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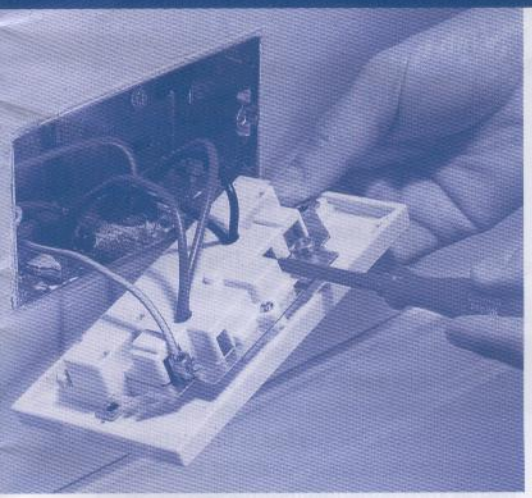
Wickes

GOOD IDEA LEAFLET 83

BASIC ELECTRICS

Contrary to popular belief carrying out a great deal of your own electrical work in the home is really quite easy. You need no higher degree of skill to add a socket-outlet or move a light than you need to tile a wall or plaster a ceiling. You just require a different type of skill. What you do need before you tackle any job however is a high degree of respect for everything electrical because if misused it can be lethal, a very clear knowledge of how electricity works, and a definite understanding of the need to work methodically and with patience at all times. The ability to recognise the possibility of danger, and to accept that uncertainty may mean dangers, are essential attributes for the amateur electrician. Effectively this is saying do your homework, proceed with caution and you will get excellent results and a lot of satisfaction into the bargain. This Good Idea leaflet aims to provide you with the background knowledge you need to understand electricity and how to work with it. While most DIY jobs will be clearly unsatisfactory if badly done - either through poor appearance or poor performance - electrical wiring will often still work, despite poor design or bad workmanship; giving no indication of danger until, for example, a fault or overload occurs, when danger of electric shock or fire may then arise with tragic consequences.



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WARNING

Improperly executed work could cause fires and potentially lethal electric shocks. Do not attempt any electrical work unless you are confident that you know what you are doing, you fully understand how to carry the work out, and you are confident of your ability to carry it out. If in doubt call in a qualified electrician.

- **Improperly executed work could cause fires and potentially lethal electric shocks. Do not attempt any electrical work unless you are confident that you know what you are doing, you fully understand how to carry the work out and are confident of your ability to carry it out.**
- **Before attempting any electrical work, this leaflet should be read in full, paying particular attention to the Safety Guidelines, The Importance of Earthing, and Rules and Regulations.**
- **If in any doubt, call in a qualified electrician.**
- **The information provided in this leaflet is not intended as a substitute for expert or professional advice, nor can it guarantee personal safety or or that of property.**
- **This information should be read in conjunction with the safety instructions and warnings of the manufacturers of any electrical accessories, tools, appliances or equipment you intend to use.**
- **While every care has been taken in the preparation of this leaflet, WBS, its staff and associate companies cannot be held responsible for any loss, damage or injury arising as a consequence of reliance placed upon the advice or information provided or admitted.**

"WHERE REFERENCE IS MADE TO LEGISLATION IT IS NOT TO BE CONSIDERED AS LEGAL ADVICE.

WHILE EVERY EFFORT HAS BEEN MADE TO ENSURE THE ACCURACY OF THE INFORMATION CONTAINED IN THIS LEAFLET, ALL PARTIES MUST RELY ON THEIR OWN SKILL AND JUDGEMENT.

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HOW ELECTRICITY WORKS

Perhaps the simplest way of describing how electricity works is to compare it to water flowing through a pipe. Both water and electricity can do 'work' as they flow between two points. For example, flowing water can turn a water wheel or a turbine; electricity can produce light as it flows through a lamp, or rotation (which can drive something) if it flows through an electric motor. The flow is the result of **pressure** in each case; the higher the pressure, the greater the flow.

But acting against this pressure, there is something called **impedance** or **resistance.** A similar situation applies to electricity in that some materials allow electricity to flow easily whilst others resist it to a greater or lesser degree and may completely prevent it. Materials which permit a flow of current are called conductors and those which prevent it are called insulators. Conductors are like the water pipe - a big one allows current to flow more easily than a small one, but the material of the conductor also affects the freedom with which a current can flow through it - the resistance. Most metals have low resistance and are good conductors, whilst many non-metallic materials such as ceramics, plastics and rubber have extremely high resistance and are used as insulators.

Like water, electricity needs somewhere to flow round - in other words, a circuit. This circuit starts at the source of supply - in the case of your house effectively at the meter - and travels through one conductor (the **phase** wire is often referred to as the live wire, but since both supply connections are effectively **'live'** the term 'phase wire' is more correct) to wherever it is needed to do work. Then it flows back through another conductor (the **neutral wire**) to its source. The flow of electric current is measured in **amperes** (A or amps for short), and is driven by the pressure difference (called potential difference) between the ends of the circuit; this is measured in **volts** (abbreviated to V), and on domestic installations a potential difference of 230V is the norm (nominal 230V to harmonise with other European Community countries). The potential difference drives the flow of electricity against the circuits impedance (measured in **ohms**, often given the symbol Ω).

As electricity flows through the circuit, the amount of work it does is measured in **watts** (W for short) and in practical terms the watts consumed are given by the product of the supply voltage and the current drawn; watts = volts x amps. So an electric fire taking a current of 10 amps from a supply at 230 volts will consume 2,300 watts or 2.3 kilowatts (2.3kW). The time factor must also be taken into account when measuring the amount of electricity we use, so our fire taking 2.3kW and burning for an hour will use up 2.3 kilowatt-hours (kWh) of electricity. This is recorded by your home's electricity meter as 2.3kWh or 2.3 units (a unit is 1 kWh).

The wiring through which the current flows possesses resistance and the pressure of the flow against the resistance creates heat. The smaller the cable, the higher the resistance, so it is important that any cable is large enough not to cause heat to be generated which could damage the cable or anything in contact with it.

