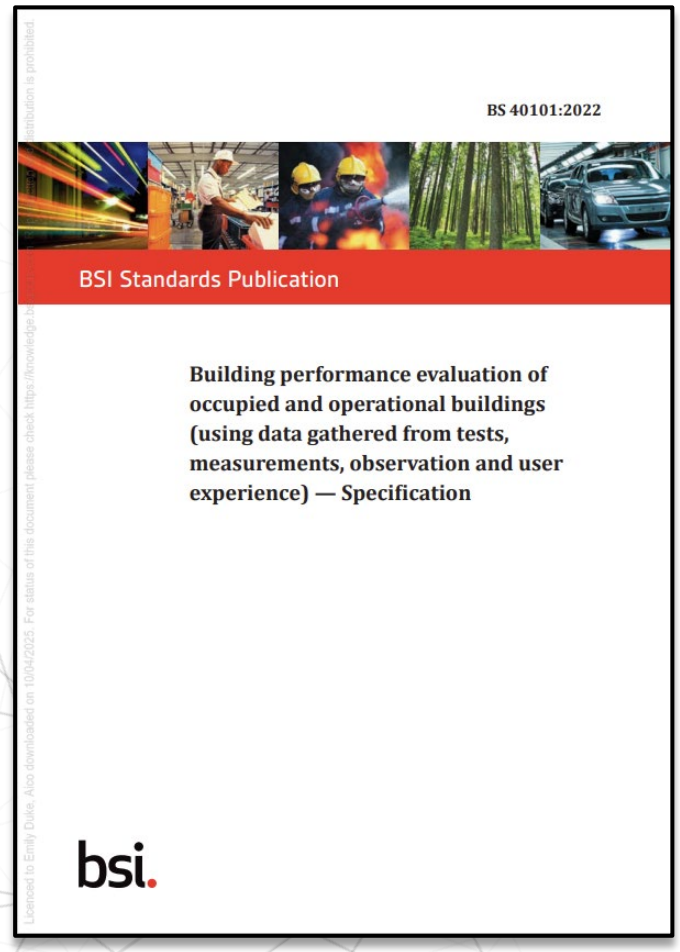
Clause 13.1 States that the Retrofit Coordinator shall evaluate every retrofit project to determine whether the intended outcomes of the project have been realised.

Clause 13.5 States that when further monitoring is required, a further monitoring and evaluation plan, in accordance with BS 40101 should be in place. This plan should identify any necessary remedial work.

Good Quality Retrofit

BS 40101:2022

Clause 5



Clause 5.7.1

States that where required, internal conditions should be monitored and analysed by three core metrics:

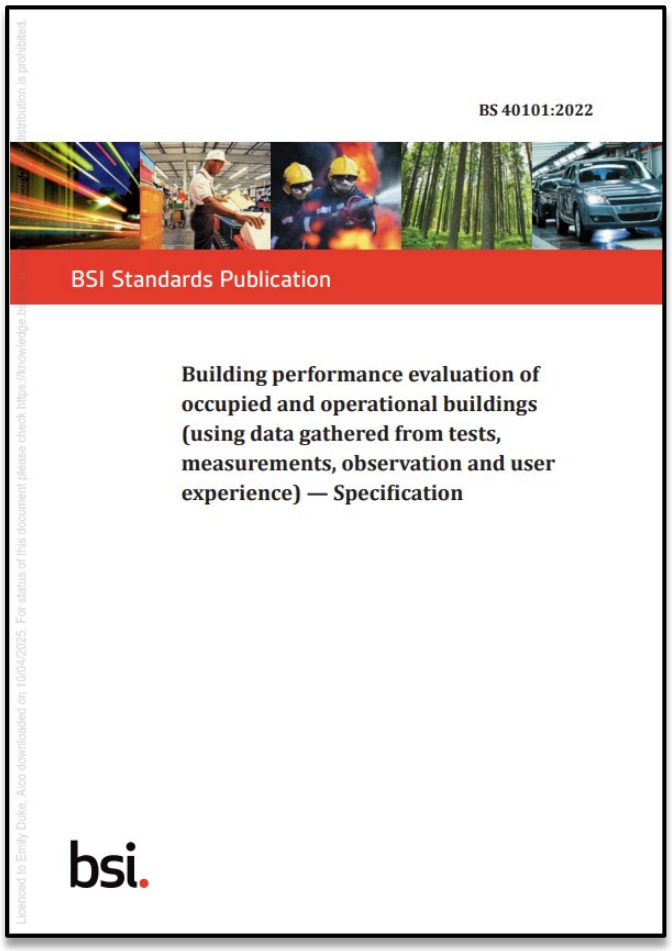
- air temperature (°C)
- relative humidity (%)
- CO2 concentration (ppm)

These core metrics can be monitored using either building integrated sensors or standalone sensors. Where battery powered sensors are used, their data capacity and battery life should be greater than 12-months (at 30 min logging intervals)

Good Quality Retrofit

BS 40101:2022

Clause 5



Clause 5.7.2

For dwellings, internal temperature and relative humidity shall be measured in the living room and main bedroom as a minimum.

