

8th
EDITION



BASIC ELECTRICAL INSTALLATION WORK

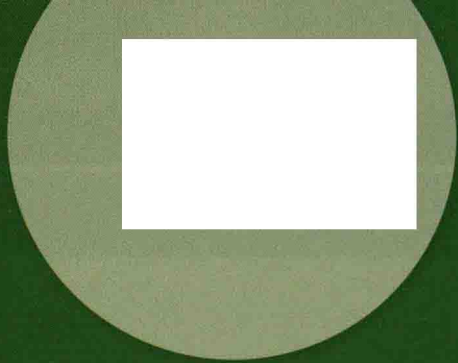
LEVEL 2

**City & Guilds 2365 Diploma in Electrical Installations
(Buildings and Structures)**

Trevor Linsley

UPDATED TO THE 17TH EDITION OF THE
IET REGULATIONS 3RD AMENDMENT 2015





Basic **Electrical** **Installation** **Work**

8th Edition

Trevor Linsley

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Basic Electrical Installation Work

Everything needed to pass the first part of the City & Guilds 2365 Diploma in Electrical Installations.

Updated in line with the 3rd Amendment of the 17th Edition IET Wiring Regulations, this new edition covers the City & Guilds 2365-02 course. Written in an accessible style with a chapter dedicated to each unit of the syllabus, this book helps you to master each topic before moving on to the next. End-of-chapter revision questions enable learners to check their understanding and consolidate key concepts learned in each chapter. With a companion website containing videos, animations, worksheets and lesson plans, this resource will be invaluable to both students and lecturers alike.

The 8th edition contains:

- Full-colour diagrams and photographs to explain difficult concepts
- Clear definitions of technical terms to make the book a quick and easy reference
- Extensive online material to help both students and lecturers.

The companion website material is available at www.routledge.com/cw/linsley

Trevor Linsley was formerly a senior lecturer at Blackpool and the Fylde College and Head of the NVQ Assessment Centre. Over the last 20 years his books have helped thousands of students to pass their electrical qualifications.

To Joyce, Samantha and Victoria

Preface

The 8th Edition of *Basic Electrical Installation Work* has been completely rewritten in five chapters to closely match the five units of the City and Guilds Level 2 Diploma in Electrical Installations (Building and Structures) (2365–02).

This book of electrical installation theory and practice will be of value to the electrical trainee working towards:

- The City and Guilds 2365–02 Level 2 Diploma in Electrical Installations (Buildings, and Structures).
- The City and Guilds 2365 Level 3 Diploma in Electrical Installations (Building and Structures) (2365–03).
- The EAL Level 3 Diploma in Electrotechnical Services.
- The SCOTVEC and BTEC Electrical Utilisation Units at Levels I and II.
- Those taking Engineering and Modern Apprenticeship courses.

Basic Electrical Installation Work provides a sound basic knowledge of electrical theory and practice which other trades in the construction industry will find of value, particularly those involved in multi-skilling activities.

The book incorporates the requirements of the latest regulations, particularly:

- 17th Edition IET Wiring Regulations (Incorporating Amendment 3: 2015);
- British Standards BS 7671: 2008 (Incorporating Amendment 3: 2015);
- Part P of the Building Regulations, Electrical Safety in Dwellings 2006;
- Hazardous Waste Regulations 2005;
- Work at Height Regulations 2005.

Trevor Linsley
2015

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- The Institution of Engineering and Technology for permission to reproduce regulations and tables from the 17th Edition IET Regulations;
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- Crabtree Electrical Industries for technical information and data;
- Legrand photographs. Visit legrand.co.uk for more information;
- RS Components Limited for technical information and photographs;
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I would like to thank the many college lecturers who responded to the questionnaire from Taylor & Francis the publishers regarding the proposed new edition of this book. Their recommendations have been taken into account in producing this improved 8th Edition.

I would also like to thank the editorial and production staff at Taylor & Francis the publishers for their enthusiasm and support, particularly my Editor, Gavin Fidler. They were able to publish this 8th Edition within the very short time-scale created by the publication of the new 3rd Amendment to the 17th Edition of the IET Regulations.