YOUR ELECTRICAL INSTALLATION

The final stage of the electrical distribution network is the main supply cable running along your street, usually underground, but sometimes overhead on poles, eventually branching off to your house.

When the supply (or service) cable enters your house, it passes firstly to a large sealed unit called the service cutout. This contains the system's main service fuse which is a protective device (see below) in the phase (or live) side of the supply which limits the total current you can draw from the system to 60, 80 or 100 amps. The service cutout also contains a neutral link. From here, two individual cables run on to the Electricity Supplier's meter, and then on to your home's main fuse box. This serves as a distribution centre, splitting the supply to serve the various separate circuits that feed your lights, power points and individual electrical appliances such as cookers and immersion heaters. Modern homes have a one-piece fuse box called a consumer unit, with one double-pole main isolating switch controlling the whole house supply, but many older homes have a number of separate fuse boxes controlling the supply to individual circuits; each may have its own isolating switch. Note that the Electricity Supplier's responsibility and ownership extend only to the outgoing terminals of the meter: the meter tails are the responsibility and property of the consumer. Some Electricity Companies, when giving a new supply connection now provide a double-pole isolating switch on the consumer's side of the meter to provide for isolation of the whole installation to facilitate safe working, e.g. on the consumer unit, without the need to interfere with the supplier's cutout. Within your fuse box or consumer unit you will find an individual fuse for each circuit or its modern equivalent, an electro-mechanical switch known as a miniature circuit breaker or MCB. Its purpose is to limit the amount of current the circuit can take since the circuit cables will overheat and may cause a fire if too much current is drawn. If the limit is exceeded by overloading the circuit with too many appliances switched on and drawing off too much current, or because of a current surge following a fault such as a short circuit, the fuse is designed to melt (or the MCB to trip itself to off) and cut off the current supply.

On modern installations you may also find another device called a residual current device (RCD) or a residual current circuit breaker (RCCB), either fitted with the consumer unit in place of or in addition to the main on-off isolating switch. This device detects any imbalance in the flow of electricity between the phase (live) and neutral sides of the circuit caused by a leakage of current to earth (see below). Such a fault could be the result of faulty insulation or someone receiving an electric shock, and its early detection followed by the almost instantaneous cutting off of the supply, is an extremely valuable safety feature.

It should be noted that when an RCD is incorporated in a consumer unit as the main switch it will disconnect the supply to the entire installation when it operates on a fault.

THE IMPORTANCE OF EARTHING

Earthing is one of the most important parts of any electrical installation, since it provides a path for current to flow safely to earth in the event of an electrical fault anywhere on the system. The aim is that all exposed metalwork of the electrical installation, of appliances connected to it, and metalwork in the house which is in contact with earth such as pipes, taps, baths, sinks, and so on, is joined by a special conductor (called a protective conductor) to a main earthing terminal. This in turn is usually connected to an earth terminal provided by your Electricity Company. In some situations - usually where the supply is from local overhead lines, it is difficult for your Electricity Company to provide you with a reliable earth connection and in that case you will be responsible for your own earthing connection. This is normally achieved by making a connection to one or more special copper rods which are driven into the ground and which are then tested to ensure their effectiveness. By this means, the voltage which may appear on exposed metalwork as the result of an electrical fault anywhere on the installation, will be limited to a safe value.

If, for example, the metal casing of an electrical appliance becomes live because of a loose wire inside it, the current will flow harmlessly to earth through the protective conductor which is connected to it. If the metal was not earthed and you touched it, the current would instead pass through your body to earth, giving you a potentially lethal electric shock. If earthing is neglected it also puts others at peril. If you neglect proper earthing on any electrical work you carry out, you do so at your peril.

MAIN EQUIPOTENTIAL BONDING

It is vital that all services entering the house are all connected back to the main earthing terminal, in order to ensure that all metalwork entering the house is at substantially the same voltage. Diagram A shows a typical earthing and main equipotential bonding layout. The earth clamps shown must be tightened securely onto the incoming services and it is most important that the surface of any pipework is cleaned up well to obtain a good electrical connection.

ELECTRICAL INSTALLATIONS AND EARTH BONDING OF BATHROOMS AND ROOMS CONTAINING SHOWER CUBICLES.

The presence of water and immersion of the body in water, create an increased risk of electric shock in these places. This means that restrictions have to be made on the choice and installation of electrical equipment for bathrooms and showers but also that special safety wiring known as supplementary bonding must be carried out there.

No socket outlets are allowed in bathrooms or rooms containing showers, other than special SELV sockets which are beyond the scope of this guide, and special shaver supply units. This means that there must be no provision for the connection of portable electrical equipment, except safety shaver sockets.

Equipment chosen for bathrooms must have special protection against moisture ingress.

There are specially designated areas or Zones where only certain electrical equipment may be installed.

Supplementary earth bonding in rooms containing baths or showers must be carried out between the earthing terminals of each electrical circuit supplying electrical equipment in the Zones 1 to 3 and metalwork known as 'extraneous-conductive-parts' in or around these Zones. Examples of 'extraneous-conductive-parts' include metal pipes, central heating pipes, metal baths and shower trays, but also any accessible metal structural parts of the building. **Diagram B** shows typical supplementary bonding connections as required between metallic parts and electrical equipment in a bathroom. The diagram is not intended to illustrate practical routes of any conductors required to achieve such connections - the necessary bonding can usually be done unobtrusively using an adjacent airing cupboard or other building voids, where metallic pipework has sweated or compression joints. You will have to run protective bonding conductors to the earthing terminals and exposed conductive parts of electrical equipment in the Zones of the bathroom, such as water heaters, electric showers and luminaires, but the metal pipework of plumbing system can be used to keep the number of additional conductors to a minimum. Where both the supply and waste pipes to a metal bath or shower basin are of plastic, then metal taps and the bath need not be bonded, but the bath or basin must be bonded if it is in contact with earthed metal, such as structural steelwork.

