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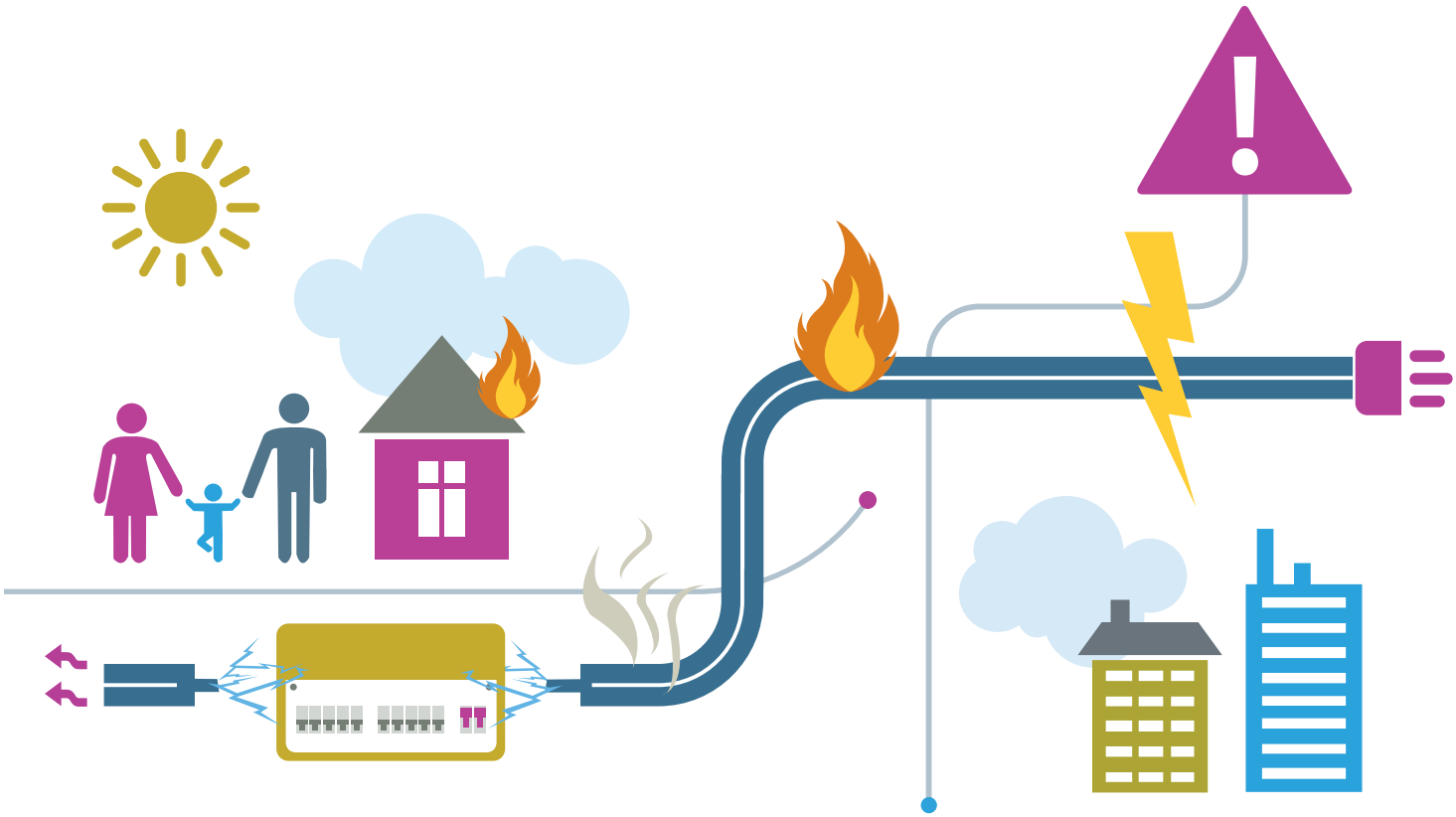
ELECTRICAL SAFETY IN UK RESIDENTIAL DWELLINGS



September 2018

BEAMA White Paper

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ABOUT BEAMA

BEAMA is the leading trade association which represents manufacturers of electrical infrastructure products and systems from transmission through distribution to the environmental systems and services in the built environment.

We work with our members to ensure their interests are well represented in the relevant political, regulatory and standardisation issues at UK, EU & international levels.