Note 1 recommends considering adding additional sensors in kitchens and bathrooms as they are key sources of moisture.

Carbon dioxide concentration should be measured in the main bedroom as a minimum, other regularly/heavily occupied areas should also be considered (e.g. living room)

Monitoring and Evaluation Tools

The Connected Home Solution

Monitoring and Evaluation Tools

Ei1000G Gateway

SmartLINK®

- Collects data from sensors via SmartLINK
- Sends data to cloud via GSM network
- Mains powered with battery backup
- Built in SIM
- Connection monitored

- ✓ Gateway Mains Absent
- ✓ Gateway Low Battery
- ✓ Gateway Check-In

Monitoring and Evaluation Tools

Ei1000G Gateway

bsi.

Kitemark™ Certificate

This is to certify that:

Ei Electronics
Shannon Industrial Estate
Shannon
Clare
Ireland

Holds Certificate Number: KM 735628

In respect of:

Internet of Things (IoT)
Security of a device against common vulnerabilities for use in a commercial environment

This issues the right and licence to use the Kitemark in accordance with the Kitemark Terms and Conditions governing the use of the Kitemark, as may be updated from time to time by BSI Assurance UK Ltd (the "Conditions"). All defined terms in this Certificate shall have the same meaning as in the Conditions.

The use of the Kitemark is authorized in respect of the Product(s) detailed on this Certificate provided at or from the above address.

For and on behalf of BSI: Frank Lee, Product Certification Technical and Compliance Director

First Issued: 2021-03-26 Effective Date: 2021-03-26
Latest Issue: 2021-03-26 Expiry Date: 2024-03-25

Page: 1 of 2

...making excellence a habit.™

This certificate has been issued by and remains the property of BSI Assurance UK Ltd, Kitemark Court, Davy Avenue, Knowlhill, Milton Keynes MK5 8PP, United Kingdom and should be returned immediately upon request.
To check its validity telephone +44 (0) 345 080 9000. An electronic certificate can be authenticated online.

BSI Assurance UK Limited, registered in England under number 7805321 at 389 Chiswick High Road, London W4 4AL, UK.
A member of BSI Group of Companies.

Gateway is **3rd party accredited by BSI** to dedicated standards:

Internet of Things (IoT)

Security of device against common vulnerabilities for use in a commercial environment

KM
735628

Monitoring and Evaluation Tools

Environmental Sensors

- Gather data on indoor environmental conditions
- Send data wirelessly to cloud via SmartLINK gateway
- Advanced machine learning technology Interprets data
- Actionable insights presented via desktop dashboard

Monitoring and Evaluation Tools

Environmental Sensors

Ei1020

Temperature & Humidity

- ✓ Condensation, Damp, Mould
- ✓ Cold Home Risk
- ✓ Excess Heat Risk
- ✓ Heat Loss Risk

Ei1025

Temperature, Humidity & CO_2

- ✓ Condensation, Damp, Mould
- ✓ Cold Home Risk
- ✓ Excess Heat Risk
- ✓ Heat Loss Risk
- ✓ **Draught Risk**
- ✓ **Indoor Air Quality Risk**
- ✓ **Void Risk**
- ✓ **Dust Mite Allergy Risk**

Monitoring and Evaluation Tools

Environmental Sensors

- Battery powered – 10-year life
- More sensors, more granular data
- Data from each area pinpoints risk
- Structural versus Environmental insight