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Health and safety in building services engineering



Unit 201/501 of the City and Guilds 2365-02 syllabus

Learning outcomes – when you have completed this chapter you should:

- know about health and safety legislation;
- know how to handle hazardous situations;
- know the electrical safety requirements when working in the building services industry;
- know the safety requirements for working with gases and heat-producing equipment;
- know the safety requirements when using access equipment;
- know the safety requirements for working safely in confined spaces and excavations;
- be able to apply safe working practices to manual handling and using access equipment.





This chapter has free associated content, including animations and instructional videos, to support your learning.

When you see the logo, visit the companion website for more on this topic www.routledge.com/cw/linsley

Safety regulations and laws

At the beginning of the nineteenth century children formed a large part of the working population of Great Britain. They started work early in their lives and they worked long hours for unscrupulous employers or masters.

The Health and Morals of Apprentices Act of 1802 was introduced by Robert Peel in an attempt at reducing apprentice working hours to 12 hours per day and improving the conditions of their employment. The Factories Act of 1833 restricted the working week for children aged 13–18 years to 69 hours in any working week.

With the introduction of the Factories Act of 1833, the first four full-time Factory Inspectors were appointed. They were allowed to employ a small number of assistants and were given the responsibility of inspecting factories throughout England, Scotland, Ireland and Wales. This small, overworked band of men were the forerunners of the modern HSE Inspectorate, enforcing the safety laws passed by Parliament. As the years progressed, new Acts of Parliament increased the powers of the Inspectorate and the growing strength of the trade unions meant that employers were increasingly being pressed to improve health, safety and welfare at work.

The most important recent piece of health and safety law was passed by Parliament in 1974 called the Health and Safety at Work Act. This Act gave added powers to the Inspectorate and is the basis of all modern statutory health and safety laws. This law not only increased the employer's liability for safety measures, but also put the responsibility for safety on employees too.

Health, safety and welfare legislation has increased the awareness of everyone to the risks involved in the workplace. All statutes within the Acts of Parliament must be obeyed and, therefore, we all need an understanding of the laws as they apply to the electrical industry.

Statutory laws

Acts of Parliament are made up of Statutes. **Statutory Regulations** have been passed by Parliament and have, therefore, become laws. Non-compliance with the laws of this land may lead to prosecution by the Courts and possible imprisonment for offenders.

We shall now look at some of the Statutory Regulations as they apply to the electrical industry.

Definition



Statutory Regulations have been passed by Parliament and have, therefore, become laws.

The Health and Safety at Work Act 1974

Many governments have passed laws aimed at improving safety at work, but the most important recent legislation has been the Health and Safety at Work Act 1974. The purpose of the Act is to provide the legal framework for stimulating and encouraging high standards of health and safety at work; the Act puts the responsibility for safety at work on both workers and managers.

The employer has a duty to care for the health and safety of employees (Section 2 of the Act). To do this he or she must ensure that:

- the working conditions and standard of hygiene are appropriate;
- the plant, tools and equipment are properly maintained;
- the necessary safety equipment – such as personal protective equipment (PPE), dust and fume extractors and machine guards – is available and properly used;
- the workers are trained to use equipment and plant safely.

Employees have a duty to care for their own health and safety and that of others who may be affected by their actions (Section 7 of the Act). To do this they must:

- take reasonable care to avoid injury to themselves or others as a result of their work activity;
- cooperate with their employer, helping him or her to comply with the requirements of the Act;
- not interfere with or misuse anything provided to protect their health and safety.

Failure to comply with the Health and Safety at Work Act is a criminal offence and any infringement of the law can result in heavy fines, a prison sentence or both.

Enforcement of health and safety regulations

Laws and rules must be enforced if they are to be effective. The system of control under the Health and Safety at Work Act comes from the Health and Safety Executive (HSE) which is charged with enforcing the law. The HSE is divided into a number of specialist inspectorates or sections which operate from local offices throughout the United Kingdom. From the local offices the inspectors visit individual places of work.

The HSE inspectors have been given wide-ranging powers to assist them in the enforcement of the law. They can:

- 1 Enter premises unannounced and carry out investigations, take measurements or photographs.
- 2 Take statements from individuals.
- 3 Check the records and documents required by legislation.
- 4 Give information and advice to an employee or employer about safety in the workplace.
- 5 Demand the dismantling or destruction of any equipment, material or substance likely to cause immediate serious injury.
- 6 Issue an improvement notice which will require an employer to put right, within a specified period of time, a minor infringement of the legislation.
- 7 Issue a prohibition notice which will require an employer to stop immediately any activity likely to result in serious injury, and which will be enforced until the situation is corrected.