The following important definitions of the Zones are for your reference and use, but Diagram B will help you to understand these.

Zone 0 is the interior of the bath tub or shower basin and only special electrical equipment known as SELV may be used here and such installations are beyond the scope of these notes.

Zone 1 is limited by the vertical plane of Zone 0 (i.e. the edge of the bath or shower tray) and the horizontal plane 2.25m above the floor. SELV equipment and certain water heaters, shower pumps and showers specially constructed for Zone 1 use are allowed here. Equipment to be installed here must have a degree of protection against moisture of IPX4 as a minimum. No switches may be installed in Zone 1 except switches of SELV circuits and insulating pull cords of cord operating switches complying with BS3676. As above, SELV installations are beyond the scope of these notes.

Zone 2 is limited by the vertical plane external to Zone 1 and a parallel vertical plane 0.60m external to Zone 1, from the floor to a horizontal plane 2.25m above the floor.
Where the ceiling height exceeds 2.25m, the space above Zone 1, up to a height of 3.0m above the floor, is counted as Zone 2.

SELV equipment, water heaters, shower pumps, showers, luminaires, fans and heating appliances constructed for use in Zone 2 are allowed in this Zone.
Equipment to be installed here must have a degree of protection against moisture of IPX4 as a minimum and be described by the manufacturer as being suitable for use in Zone 2.

No switches are permitted here except those permitted in Zone 1 and special safety shaver sockets complying with BS EN 60742 Chapter, Section 1, but only if they are fixed where direct spray from showers is not possible.

Zone 3 is limited by the vertical plane external to Zone 2 and a vertical plane 2.4m external to Zone 2, from the floor to a horizontal plane 2.25m above the floor. Where the ceiling height exceeds 2.25m, the space above Zone 1, up to a height of 3.0m above the floor, is counted as Zone 3. In Zone 3, in addition to the items allowed in Zones1 and 2, appliances are now allowed, but must not be portable, and must also be fixed unless specially protected with a residual current device (RCD) with a 30mA residual operating current. Since socket outlets are not permitted, appliances must be permanently connected (for example by using spur boxes).

Outside Zone 3, appliances are allowed, but no socket outlets must be installed.

Some houses have shower cubicles installed in other rooms. In that case, any socket outlets (other than a safety shaver socket) must be outside the Zones and must be protected by a residual current device (RCD) with a 30mA residual operating current. Supplementary earth bonding will still be necessary, but not outside Zone 2.

YOUR HOME'S CIRCUITS

Every electrical circuit consists of two current carrying wires, the phase or live one carrying the current to where it is needed, and the neutral returning it to source. Within your home, every circuit is supplied by means of cable which contains individually insulated and colour-coded wires or cores to form the circuit, plus an uninsulated third core sandwiched between the live and neutral cores within the cables outer PVC sheathing; this acts as the protective conductor or earth core. In fixed wiring cables the Live core is coloured RED and the Neutral core is BLACK. In flexible cables the Live is BROWN and the Neutral is BLUE.

Note that the incoming cables - the phase and neutral meter tails - both enter the consumer unit and are connected to a double pole main isolating switch before being linked to the phase busbar and the neutral terminal block. The main earthing conductor also enters the consumer unit and is connected to the main earth terminal block. Within a modern consumer unit, the incoming phase or live cable core is connected to a metal strip often called a busbar. This is the starting point for all your house circuits, each of which is protected by its own fuse or MCB. One end of each fuse or MCB is connected to the busbar; the phase core

of the circuit cable is connected to a terminal at the other end of the fuse or MCB. The neutral core of each circuit cable is connected to a neutral terminal block within the consumer unit, and this is in turn connected to the supply cables neutral core to complete the circuit. The earth cores from all the circuit cables are similarly connected to another terminal block within the unit, and this is in turn connected to the house's earthing system as already described. **Diagram C** shows a typical consumer unit layout. Most of the circuits in your house are known as radial circuits. This means that the cable starts at the consumer unit, runs from one outlet or take-off point (light fitting, power point or whatever) to another and terminates at the most remote outlet or take-off point.

Modern power circuits feeding socket-outlets are usually wired up in a slightly different way, with the circuit cable returning from the last take-off point to the consumer unit to form a ring. The two phase (live) cores are both connected to the same terminal on the circuit fuse holder or MCB, while the two neutral and two earth cores are connected to the neutral and earth terminal blocks respectively. The advantage of this arrangement is that current can flow down the phase (live) core in either direction round the ring to a given take-off point, so the circuit can effectively carry more current than a single radial circuit could without the need for using bigger and more expensive cable. This is known as a ring circuit or ring main, and is used to supply power points - also known as socket-outlets - throughout the house unless there is a sound reason for using radial circuits instead, such as a single point supply to a cooker or a water heater.

Within the consumer unit you will find that the various circuit fuses or MCBs are marked with different current ratings. Five different ratings are commonly found; these are:-

- 5 or 6-amp for lighting circuits (may also be colour-coded white);
- 15 or 16-amp for immersion heaters, and single socket-outlets not on a radial or ring circuit with other sockets (may also be colour-coded blue);
- 20-amp for night-storage heaters and multi-outlet radial power circuits feeding 13-amp socket-outlets (often colour-coded yellow);
- 30 or 32-amp for ring circuits, multi-outlet radial circuits and circuits to small cookers, electric showers, etc., (may also be colour-coded red);
- 40 or 45-amp for circuits to powerful cookers, showers, water heaters, etc., (may also be colour-coded green).

A typical domestic installation will have two lighting circuits (radials) and at least two power circuits, (rings) often wired up to serve upstairs and downstairs respectively. A radial circuit to an immersion heater and another to an electric cooker will take up the remaining fuseways in a standard six-way unit, although many recently built homes have units with more ways to cope with additional circuits to outbuildings, and extra appliances such as instantaneous showers.