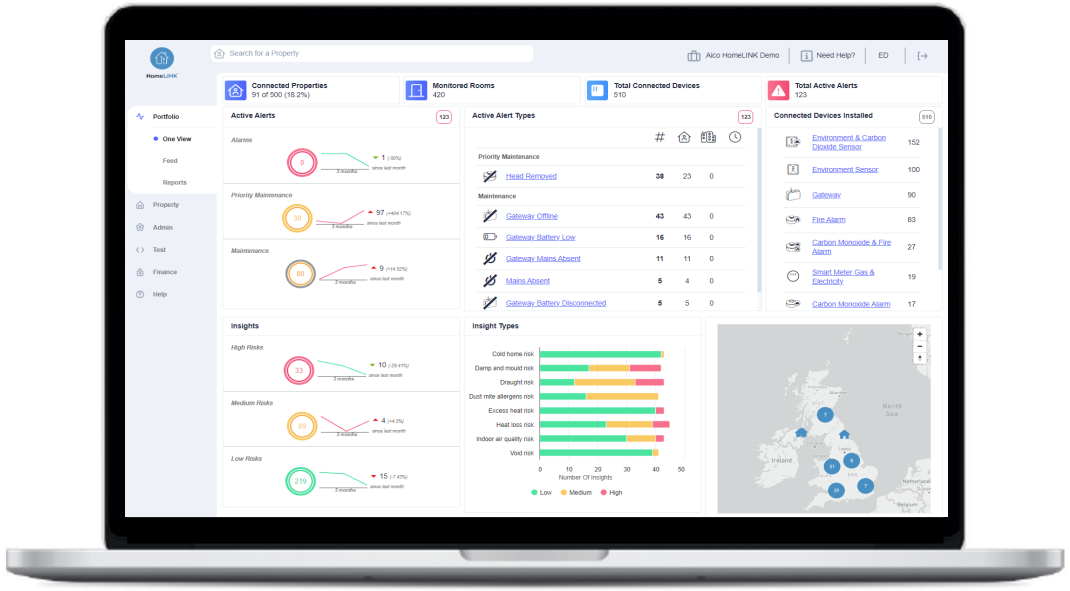
Monitoring and Evaluation Tools

Signature of Mould Insight

- Identify if an issue is Structural or Environmental
- Room specific insights
- Detailed analysis of 6 components
- Rolling 8-week period
- Recalculated daily