Details of other BEAMA activity can be found on the BEAMA website.

EXECUTIVE SUMMARY

Occupants in residential buildings are protected from the risk of injury from electrocution and fire by national regulations and standards for electrical installations. This protection covers the four main electrical risks of: Overcurrent: Electric shock: Overvoltage; and Arc faults. Whilst regulations and standards are focused on new installations, they are also applicable to alterations and additions to existing electrical installations. However, there are many electrical installations in older residential properties which are inadequate and do not fall within current assessments that have to be made by law.

Current Regulations and Standards have evolved over the past few decades and the latest versions now offer significantly more protection for building occupants than previous editions. Studies show that safety levels of electrical installations in older buildings are far below the requirements of the current standards. For example, in 2013-14 over 3,000 fires in residential properties were attributable to the electrical distribution system within the building (Source: DCLG Fire Statistics). As the improvement and renovation rate for the existing UK housing stock is less than 4% per annum, the potential for these fires remains unabated.

To improve the safety level of electrical installations in existing residential buildings there is a need to verify that the essential safety requirements for electrical installations are being maintained. To facilitate this, the introduction of mandatory inspections is required. These would inform the property owner about the current safety level of their electrical installation and identify where improvements are required to meet the current safety requirements. BEAMA welcomes the recent government announcement to introduce, as part of a package of measures to strengthen safety, a mandatory requirement on landlord owned properties in the private rented sector to ensure that electrical installations in their properties are inspected every 5 years. BEAMA's view is that this mandatory requirement should be extended to all dwellings, including the private sector.

The increasing use of electrical products, appliances and new technologies in the home will place further strain on older installations that maybe below current standard requirements. Without immediate intervention the risk of longer-term safety problems will only increase. Introducing such mandatory inspections of electrical installations would bring the UK into line with many other countries in Europe e.g. Belgium, Switzerland, France and Norway, and over time will contribute towards significantly reducing the number of electrical fires and injuries that we currently see.

This white paper presents the relevant evidence, options and proposals for the best way to address the issue of unsafe electrical installations in older residential properties.

BEAMA RECOMMENDS THAT FOR ALL DWELLINGS, A PERIODIC INSPECTION FREQUENCY OF 5 YEARS, OR CHANGE OF OCCUPANCY, BE ADOPTED BY APPROPRIATE LEGISLATION

INTRODUCTION

There is a comprehensive legislative framework to ensure that all new residential buildings conform to accepted electrical safety standards. These protect occupants from the danger of electrocution and electrically induced fires. The protection covers the four main risks