Each circuit is wired in cable of a size to suit its likely current demand. For example, lighting circuits usually use cable with cores having a cross-section of 1 square millimetre (usually written as 1mm^2 and known colloquially as '1-mil' cable), or 1.5mm^2 where the current requirement is to be higher than normal, or the cable run longer than normal. As a general rule you would use 1.0mm^2 where the number of lights is limited to eight on a circuit, and 1.5mm^2 only when the number of lights is to be between nine and twelve, and not exceeding 1200 watts in total.

Power circuits are usually wired in 2.5mm^2 (2-point-5-mil) cable, while circuits to high-powered individual appliances such as cookers and electric showers may use 4, 6 or even 10mm^2 cable depending on the current usage.

CIRCUIT WIRING

Where a circuit supplies a single major appliance, e.g. a cooker or water heater, the cable runs directly to it from the consumer unit fuse or MCB, via a cooker control unit or a fused spur connection unit adjacent to the appliance. With circuits for lighting and socket-outlets however, each circuit cable provides current to several take-off points, and in this case the cable 'loops' from one point to the next. At each point there are separate live, neutral and earth terminals to which the cores of the incoming and outgoing cables are connected.

There are, however, important differences in the way modern multi-outlet circuits are wired up, and in each case certain restrictions on the circuit size also apply, so let's have a look at each circuit in turn. First, power circuits.

Socket outlet circuits may be one of three types (four if you count the type supplying just a single socket and run from a 15-amp fuseway). All are designed for use with 13-amp socket-outlets accepting fused plugs with rectangular pins. They **must not** be wired up with sockets taking unfused round-pin plugs; these are now obsolete and their use on a ring circuit is dangerous.

Ring circuits in a domestic situation are usually wired in 2.5mm^2 cable from a 30 or 32-amp fuseway, and return to it, and may feed an unlimited number of socket-outlets on the ring so long as the total floor area of the rooms containing them does not exceed 100 sq.m. (1075sq.ft.). The reason for the absence of a limit on the number of socket-outlets is that you are unlikely to be using every outlet at once; the floor area restriction is a more practical way of limiting the risk of overloading. With modern kitchens, dishwashers, washing machines and tumble driers are now commonplace and such a concentrated electrical load may well require a separate, dedicated circuit.

Radial circuits may be of two types. The first is wired in 2.5mm^2 cable, just like a ring main, but is run from a 20-amp fuseway and may feed an unlimited number of sockets so long as the floor area served does not exceed 20 sq.m. (215 sq.ft.). The second is wired in 4mm^2 cable, is run from a 30 or 32-amp fuseway (which must be a cartridge fuse or MCB, not a rewirable fuse), and may feed an unlimited number of sockets within a maximum floor area of 75 sq.m. (800 sq.ft.)
It is not recommended that a 2.5mm^2 radial circuit is used for a kitchen, without special knowledge, owing to the potential for electrical overload.
With either type of circuit, ring or radial, branch cables (spurs) can be connected to the main circuit cable to feed individual remote take-off points which would be uneconomical in terms of cable use to include on the main circuit run. The spur cable may be connected in at an existing socket-outlet, or may be linked to the circuit cable directly by means of a 30 amp junction box. The only limitations are that each spur may feed just one socket-outlet (single, double or treble), or one fused connection unit, and that the total number of **unfused** spurs on the circuit is not greater than the number of sockets and fixed equipment already connected to the main circuit.

There is no limit to the number of **fused** spurs that may be connected to a circuit. Indeed some gain may be achieved by reducing the cable size of such a fused spur, connected through a fused connection unit with the fuse not exceeding 13A. In addition there is no limit on the number of outlets which may be served by a fused spur, though in practice the total loading will be limited by the 13A fuse rating.
Lighting circuits may be wired up in one of two ways, although in practice elements of both systems are often found on any installation. Both types are wired up as radial circuits, with the circuit cable starting at the consumer unit fuseway and terminating at the most remote light position. Because each circuit is

protected by a 5 or 6-amp fuse, the maximum loading possible when using a 5-amp fuse at a supply voltage of 230V is 5 x 230 = 1150 watts or, when using a 6-amp fuse at a supply voltage of 230V, is 6 x 230 = 1380 watts. Each lighting point is assumed to be capable of supplying a 100 watt bulb, so the theoretical maximum number of lights on each circuit is limited to 12. In practice, the maximum is usually limited to eight to allow for higher-wattage bulbs to be used if required.

The major difference between lighting and power circuits is the need to provide independent on-off switching of each light on the circuit. On power circuits the switch built into each socket-outlet provides this facility. The switch controlling each light is wired to break the circuit continuity in the phase side of the circuit to the light concerned, while maintaining the circuit continuity to other lights further on down the circuit. This switching is provided in one of two ways.

With **loop-in** wiring, the circuit cable runs from the consumer unit to each lighting point in turn, just as a radial power circuit runs from socket to socket. There are four terminals at the light fitting, allowing a separate switch cable to be connected in to control the light. **Diagram E** shows the connections. With **junction-box** wiring the circuit cable connects a series of junction boxes, each containing four terminals; separate cables then run from each box to the light fitting and to its switch. See **Diagram F**. The choice of one method or the other is made according to which is the most convenient and is the most economical in use of cable. As with power circuits, spurs can be connected to the main circuit cable to feed remote loop-in lights or junction boxes. The spur can be connected into the circuit at a loop-in light fitting or at a new junction box (there is seldom room for more than four cables within an existing box on the main circuit). The only restriction is that the number of light fittings-including spurs - on the circuit should not exceed eight.

Light switches are wired up in the same cable as the rest of the lighting circuit, with the phase and neutral cores connected to the switch terminals. The only exception to this is where a light is controlled from two or more switch positions (known as two-way switching, and most often found on staircases). Here special three-core-and-earth cable is used to interconnect the switches. In either case, the earth core is taken to a terminal on the mounting box if the switch is plastic; if it is metal, it is connected to a terminal on the switch faceplate and this is then further connected with a short earth loop to the mounting box if this is metal.