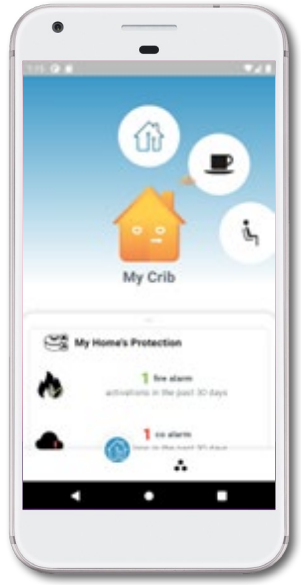
Monitoring and Evaluation Tools

The Platforms



Portal

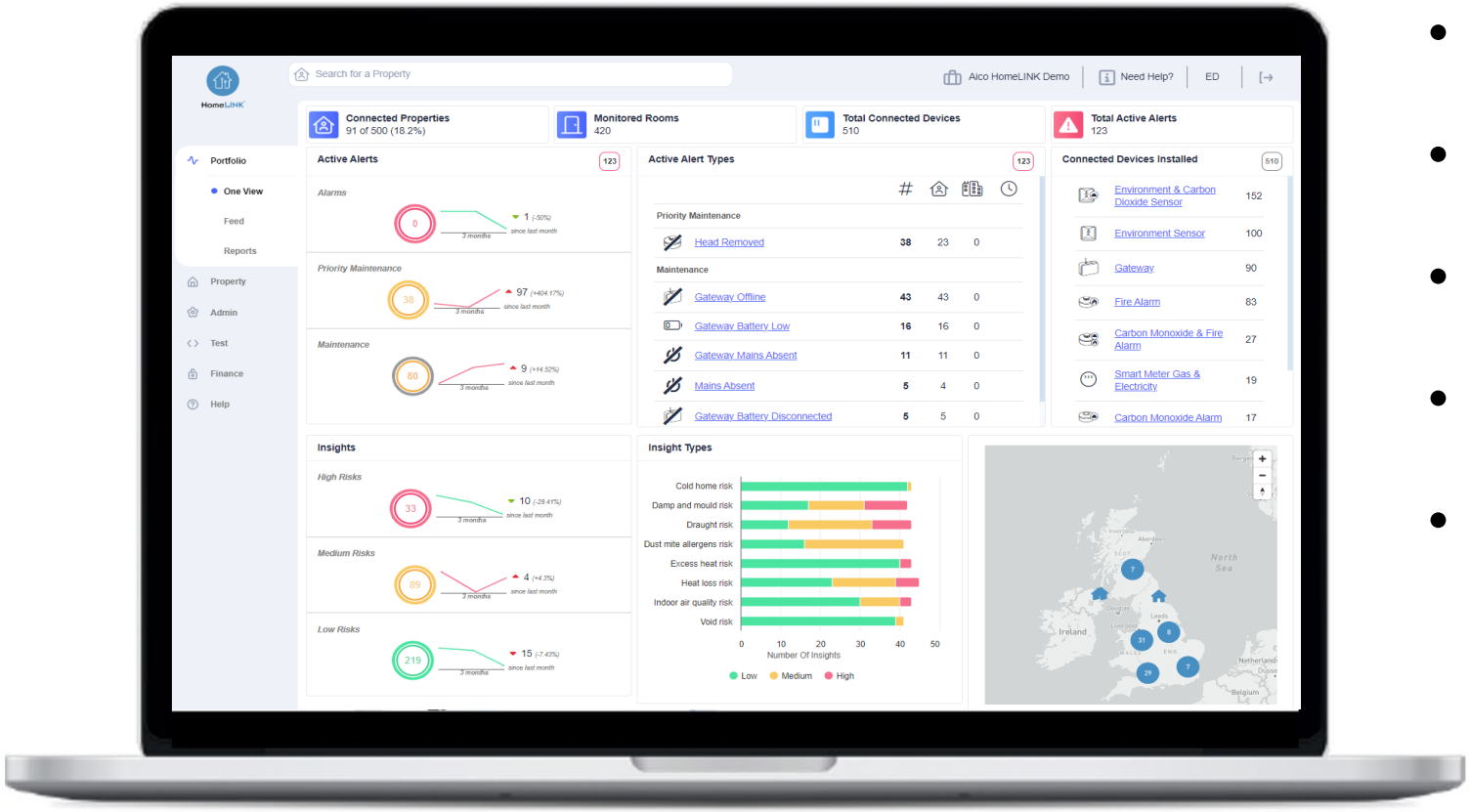
Installer App



Resident App

Monitoring and Evaluation Tools

The HomeLINK Portal



- Designed for Landlords
- KPI based dashboard
- Portfolio view - top level
- Property view – drill down
- Granular view – raw data & export to excel

Monitoring and Evaluation Tools

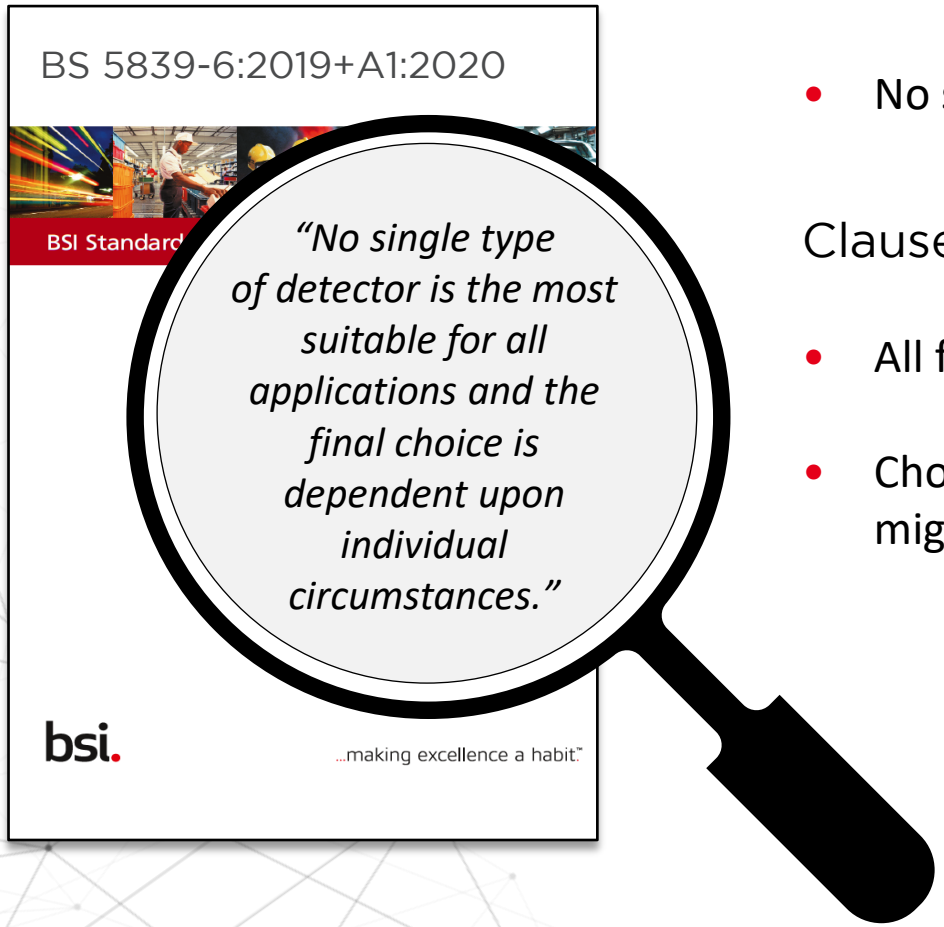
The Installer App

- Install systems - QR code scanning
- View status of devices
- View event history of devices
- Add/remove devices

Protecting Zero Carbon Technology

BS 5839-6:2019+A1:2020

Clauses 10 and 12



Clause 10 provides information on sensor types and their selection

- No single type of detector is the most suitable for all applications

Clause 12 provides information on limitation of false alarms

- All fire detectors respond to some extent to phenomena other than fire
- Choice of detector type needs to take into account both the type of fire that might be expected and the need to avoid false alarms

Protecting Zero Carbon Technology

BS 5839-6:2019+A1:2020

Clause 11.2 Note P

p) Where photovoltaic power systems, boilers, and UPS systems are installed within loft spaces, a smoke detector/alarm or multi-sensor fire detector/fire alarm should be installed.