Figure 1.1 Both workers and managers are responsible for health and safety on site.

- 8 Prosecute all persons who fail to comply with their safety duties, including employers, employees, designers, manufacturers, suppliers and the self-employed.

Safety documentation

Under the Health and Safety at Work Act, the employer is responsible for ensuring that adequate instruction and information is given to employees to make them safety conscious. Part 1, Section 3 of the Act instructs all employers to prepare a written health and safety policy statement and to bring this to the notice of all employees. Figure 1.2 shows a typical Health and Safety Policy Statement of the type which will be available within your company. Your employer must let you know who your safety representatives are, and the new Health and Safety poster shown in Fig. 1.3 has a blank section into which the names and contact information of your specific representatives can be added. This is a large laminated poster, 595 × 415mm, suitable for wall or notice-board display.

All workplaces employing five or more people had to display the type of poster shown in Fig. 1.3 after 30 June 2000.

To promote adequate health and safety measures the employer must consult with the employees' safety representatives. In companies which employ more than 20 people this is normally undertaken by forming a safety committee which is made up of a safety officer and employee representatives, usually nominated by a trade union. The safety officer is usually employed full-time in that role. Small companies might employ a safety supervisor who will have other duties within the company, or alternatively they could join a 'safety group'. The safety group then shares the cost of employing a safety adviser or safety officer, who visits each company in rotation. An employee who identifies a dangerous situation should initially report to his site safety representative. The safety representative should then bring the dangerous situation to the notice of the safety committee for action which will remove the danger. This may mean changing company policy or procedures or making modifications to equipment. All actions of the safety committee should be documented and recorded as evidence that the company takes its health and safety policy seriously.

The Electricity Safety, Quality and Continuity Regulations 2002 (formerly Electricity Supply Regulations 1989)

The Electricity Safety, Quality and Continuity Regulations 2002 are issued by the Department of Trade and Industry. They are statutory regulations which are enforceable by the laws of the land. They are designed to ensure a proper and safe supply of electrical energy up to the consumer's terminals.

These regulations impose requirements upon the regional electricity companies regarding the installation and use of electric lines and equipment. The regulations are administered by the Engineering Inspectorate of the Electricity Division of the Department of Energy and will not normally concern the electrical contractor, except that it is these regulations which lay down the earthing requirement of the electrical supply at the meter position.

FLASH-BANG ELECTRICAL

Statement of Health and Safety at Work Policy in accordance with the Health and Safety at Work Act 1974

Company objective

The promotion of health and safety measures is a mutual objective for the Company and for its employees at all levels. It is the intention that all the Company's affairs will be conducted in a manner which will not cause risk to the health and safety of its members, employees or the general public. For this purpose it is the Company policy that the responsibility for health and safety at work will be divided between all the employees and the Company in the manner outlined below.

Company's responsibilities

The Company will, as a responsible employer, make every endeavour to meet its legal obligations under the Health and Safety at Work Act to ensure the health and safety of its employees and the general public. Particular attention will be paid to the provision of the following:

- 1 Plant equipment and systems of work that are safe.
- 2 Safe arrangements for the use, handling, storage and transport of articles, materials and substances.
- 3 Sufficient information, instruction, training and supervision to enable all employees to contribute positively to their own safety and health at work and to avoid hazards.
- 4 A safe place of work, and safe access to it.
- 5 A healthy working environment.
- 6 Adequate welfare services.

Note: Reference should be made to the appropriate safety etc. manuals.

Employees' responsibilities

Each employee is responsible for ensuring that the work which he/she undertakes is conducted in a manner which is safe to himself or herself, other members of the general public, and for obeying the advice and instructions on safety and health matters issued by his/her superior. If any employee considers that a hazard to health and safety exists it is his/her responsibility to report the matter to his/her supervisor or through his/her Union Representative or such other person as may be subsequently defined.

Management and supervisors' responsibilities

Management and supervisors at all levels are expected to set an example in safe behaviour and maintain a constant and continuing interest in employee safety, in particular by:

- 1 acquiring the knowledge of health and safety regulations and codes of practice necessary to ensure the safety of employees in the workplace,
- 2 acquainting employees with these regulations on codes of practice and giving guidance on safety matters,
- 3 ensuring that employees act on instructions and advice given.