With pendant lights, two-core circular flex with no earth core is used so long as the pendant lampholder and the lampshade or light fitting are plastic; if it is metal, three-core flex with an earth core must be used.

Note that many older lighting circuits were wired up without a protective conductor (earth). Only plastic light fittings may be used on such a circuit, and an earth should be added at the earliest possible opportunity.

The flex to pendant lampholders must be of the 85°C heat-resisting P.V.C. type to BS 6141.

Some ceiling mounted light fittings - correctly called luminaires - may be supplied with high temperature resistant sleeving to be fitted over the wiring to the light fitting. If supplied such sleeving must be used in order to protect from fire risks. Always follow the manufacturer's mounting instructions for luminaires. Fires have resulted from the omission of heat-insulating mounting spacers for example. Similarly, if a light fitting has a stated maximum wattage for bulbs, do not exceed this maximum. To do so would again encourage the risk of fire caused by overheating.

WIRING ACCESSORIES

There is a wide range of different wiring accessories used on house wiring circuits. On lighting circuits, for instance, you will need ceiling roses plus lampholders for installing pendant lights, (batten lampholders for fixing a light directly to the ceiling), special circular conduit boxes for mounting some close-fitting types of light, four-terminal junction boxes and switches. These may be wall - or ceiling - mounted, capable of one-way or two-way switching and, in the case of wall switches, may be flush - or surface- mounted on metal or plastic mounting boxes, the latter sometimes referred to as patresses. You may also want switches with two or more gangs (rockers) to allow several lights to be controlled from one switch position, or dimmer switches to allow you to vary each lights intensity.

For power circuits, you will need single or double socket-outlets, again with metal or plastic mounting boxes depending on whether they are to be flush - or surface-mounted. Socket outlets are available switched or unswitched. You may also want fused connection units to supply permanently wired appliances such as freezers, extractor fans and central heating controls.

For circuits to individual appliances such as cookers, immersion heaters and electric showers, you will need special double-pole isolating switches which disconnect both the phase and neutral sides of the circuit. These switches may be wall or ceiling mounted, and come in a range of current ratings - 20-amp for immersion heaters, for example, 30-amp for showers and 45-amp for cookers. Ordinary light switches are the single-pole type, interrupting only the phase (live) side of the circuit, which is why you must never rely on this switch to isolate a light fitting from the mains for repair. Lastly, you may want to install other special accessories such as shaver supply units in bathrooms.

CABLE AND FITTINGS

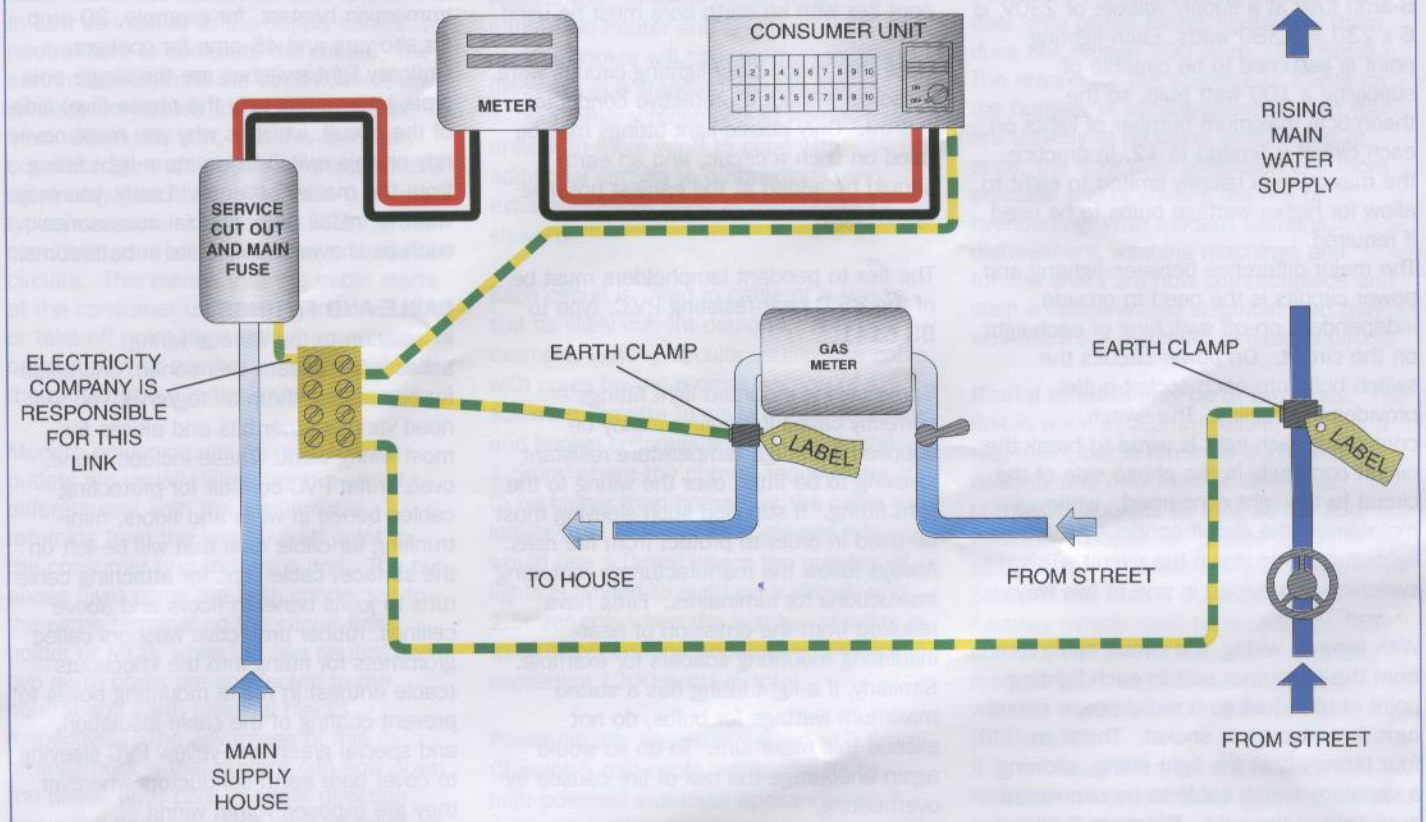
In addition to the various wiring accessories already mentioned, and cable for connecting them all together, you will need various other bits and pieces for most wiring work. These include round, oval, or flat PVC conduit for protecting cables buried in walls and floors, mini-trunking for cable runs that will be left on the surface, cable clips for attaching cable runs to joists beneath floors and above ceilings, rubber protective washers called grommets for fitting into the knockouts (cable entries) in metal mounting boxes to prevent chafing of the cable insulation, and special green-and-yellow PVC sleeving to cover bare earth conductors wherever they are exposed within wiring accessories. Green-and-yellow earth cable will be needed for local supplementary equipotential bonding together with earth clamps for pipe bonding.

