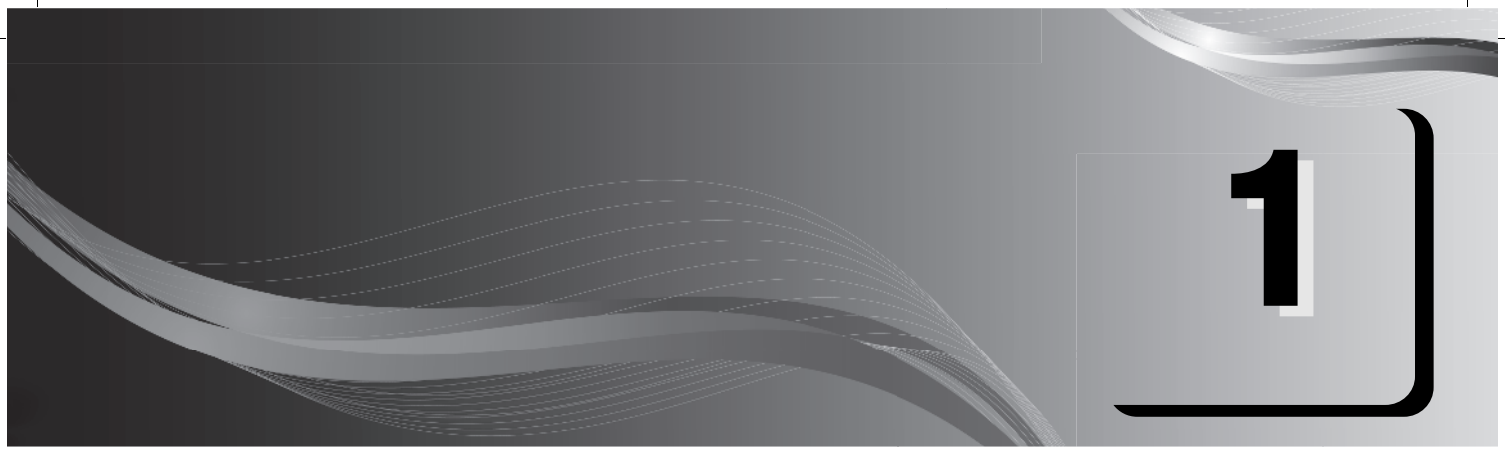

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Introduction

This book contains designs for electrical installations that have been prepared with reference to the Wiring Regulations and includes interpretations of particular technicalities.

This is not a do-it-yourself book for the amateur or untrained person. It is a guidance manual for competent electrical designers and students of installation practice.

As far as possible, all information accords with the requirements of *BS 7671*: *2008*, incorporating Amendment 1, 2011 *Requirements for Electrical Installations*, the IET Wiring Regulations (17th edition), which is issued jointly by the British Standards Institution (BSI) and the Institution of Engineering and Technology (IET) as *BS 7671*. Relevant Regulation numbers and other references are shown in the margins. (Because of the space restrictions, the following abbreviations have been used: Ch. – Chapter; Sec. – Section; Defs – Definitions; App. – Appendix.) Reference is also made to various other British and European Standards and related Health and Safety documentation.

1.1 Layout of chapters

Interspersed throughout the book are two types of chapters, giving information in different formats.

1. *Project chapters*: These may be compared with a selection of recipes for an experienced chef. The recipes give ideas for the design of typical electrical installations. Each project is dealt with on a stand-alone basis. Cross-references between these chapters are avoided, wherever possible, and similar information may be found for more than one scheme.

Electrical Installation Designs, Fourth Edition. Bill Atkinson, Roger Lovegrove and Gary Gundry.

2. *Topic chapters*: These supplement the project chapters with in-depth discussion of generalised technicalities. They also provide study information on regulatory subjects. It may be necessary to refer to these details to finalise a design with particular problems.