NOTE 3 To avoid unwanted alarms, this is typically an ionization chamber smoke detector or a multi-sensor detector with drift compensation.

Clause 12.2 Note G

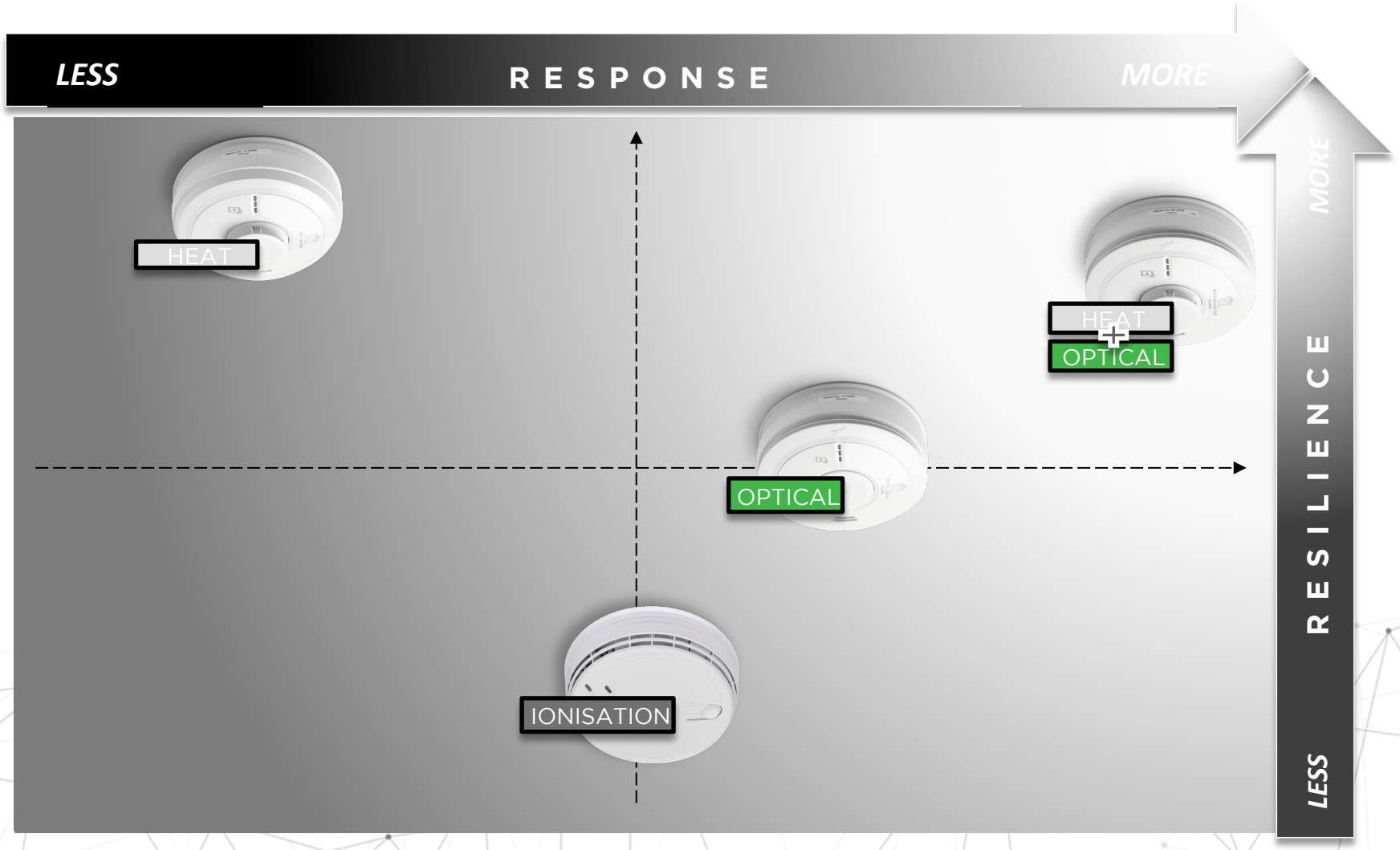
g) If it is necessary to install a smoke detector in a room or area in which significant quantities of dust or dense tobacco smoke are likely to occur (e.g. a dusty loft space), either:

1) an ionization chamber smoke detector should be used in preference to an optical smoke detector, unless there are overriding reasons to the contrary; or

2) a multi-sensor fire detector may be used, provided that it would be likely to minimize unwanted alarms resulting from dust ingress or tobacco smoke ingress.