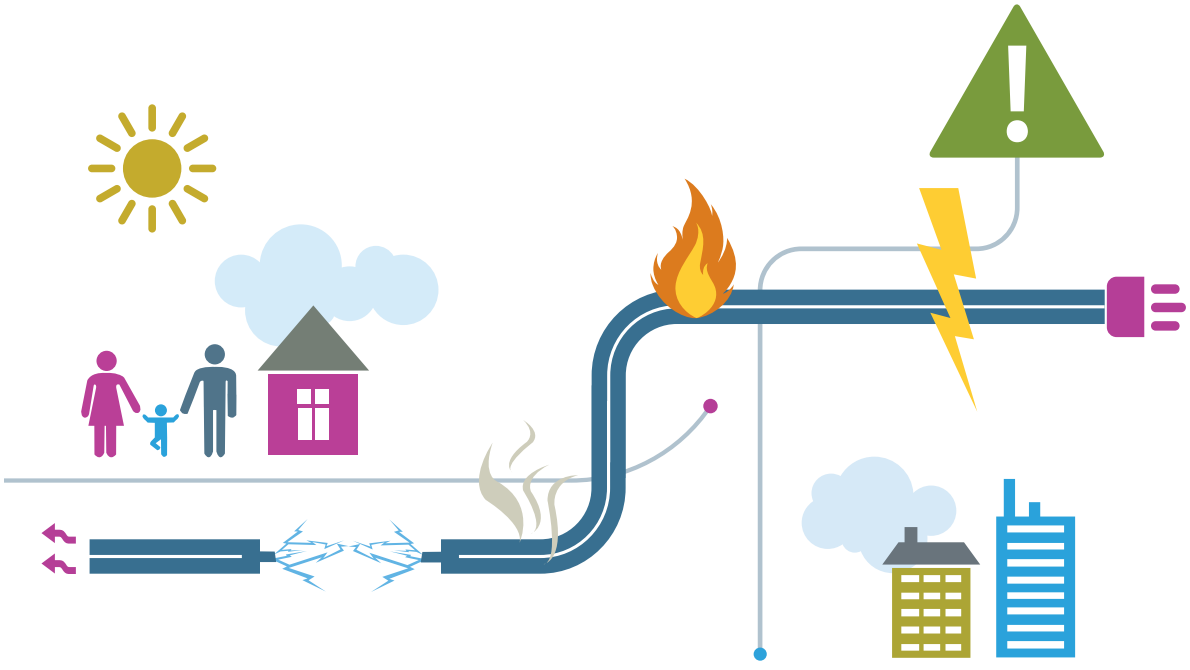
- **Overcurrent** is a load current that exceeds the rated current of the equipment or the rated current carrying capacity of a conductor. An overcurrent may result from an overload, a short circuit, or an earth fault.
- **Electric shock** is a dangerous physiological effect resulting from the passing of an electric current through a person coming into contact with a live conductor.
- **Overvoltage** occurs when the voltage in a circuit or part of it is raised above its upper design limit. These conditions may be hazardous depending on their duration. The overvoltage event can be transient (e.g. a voltage spike) or permanent, leading to a power surge. Electronic and electrical devices are designed to operate at a certain maximum supply voltage, and considerable damage can be caused by voltage that is higher than that for which the devices connected to the circuit are rated.
- **Arc fault** is a dangerous unintentional parallel or series arc of electricity between two or more conductors. The arc translates into heat, which can break down the conductor insulation and possibly result in an electrical fire.

Modern electrical devices such as RCCBs, RCBOs, MCBs, SPDs and AFDDs increase the protection of installations against these risks and, indeed, BS 7671 (IET Wiring Regulations) requires that installations are protected against these risks. BS 7671 is constantly evolving and each revision offers significantly more protection for persons, property and livestock than previous editions.

In addition to not meeting current standard requirements, older installations will deteriorate over time. The rate of deterioration is accelerated by the increasing use of electricity, different ways of generating and managing electricity and the nature of the equipment used in electrical installations. The two most likely sources of potential problems from this deterioration are the electrical cable insulation and the electrical connections.

This white paper looks at the status of current legislation, examines the age profile of dwellings and defines dangerous installations along with the associated consequences.

The paper concludes with recommended actions, including a program of regular inspections which will help to improve the safety of existing electrical installations in residential buildings ensuring that older buildings and their occupants enjoy the same level of safety and protection as that afforded in newer buildings.



1 CURRENT LEGISLATION & REGULATION

The Building Regulations 2010 for England and Wales is a regulation that requires that reasonable provision is made in the design and installation of electrical installations of dwellings to protect persons operating, maintaining or altering the installations from fire or injury. An associated document known as Approved Document P, Electrical Safety –Dwellings gives practical guidance approved by the Secretary of State for meeting the requirements of the Building Regulations.

Approved Document P effectively calls for compliance with BS 7671 – Requirements for electrical installations – otherwise known as the IET Wiring Regulations. These Regulations apply to the design, erection and verification of the electrical installations. The Regulations are periodically reviewed as technology develops over the years and has enabled improvements in installation safety to be made.

BS 7671 is a joint publication between BSI and the IET and the UK participation is entrusted to Joint Technical Committee JPEL/64 Electrical Installations. Members of JPEL/64 comprise of a wide range of industrial experts who are responsible for installation and related standards matters at national, European and International levels. The periodic amendment and revision of BS 7671 is necessary in order to maintain its technical alignment with the European CENELEC harmonised documents which in turn are derived from the International IEC 60364 series of standards for low voltage electrical installations.

Other relevant legislation includes:

- The Landlords and Tenants Act 1985 requires that the electrical installation in a rented property is safe when a tenancy begins and maintained in a safe condition throughout the tenancy.