1.2 Wiring regulations

Throughout this book the terms Wiring Regulations (or Regulations) refer to *BS 7671:2008 Requirements for Electrical Installations*, the IET Wiring Regulations, issued jointly by the BSI and the IET. The Standard therefore represents a code of acceptable safety for electrical installations to protect:

- persons;
131.1 - property; and
- livestock.

against electrical hazards, which are described as:

- electric shock;
- fire;
- burns;
- ignition of a potentially explosive atmosphere;
- undervoltages, overvoltages and electromagnetic effects;
- injury from mechanical movement of electrically actuated machinery;
- power supply interruptions or interruptions of safety services; and
- arcing or burning, excessive pressure or toxic gases.

114.1 The Regulations are not a statutory document, but are quoted as a means of compliance with certain statutory instruments. Criminal charges could not be brought for failure to comply with the Wiring Regulations, and such non-compliance could be used in evidence if there were a charge for breach of the forthcoming *Electrical Safety Quality and Continuity Regulations (ESQCR)* or the *Electricity at Work Regulations*.

It would be most unwise to ignore any of the requirements of the Regulations. They must be considered in their entirety and are a pass or fail test. An installation cannot partially comply.

1.3 Terminology

In order to understand technicalities, the importance of correct terminology is stressed throughout this book. In general, however, the use of overcomplicated expressions and trade jargon has been avoided.

The Wiring Regulations contain a list of definitions for words and expressions, which may not accord with standard dictionary definitions. Wherever there is any doubt, the Wiring Regulations definition should be applied.

1.4 Competence and responsibility

Any person involved with the installation of wiring in buildings takes on both legal and moral responsibilities for safety. A high level of technical and practical competence is essential. This can only be achieved with appropriate study.

There are always three components to an electrical installation project:

1. Design;
2. Installation;
3. Inspection and testing.

Often one person or company takes on all three responsibilities, especially for simple repetitive jobs such as house wiring. On larger schemes, specialist companies may be contractually involved for each aspect and in turn use a team of operators. As the work progresses from planning to completion, there must always be one or more supervising individuals, who will eventually certify that the three aspects of the contract have been carried out in accordance with the Wiring Regulations and any other statutory or specification requirements.

1.5 Procedures

1.5.1 Design

It is sometimes thought that the use of tried and tested methods removes the design aspect from a scheme. This is not the case. Every project involves electrotechnical design decisions, which should not to be confused with architectural or customer instructions for the physical location of electrical equipment. Thus, a self-employed electrical contractor, who makes a decision on the selection and connection of an electrical accessory, is a designer. The same applies to an electrician who makes a similar decision on behalf of an employer.

All technical design information must be recorded. This is a requirement of the Wiring Regulations. IET guidance stresses that it is essential to prepare a full specification prior to commencement or alteration of an electrical installation. The size and content of the specification will correspond with the complexity of the work. For simple installations, a schedule of circuit details and test results may suffice. 514.9

The designs shown in the following chapters are for guidance only and each one includes a suggestion for a suitable design specification. A person selecting this guidance makes a design decision and therefore becomes the person responsible.

632.3 Upon completion of a contract, the person or persons responsible for the design, construction, and inspection and testing of the installation must, as appropriate, provide the person who ordered the work with an Electrical Installation Certificate, stating the works that were carried out, together with schedules for inspection and for test results.

1.5.2 Installation

Where a technical design is drawn up by an electrical engineer or other competent person, it should not be the installer's job to check design details, unless this is one of the contract requirements. The installer is always under obligation to point out to the designer any obvious conflict with regulations or standards and the installer should always refuse to carry out substandard work. There would be no defence in law against creating an unsafe installation on the basis of inherently bad instructions.

The installer will use the designer's specification document as required by the Wiring Regulations. This may only cover performance requirements or may give full technical details for the selection and erection of equipment. Once again it must be emphasised that a non-technical instruction to take an electrical supply to a particular appliance or location does not constitute design information.

The installer has the responsibility to ensure that equipment is installed correctly and in accordance with the specification, supplemented by manufacturers' information. The installer is often delegated other tasks, such as that of negotiating with the electricity supply company and verifying local licensing requirements.