Protecting Zero Carbon Technology

Limitation of False Alarms



Protecting Zero Carbon Technology

Multi-Sensors

FIRE

OPTICAL / HEAT

- **Ideal for Open plan areas & Lofts with electrical equipment**
- Increased resistance to false alarms

FIRE

HEAT / CO

- Ideal for Kitchens and garages with fuel burning appliances
- Dual alarm tones & visual indicators

FIRE + CO

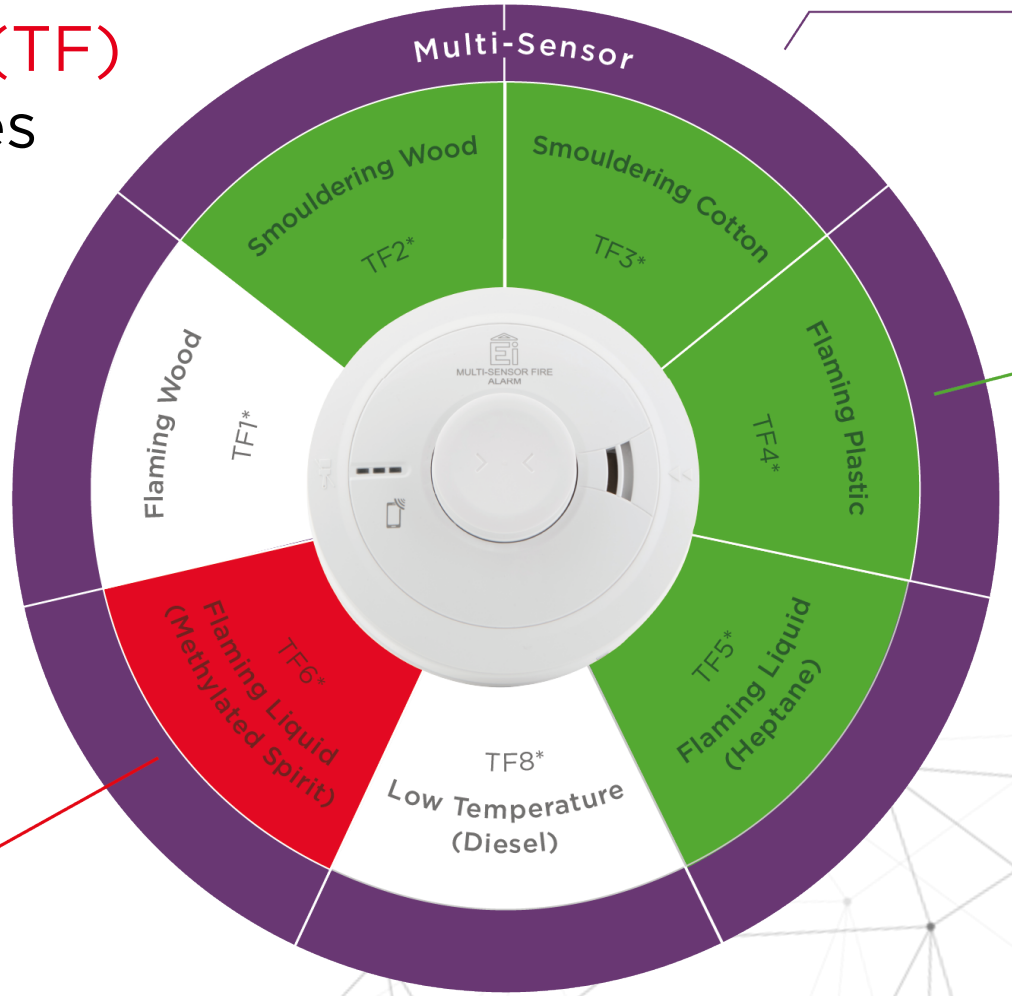
OPTICAL / HEAT / CO

- Ideal for Lofts/Living/Open plan areas with fuel burning appliances
- Increased resistance to false alarms

Protecting Zero Carbon Technology

Multi-Sensors

Test Fire (TF) Categories



Multi-Sensor alarm
passes all these test fires to get the

BS EN 14604:2005 &
BS EN 5446-2:2003
plus extra commerial test fires.