  The Housing Act 2004 (England and Wales) introduced a risk assessment for privately rented homes – Housing, Health and Safety Rating System (HHSRS) comprising 2 categories which incorporate 29 classes of hazard, replacing the earlier Fitness Standard. For 23 – Electrical Hazards this covers shock and burns resulting from exposure to electricity including lightning strikes. How frequently this needs to be done depends on the age and type of property, and whether there has been any change of occupancy. Some elements or facilities will need to be checked more frequently than others or when required by law (e.g., gas appliances).

- The Management of Houses in Multiple Occupation (HMO) (England) Regulation 2006 and the Management of Houses in Multiple Occupation (Wales) Regulation 2006 require that every electrical installation in an HMO is inspected and tested at least every five years. If the property is not an HMO then a landlord is not legally obliged to do this, except in Scotland where it became a legal requirement from 1st December 2015.

- The Building (Scotland) Act 2003 gave responsibility to Scottish Ministers for creating Building Regulations and preparing technical guidance to ensure buildings are safe, efficient and sustainable for all. The Government Technical Handbooks (domestic and non-domestic) associated with the Act effectively call for compliance with the requirements of the IET Wiring Regulations (BS 7671).

- From 1st December 2015, under sections 13(4A) and 19B (4) of the Housing (Scotland) Act 2006, private landlords in Scotland are required by law to ensure that their properties are electrically safe. This covers any installation in the property for the supply of electricity, electrical fixtures and fittings, any appliances provided by the landlord under the tenancy.

Whilst the government has recently announced plans to introduce a mandatory requirement on landlord owned properties in the private rented sector to ensure that electrical installations in their properties are inspected every 5 years there are currently no mandatory requirements for periodic inspections to be carried out on existing installations for privately owned dwellings in England, Wales, Scotland and Northern Ireland.

Dwellings will have experienced ageing and deterioration over time due to use and misuse by their occupants which may lead to damaged or destroyed switches, socket-outlets, fixed wiring conductors, electrical connections, terminations and consumer units. In addition, electricity usage may have also changed over the years due to lifestyle and increased reliance on technology and greater electrical appliance use. More electrical and electronic appliances are connected to the existing older electrical installation having an insufficient number of socket outlets, leading to the increased use of adaptors and multiple portable socket-outlets (extension leads and cable reels etc.). Also, the needs of a family will change over the years as it grows and develops.

Fortunately, there are simple steps that can be taken to address these potential risks.

2 TYPICAL OLDER INSTALLATIONS

Older electrical installations may have insufficient levels of safety due to:

- Ageing of the electrical installation including deterioration of aged insulation materials and continued use of damaged items of electrical equipment.
- Loose electrical connections.
- Increased use of electricity by a larger number of building inhabitants having increased individual power usage requirements.
- Modifications to the electrical installation performed by unskilled persons rather than by a qualified electrician.

Specifically, the following safety critical problems may be present:

- Absence of a protective earthing conductor (PE) in electrical power and lighting circuits.
- Damaged socket-outlets or socket-outlets without a PE conductor.
- Absence of RCD protection;
  - in locations containing a bath/shower
  - for socket-outlets
  - To protect cables concealed within walls.
  - To protect lighting circuits
- Overcurrent protective devices (e.g. fuse or circuit breaker) not rated according to the cross-section of the connected conductors.
- Sockets-outlets and switches that have become hot or display burn marks indicating over-loading or loose electrical connections.
- Lack of fixed socket-outlets resulting in the incorrect and excessive use of plug adaptors and portable multiple socket-outlets (extension leads, cable reels etc.) leading to the overloading of fixed socket-outlets.