Upon completion of the project, the installer certifies that the installation work has been carried out in accordance with the Wiring Regulations.

1.6 Inspection and test

610.1 No matter how simple or straightforward a job is, the work should always be inspected, both during the course of the work, and upon completion, and tested before the installation is put into service. This applies equally to work carried out by a self-employed operator. Self-certification is normally acceptable, provided that the contractor has the competence and equipment to test correctly. The customer or an insurer may require specialist certification. This particularly applies in the case of safety alarm systems or work in hazardous areas.

Whether an in-house or independent specialist, the inspector must be given the full design documentation, with amendments showing any relevant on-site modifications. On larger projects, this will include 'as fitted' drawings.

Certain parts of the installation may be hidden from view upon completion. In such cases the inspector must arrange for inspection during the course of erection or receive certified confirmation that the work is satisfactory.

Upon completion of the project, the inspector certifies that the inspection and test have been carried out in accordance with the Wiring Regulations. 631.1

1.7 Completion

The signatures of the designer, installer and inspector are required for the Electrical Installation Certificate. This cannot be issued until the work has been completed in accordance with the Wiring Regulations. Where there are acceptable departures from the Regulations, these must be shown on the certificate. See Chapter 15 for inspection and test procedures. 632.3

1.8 Working methods and materials

The Wiring Regulations require good workmanship by competent persons and that proper materials are used. 134.1.1

1.9 Operatives

Any person carrying out electrical work must be competent, trained and skilled in the type of installation work being carried out. Where trainees or unskilled operatives are employed for electrical work, they must be appropriately supervised.

Workmanship must be of a quality appropriate to the location. A working knowledge of the building structure is necessary where holes and fixings are made to carry cables. Decor should be disturbed as little as possible, with prearranged responsibility for making good.

1.10 Materials

The Regulations require that every item of equipment complies with a British or harmonised Standard. Alternatively, equipment complying with a relevant foreign standard may be used, provided that the designer confirms that the equipment provides a degree of safety acceptable to the Regulations. This may mean product certification by an approvals organisation. 511.1

1.11 Amendments to *BS 7671: 2008*

There is one amendment to *BS 7671*: *2008*, published in 2011. Many of the changes are minor, resulting from European harmonisation, and the numbering of product standards where these have also been harmonised. Where changes have been made that affect the technical or practical aspects of this book, the text has been changed accordingly. If an amendment noticeably alters conventional procedures, details of the change have been included. This particularly applies in the case of voltage harmonisation.

1.12 Voltages

On 1 January 1995, the *Electricity Supply Regulations 1988* were changed to take into account a change in the standard UK supply voltage (Table 1.1). All specifications, designs and calculations should now use the 230/400 V figures. The change in voltage is minimal, therefore load assessments given in this book have not been recalculated, but there are other consequences to be considered.

Taking all of the above factors and tolerances into account, it will be seen that under the most extreme circumstances, equipment rated at 230 V may be supplied at anything between 216 and 253 V.

1.13 Voltage drop

The Regulations require the voltage at the terminals of fixed current-using equipment under normal service conditions to be greater than the lower limit corresponding to the product standard for that equipment.

Table 1.1 Changes in nominal voltage.

	Nominal voltage	Tolerance % +	Tolerance % −	Range volts max.	Range volts min.
Up to 1.1.95					
U_o	240	6	6	254	226
U	415	6	6	440	390
From 1.1.95					
Uo	230	10	6	253	216
U	400	10	6	440	376

For an installation supplied from a public supply, a voltage drop of 3% for lighting and 5% for other uses is deemed to satisfy this requirement. At 230 V, this is 6.9 V and 11.5 V, respectively. Care therefore needs to be taken in the selection of cables, particularly where equipment is voltage-dependent:

- Motor starting currents may be such that machines may stall before achieving full speed running conditions.
- Inductive lighting loads take high current on start up and luminaires could fail to strike, especially in cold weather.

All of the designs shown in this book use cables that are capable of handling the prospective loadings with a reasonable margin of safety.