Optical
alarms have to pass these test fires to get the

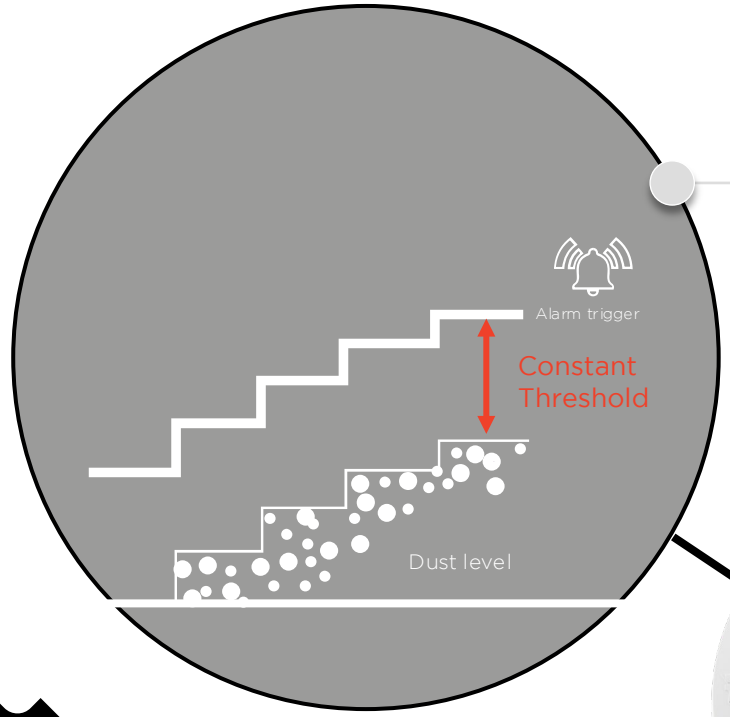
BS EN 14604:2005

Heat
alarms have to pass this test fire to get the

BS EN 5446-2:2003

Protecting Zero Carbon Technology

Multi-Sensors

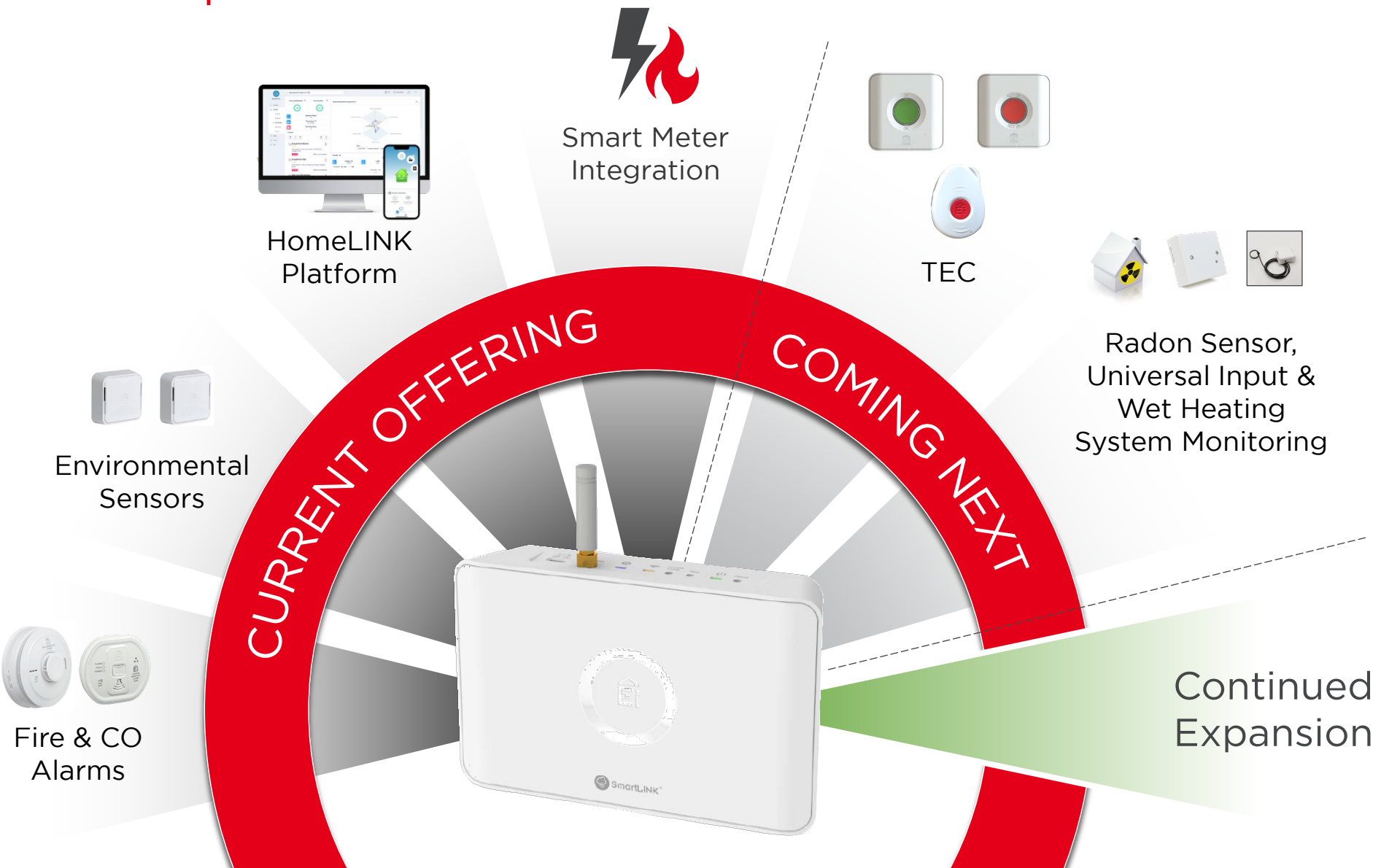


Drift compensation is designed into all Aico alarms at conception:

Multi-level Dust Compensation – should any minute particles pass through the ultrafine mesh the algorithm automatically recalibrates to compensate, whilst maintaining the alarm threshold.