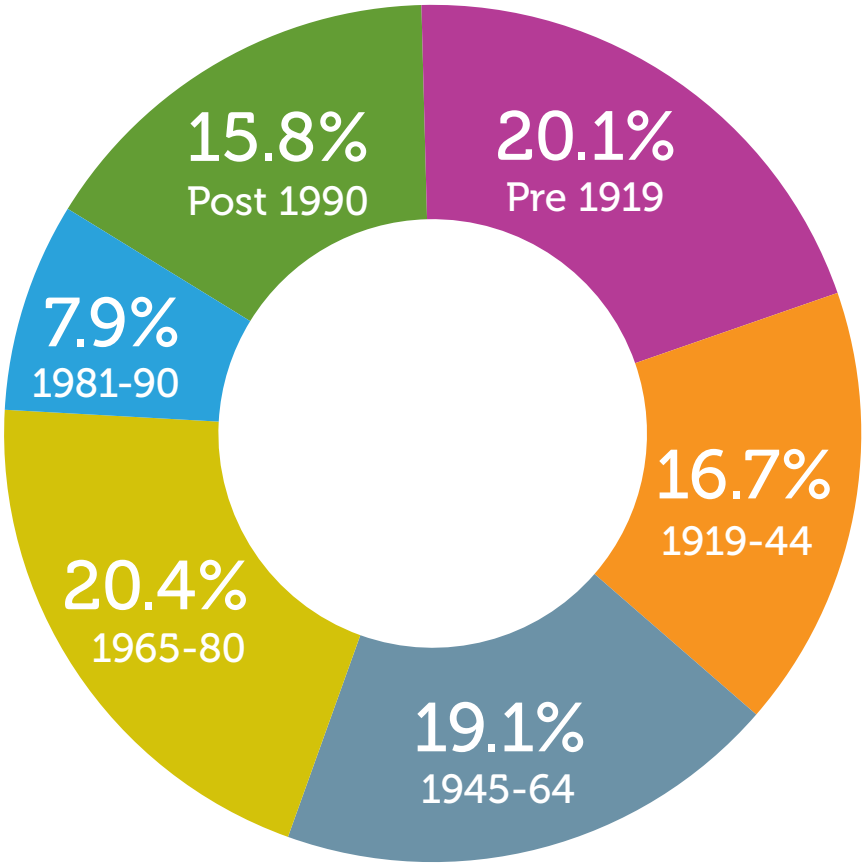
FIGURE 1: MAINS PROTECTION AND METERING IN OLD RESIDENTIAL BUILDING

2.1 AGE PROFILE OF DWELLINGS

In England, stock of existing dwellings is estimated at 28 million units by the DCLG's Dwelling stock estimates (2015). 84% were built more than 25 years ago, 56% before 1965 and 37% before 1945. The situation changes very slowly, because each year less than 1% of the housing stock consists of new buildings (200,000+).

The 90's was an important decade. In most European countries, this was the period when significant changes to electrical installations standards were introduced including the introduction of new requirements regarding equipotential bonding, use of high sensitivity RCDs for protection of some socket outlets. Use of RCDs in dwellings was further extended in 2008. Further expansion of the use of RCDs to include the protection of luminaires has been announced in the publication of the 18th Edition of the Wiring Regulations.

The use of electricity increased significantly between the 1950's and the early 2000's. This was due to the widespread growth in the use of electrical appliances in dwellings. On average electricity consumption in the UK per capita more than doubled between 1960 to 2014 (Source: World Bank). Figures show that the number of electrical appliances per dwelling multiplied by 10 over this period.



Note: The devolved administrations have acquired differing powers over housing and housing related matters. This has resulted in some legislative divergence and the collection of statistics in different formats. For the sake of simplicity the major legislation in force in England has been referenced along with statistics for England, which represents over 85% of the total UK housing stock.

FIGURE 2: CONSTRUCTION YEAR OF DWELLINGS IN ENGLAND (SOURCE DWELLING STOCK ESTIMATES, 2015, DCLG)

THE 90'S WAS AN IMPORTANT DECADE. IN MOST EUROPEAN COUNTRIES, THIS WAS THE PERIOD WHEN SIGNIFICANT CHANGES TO ELECTRICAL INSTALLATIONS STANDARDS WERE INTRODUCED

3 DANGEROUS INSTALLATIONS

Electrical installations will age with time. It is inevitable that the conditions and safety levels of electrical installations will deteriorate. Safety levels can also be affected by everyday use, misuse and DIY alterations (particularly those where unauthorised alterations are carried out by persons that are not competent for the tasks involved). A typical electrical installation has most of its component parts hidden from view, beneath floors, in loft spaces or in partition floors The condition of these parts cannot be readily observed by the user. Loose connections & damaged/ageing insulation on hidden cables can be a source of overheating, earth leakage current and arc faults that in turn can lead to ignition of surrounding combustible materials and fire. Without regular inspections by competent persons the types of conditions that are associated with risk & hazards cannot be recognised or acted upon.