General Managers are ultimately responsible to the Company for the rectification or reporting of any safety hazard which is brought to their attention.

Joint consultations

Joint consultation on health and safety matters is important. The Company will agree with its staff, or their representatives, adequate arrangements for joint consultation on measures for promoting safety and health at work, and make and maintain satisfactory arrangements for the participation of their employees in the development and supervision of such measures. Trade Union representatives will initially be regarded as undertaking the role of Safety Representatives envisaged in the Health and Safety at Work Act. These representatives share a responsibility with management to ensure the health and safety of their members and are responsible for drawing the attention of management to any shortcomings in the Company's health and safety arrangements. The Company will in so far as is reasonably practicable provide representatives with facilities and training in order that they may carry out this task.

Review

A review, addition or modification of this statement may be made at any time and may be supplemented as appropriate by further statements relating to the work of particular departments and in accordance with any new regulations or codes of practice.

This policy statement will be brought to the attention of all employees.

Figure 1.2 Typical Health and Safety Policy Statement.



Health and Safety Law

What you need to know

All workers have a right to work in places where risks to their health and safety are properly controlled. Health and safety is about stopping you getting hurt at work or ill through work. Your employer is responsible for health and safety, but you must help.






What employers must do for you

- 1 Decide what could harm you in your job and the precautions to stop it. This is part of risk assessment.
- 2 In a way you can understand, explain how risks will be controlled and tell you who is responsible for this.
- 3 Consult and work with you and your health and safety representatives in protecting everyone from harm in the workplace.
- 4 Free of charge, give you the health and safety training you need to do your job.
- 5 Free of charge, provide you with any equipment and protective clothing you need, and ensure it is properly looked after.

What you must do

- 1 Follow the training you have received when using any work items your employer has given you.
- 2 Take reasonable care of your own and other people's health and safety.
- 3 Co-operate with your employer on health and safety.
- 4 Tell someone (your employer, supervisor, or health and safety representative) if you think the work or inadequate precautions are putting anyone's health and safety at serious risk.

If there's a problem

- 1 If you are worried about health and safety in your workplace, talk to your employer, supervisor, or health and safety representative.
- 2 You can also look at our website for general information about health and safety at work.
- 3 If, after talking with your employer, you are still worried, phone our Infoline. We can put you in touch with the local enforcing authority for health and safety and the Employment Medical Advisory Service. You don't have to give your name.

Your health and safety representatives:

Other health and safety contacts:

Fire safety
You can get advice on fire safety from the Fire and Rescue Services or your workplace fire officer.

Employment rights
Find out more about your employment rights at:
www.direct.gov.uk



Health and Safety Executive

Health and Safety Executive is the national authority for health and safety. It is a non-departmental public body, sponsored by the Department of Health. It is a registered charity. Registered office: 1, The Triangle, Watlington Road, Watlington, Oxford OX12 9BT. Tel: 01865 566000. Fax: 01865 566001. Email: enquiries@hse.gov.uk

Figure 1.3 Health and Safety law poster. Source: HSE © Crown copyright material is reproduced with the permission of the Controller of HMSO and Her Majesty's Stationery Office, Norwich.

The regional electricity companies must declare the supply voltage and maintain its value between prescribed limits or tolerances.

The government agreed on 1 January 1995 that the electricity supplies in the United Kingdom would be harmonized with those of the rest of Europe. Thus the voltages used previously in low-voltage supply systems of 415V and 240V have become 400V for three-phase supplies and 230V for single-phase supplies. The permitted tolerances to the nominal voltage have also been changed from $\pm 6\%$ to $+10\%$ and -6% . This gives a voltage range of 216–253V for a nominal voltage of 230V and 376–440V for a nominal supply voltage of 400V.

The next proposed change is for the tolerance levels to be adjusted to $\pm 10\%$ of the declared nominal voltage (IET Regulation, Appendix 2:14).

The frequency is maintained at an average value of 50Hz over 24 hours so that electric clocks remain accurate.

Regulation 29 gives the area boards the power to refuse to connect a supply to an installation which in their opinion is not constructed, installed and protected to an appropriately high standard. This regulation would only be enforced if the