All Aico Alarms containing an Optical sensor – have this feature as standard

Technology
Future Expansion

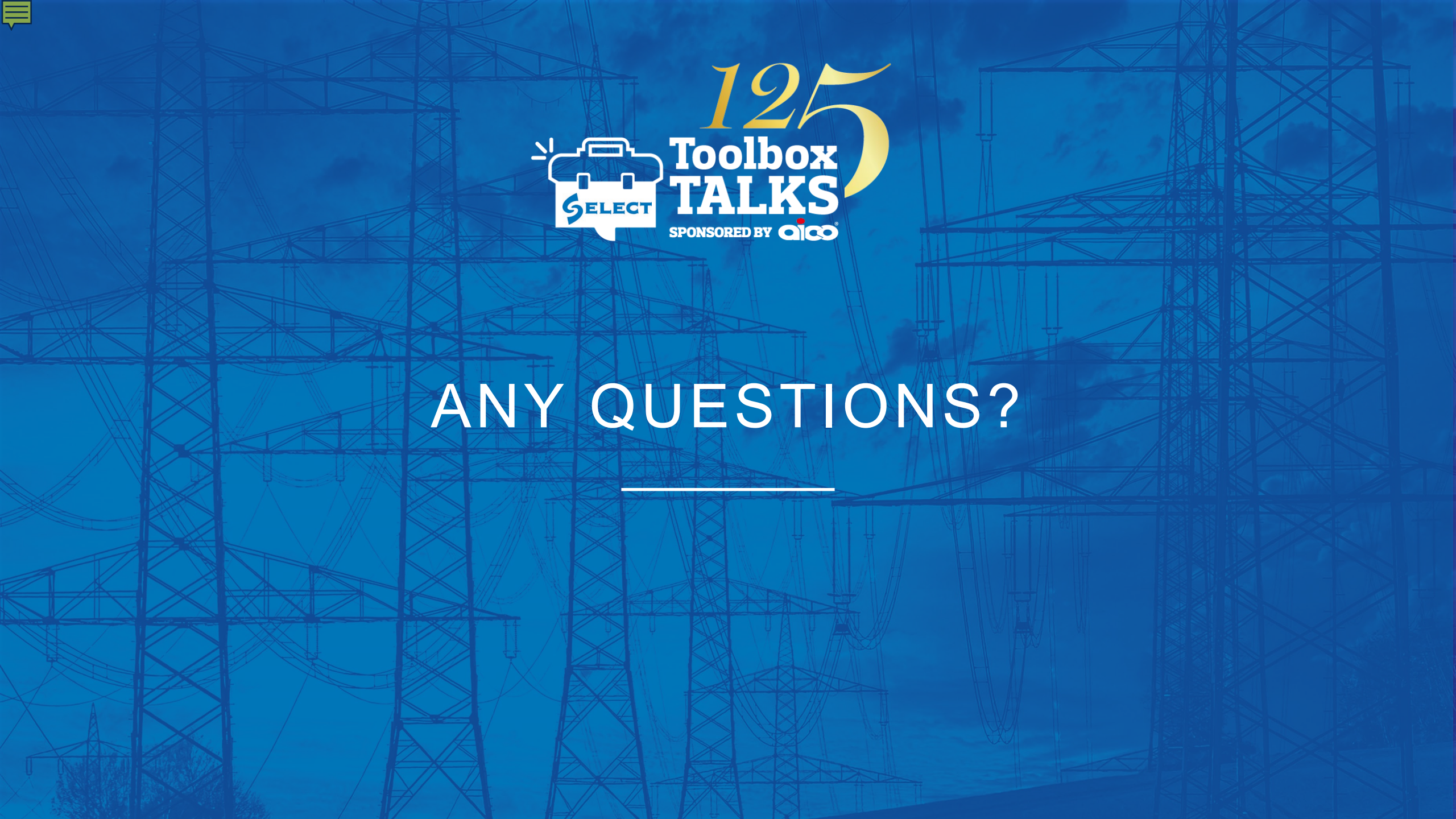


Further Training

Gold Standard Installer

Further Training

Next Steps...


125
Toolbox
TALKS
SELECT
SPONSORED BY aico
ANY QUESTIONS?

125 Toolbox TALKS SPONSORED BY aico

Kahoot!

TECHNICAL QUIZ

MAY/JUNE 2025

THANK YOU

125 Toolbox TALKS

SPONSORED BY aico®