Department for Communities and Local Government (DCLG) English Housing Survey (2013-14), Fire and Fire Safety states that to reduce the risks of fire, the electrical installation in a home should:

- Meet the current building requirements
- Be properly installed and maintained
- Be regularly checked and tested
- Provide sufficient and appropriately sited electric socket outlets to help reduce the need for extension leads and overloaded sockets

Furthermore, it notes that defects to socket-outlets or switches increases the risk of fire, and that RCDs can reduce the incidence of fire associated with earth faults in electrical systems, equipment and components. It also provides further information based on age of dwelling on the presence of five important electrical safety features: PVC wiring, earthing system, up to date consumer unit, overload protection and RCD protection.

Only just over half of the housing stock built before 1980 has been updated to include all 5 of these safety features. Less than two thirds have RCD protection or an up to date consumer unit.

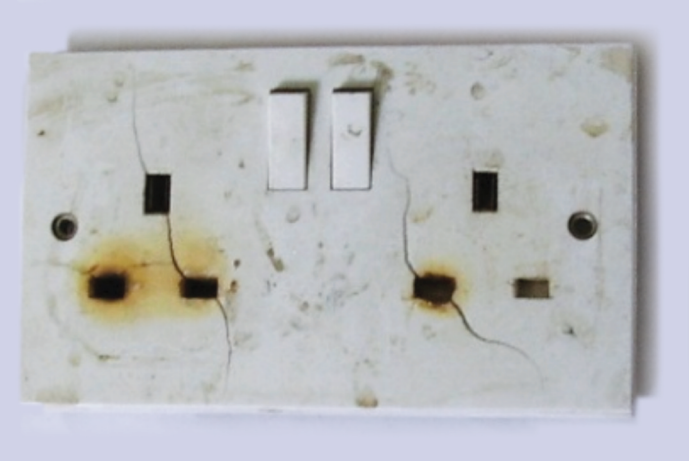


FIGURE 3: EXAMPLE OF A BADLY DAMAGED TWIN SOCKET OUTLET DISPLAYING THE EFFECTS OF CONSIDERABLE OVERHEATING

3.1 CONSEQUENCES OF DANGEROUS INSTALLATIONS

Dangerous electrical installations lead to risks to people (e.g. electric shocks, electrocution, burns, death) as well as risks to the building and infrastructure (e.g. fire, electrical installation destruction, damage to equipment), all with considerable associated costs both in terms of installation and equipment repairs and potentially for personal lifetime medical care.

Each year in Europe, 16,000 persons are injured and 540 die, due to electrical accidents, according to the International Federation for the Safety of Electricity Users (FISUEL: http//www.fisuel.org). Annually, more than 300 electrocutions occur in Western Europe (France, UK, Italy, Germany, Spain, Norway, Netherlands and Sweden). Most of these accidents and fatalities could be avoided if electrical installations complied with the current standard safety requirements for protection against electric shock. Mortality statistics produced by the Office for National Statistics indicates that in 2016, for England and Wales, there were 10 deaths due to exposure to electrical current. It is estimated that 2.5m people receive a mains voltage electric shock per year of whom 350,000 experience serious injuries.

Fire and rescue authorities attended 170,000 fires in England in 2013-14. During this period there were 3,614 non-fatal fire casualties and 275 fire fatalities. The main sources of ignition attributable to dwellings are cooking appliances, space heating appliances and the electrical distribution system.

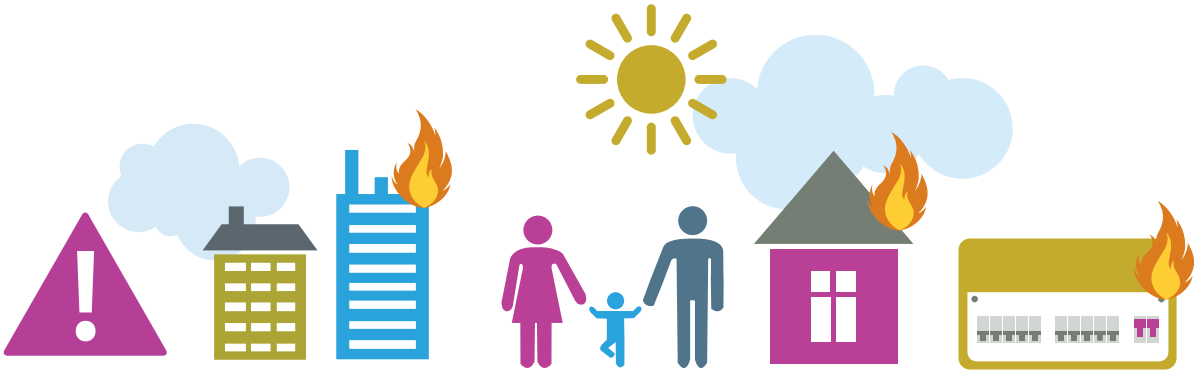
Sources of Fires in Dwellings

Government statistics show that the number of accidental fires in dwellings in England that have "electrical distribution" as the source of ignition have not significantly reduced over time. By comparison other more visibly obvious factors such as smokers materials (reduced by 24% over 7 years) cooking appliances (reduced by 15% over 7 years) are several times greater than the reductions in the numbers of electrical fires in electrical distribution for the same period. Fires with electrical distribution as the source have only reduced by 7% over the same 7 year period. There are risks associated with ageing & degrading installations that cannot be observed by those living within the dwelling. The only effective way to ensure that an installation is safe for continued use is through a structured regime of periodic inspections.

The UK fire statistics are derived from The Home Office detailed information on incidents attended by Fire and Rescue Services. This information covers fires, false alarms and other incidents attended by firecrews. The statistics include the numbers of incidents, fires, fatalities and casualties as well as information on response times to fires.

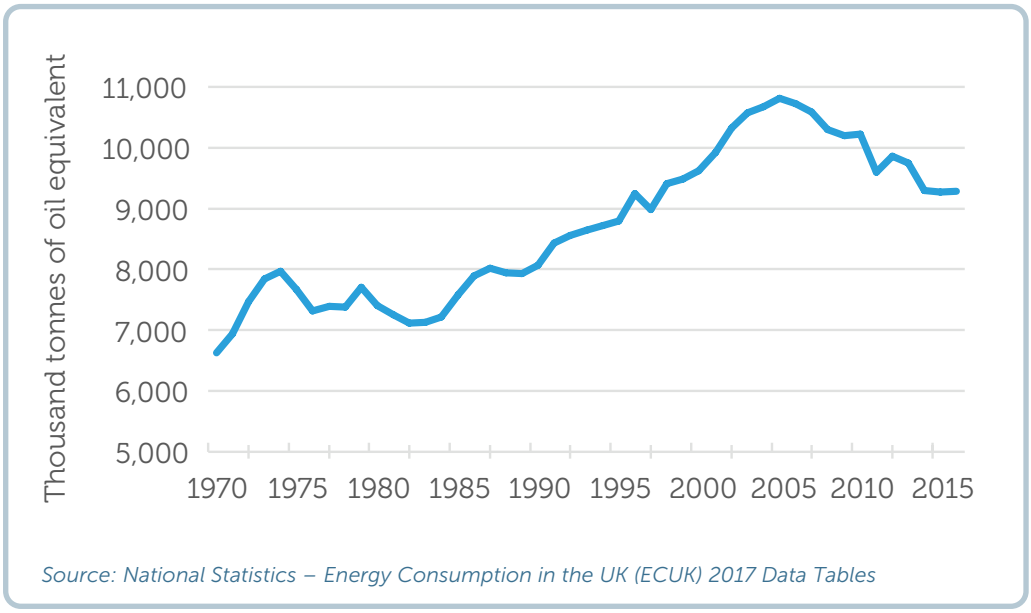
Year	Cooking appliances	Electrical distribution	Other electrical appliances
2010/11	15,744	3,462	4,098
2011/12	15,552	3,267	4,013
2012/13	14,853	3,587	3,895
2013/14	14,362	3,395	3,656
2014/15	14,306	3,356	3,527
2015/16	14,294	3,355	3,433
2016/17	13,414	3,223	3,561
Reduction 2010/11 to 2016/17	2330 (15%)	239 (7%)	537 (13%)

FIGURE 4: UK GOVERNMENT STATISTICS SHOWING THE REDUCTION OF INCIDENCE OF ACCIDENTAL FIRES CAUSED BY COOKING APPLIANCES, ELECTRICAL DISTRIBUTION AND OTHER ELECTRICAL APPLIANCES 2010/11 TO 2016/17



4 ELECTRICITY CONSUMPTION

The annual domestic consumption of electricity rose from 1970 until 2005 as use of electricity became more commonplace and households increased their reliance on electrical appliances and equipment for entertainment, space heating, cooking and other household activities. After 2005, with the drive to meet our UK climate change targets, the energy efficiency of both the home and the electrical appliances used in it has improved significantly. From 2005 to 2016, national Statistics index of domestic energy intensity has fallen some 25%. We are using electricity for more applications, however it is being used more efficiently.



Source: National Statistics – Energy Consumption in the UK (ECUK) 2017 Data Tables

FIGURE 5: ANNUAL DOMESTIC CONSUMPTION OF ELECTRICITY

4.1 EVOLVING NEEDS OF ELECTRICAL INSTALLATIONS

The electrical generation and distribution systems are undergoing fast change as new means of local generation such as photovoltaic (PV), wind power and energy storage gain widespread acceptance. In addition, there are many new and heavy loads placed on existing electrical systems due to the ubiquity of electrical household appliances and typically the increasing adoption of electric vehicles (EV). These changes can accelerate ageing and precipitate potential safety issues if existing electrical installations are not maintained in order to meet these new demands. The following issues may arise.

- Wider voltage fluctuations due to embedded generation (wind, solar, etc.)
- Changes in earthing requirements: wider use of plastic pipes for water supplies, need for local earthing rather than relying on the electricity utility, and concerns over touch potentials, particularly in respect of EV charging systems.
- Increased load currents within the installation.

Proper understanding and management of these issues requires regular inspection to identify risks and to propose modifications to the existing electrical installation.

5
SUMMARY OF ISSUES WITH OLDER INSTALLATIONS

Many electrical installations in UK homes fall far below the levels of safety of current installation standards. These can be redressed by improving the integrity of the installation and incorporation of modern protective devices.

Changes in patterns of occupancy and usage often means that older installations no longer meet the demands of the building's occupants. The rate of building renovation in the UK is also very low and there are no formal requirements for building owners, other than the recently announced mandatory requirement on landlord owned properties, to assess the safety and functionality of these existing installations to identify where improvements may be necessary. The data is worrying. For example, over half of all dwellings were built before 1965 and even with a rewire in the 1980's this would still mean that these electrical installations are unlikely to benefit from modern protective devices. With a renovation rate estimated at less than 4% per year and no formal mechanisms to review and upgrade installations throughout their life this situation is likely to persist.

6
PROPOSED SOLUTION

As stated in the European Harmonised Document HD 60364-6, Low voltage electrical installations – Part 6: Verification, periodic verification of electrical installations in dwellings is strongly recommended:

6.5.2 Frequency of periodic verification

6.5.2.1 (Extract) The frequency of periodic verification of an installation shall be determined having regard to the type of installation and equipment, its use and operation, the frequency and quality of maintenance and the external influences to which it will be subjected.

The maximum interval in periodic verifications may be laid down by legal or national regulations.

Such periodic verifications would contribute to continuous improvement in the safety level of existing electrical installations in dwellings. BEAMA recommends that for dwellings, a periodic inspection frequency be adopted by appropriate legislation.

- Every 5 years
- Change of occupancy or use
- Notifiable work as required by Part P of the Building Regulations

CONCLUSION

Many electrical installations in homes in the UK fall far below the levels of current installation standards. Changes in patterns of occupancy and use may also mean that the installations no longer meet the needs of the building's occupants. The rate of renovation in the UK is very low and there are no requirements for building owners to assess the safety and functionality of these installations to identify where improvements for safety may be necessary.

The data is worrying. Only just over half of the housing stock built before 1980 had all 5 safety features with less than two thirds having RCD protection or an up to date consumer unit. Ageing installations will deteriorate and compromise the safety of the building's occupants. With a renovation rate estimated at less than 4% per year and no formal mechanisms to review and upgrade installations throughout their life this situation is likely to get worse. An analysis of electrical installations in existing dwellings clearly shows that these do not comply with current installation standards and demonstrates that there is still much room for improvement.

Although many older residential installations will have been previously upgraded they may not meet current safety requirements and further updating of the electrical installation will therefore be necessary. It is recommended that installations are regularly inspected and maintained in accordance with the latest safety requirements.

Experience from various countries shows that mandatory safety inspections of older electrical installations are a useful tool to identity the potential safety issues in dwellings. The safety of UK dwellings and their occupants would be greatly improved with this approach.

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