SAFETY GUIDELINES

There are several safety points to remember whenever you are carrying out any electrical work.

- Don't attempt any job unless you know exactly what you are doing, understand how to do it and are confident you can complete it.
- **IF IN ANY DOUBT** consult a qualified electrician.
- ALWAYS turn off the power using the main isolating switch at the fuse box or consumer unit before beginning any electrical work. If you are working on just one circuit, after switching OFF the power at the main switch, remove the appropriate circuit fuseholder or switch off the relevant MCB before restoring power to other circuits in the house. When you have completed work on that circuit, again switch OFF at the main isolating switch before replacing the rewirable fuse or turning the MCB on. Then the mains isolating switch can be set to ON again.
- ALWAYS unplug any electrical appliance from the mains before attempting to inspect or repair it.

DIAGRAM A



LABELS TO READ 'SAFETY ELECTRICAL CONNECTION–DO NOT REMOVE'

DIAGRAM B

DIAGRAM B - BATHROOM/ROOM CONTAINING A SHOWER : ZONES AND SUPPLEMENTARY BONDING (TYPICAL)

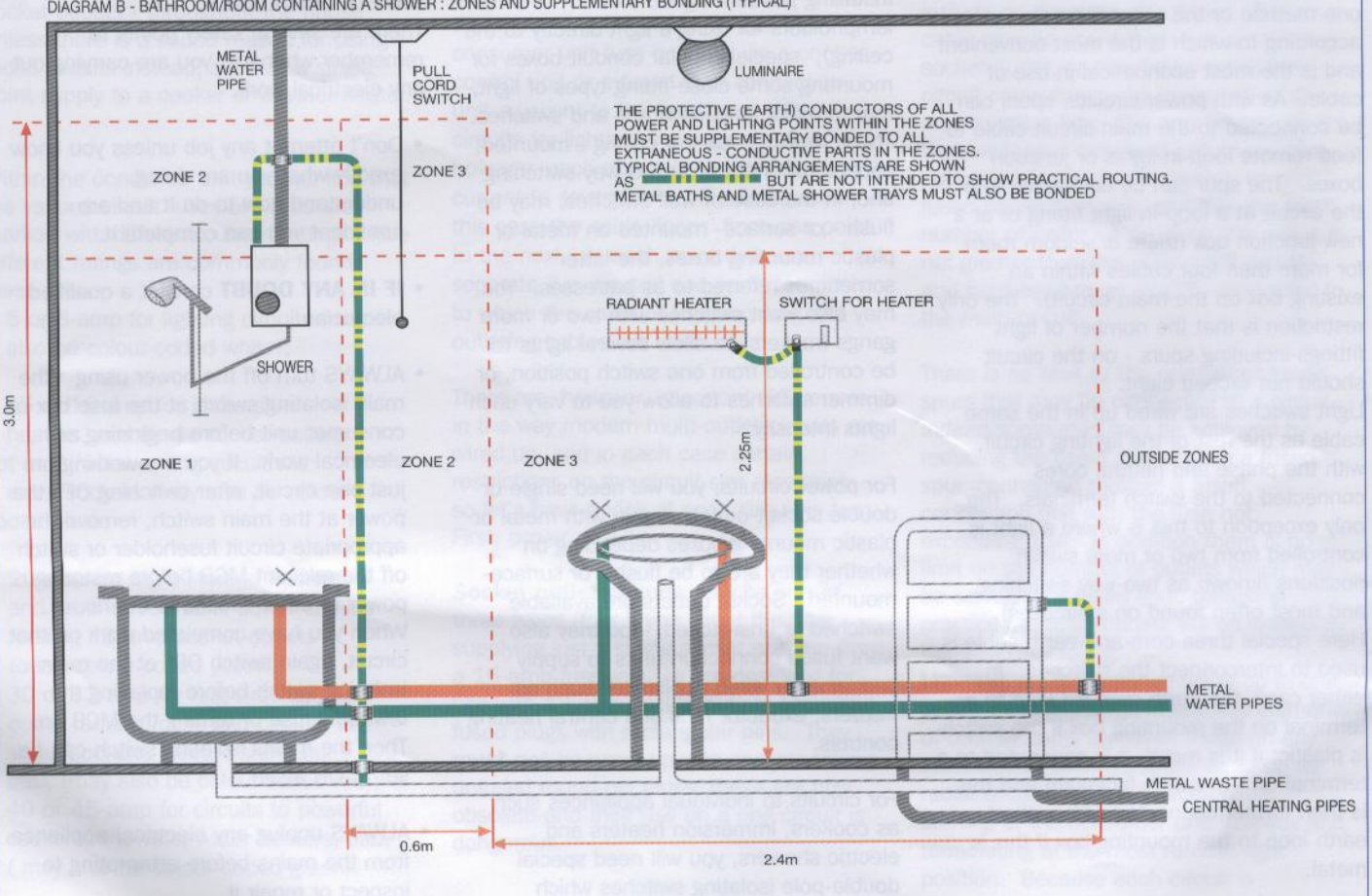


DIAGRAM C

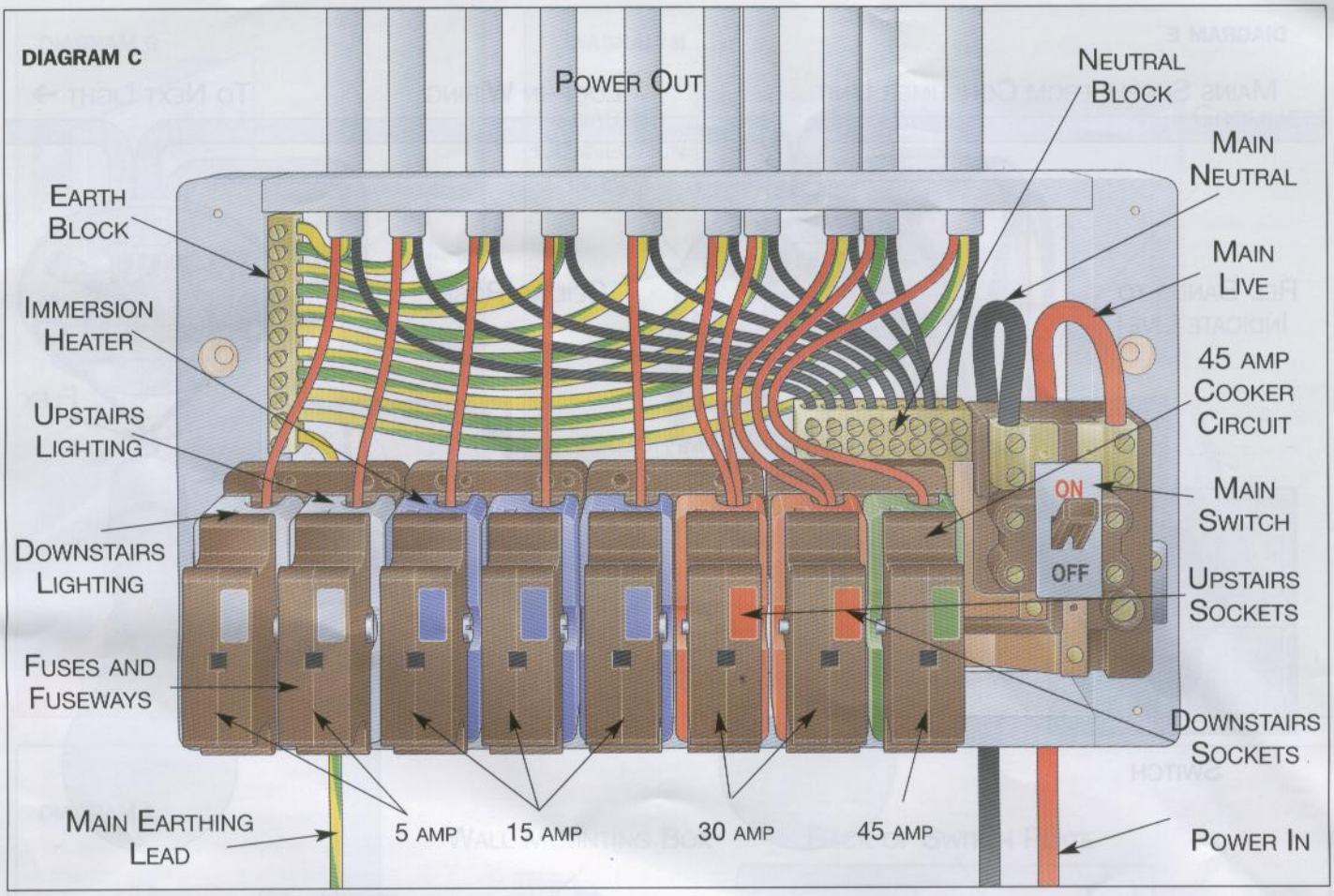


DIAGRAM D

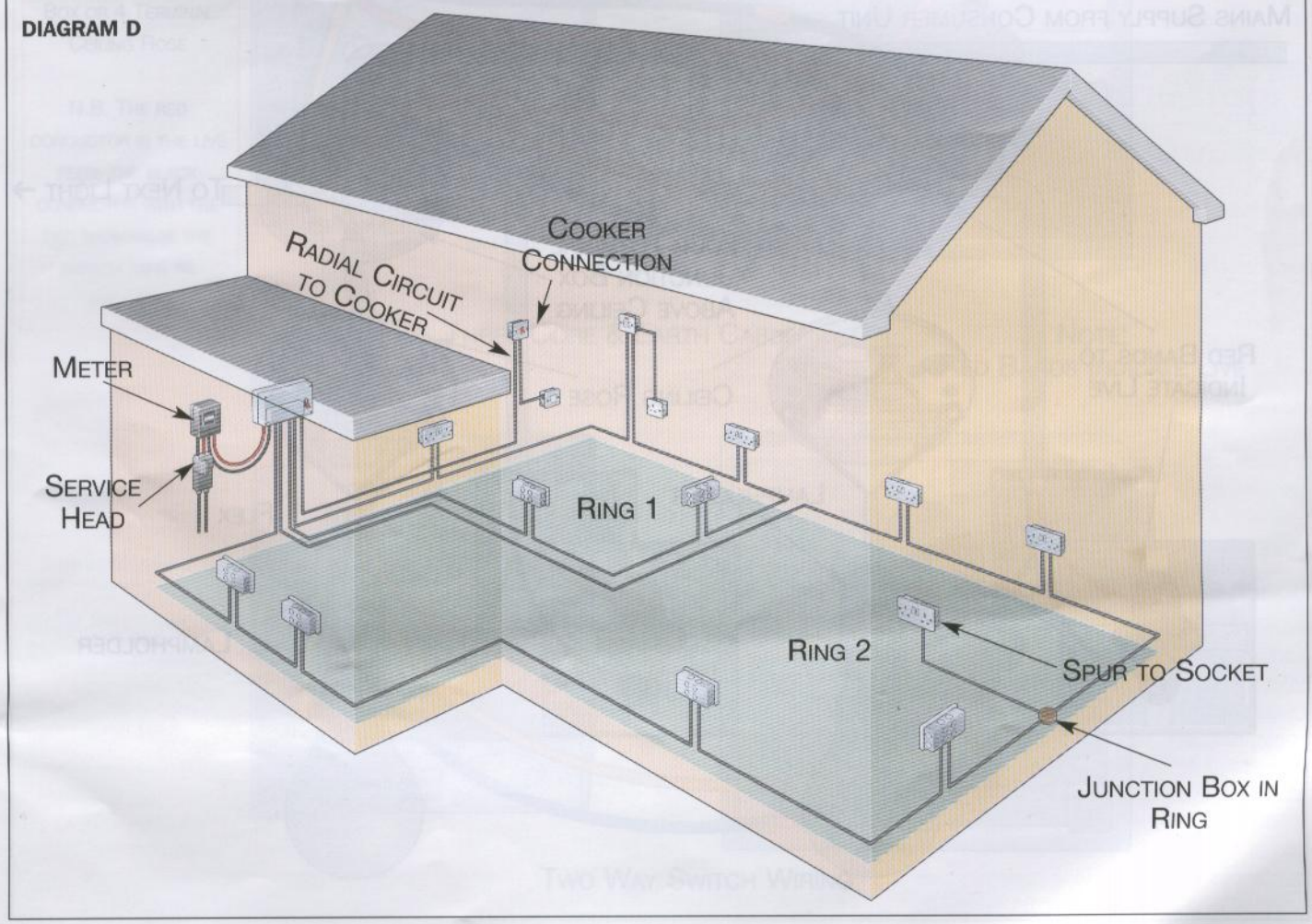


DIAGRAM E

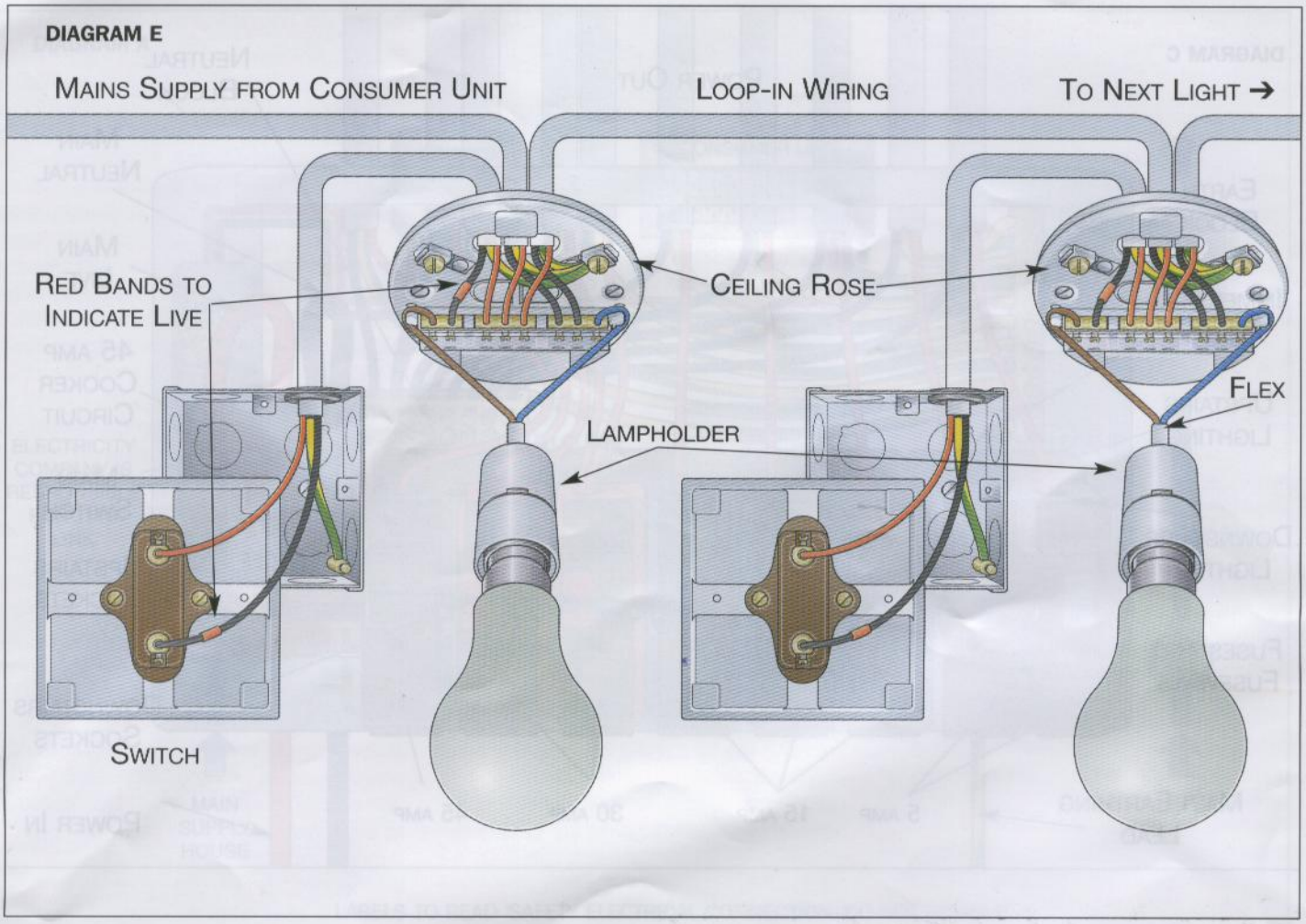


DIAGRAM F

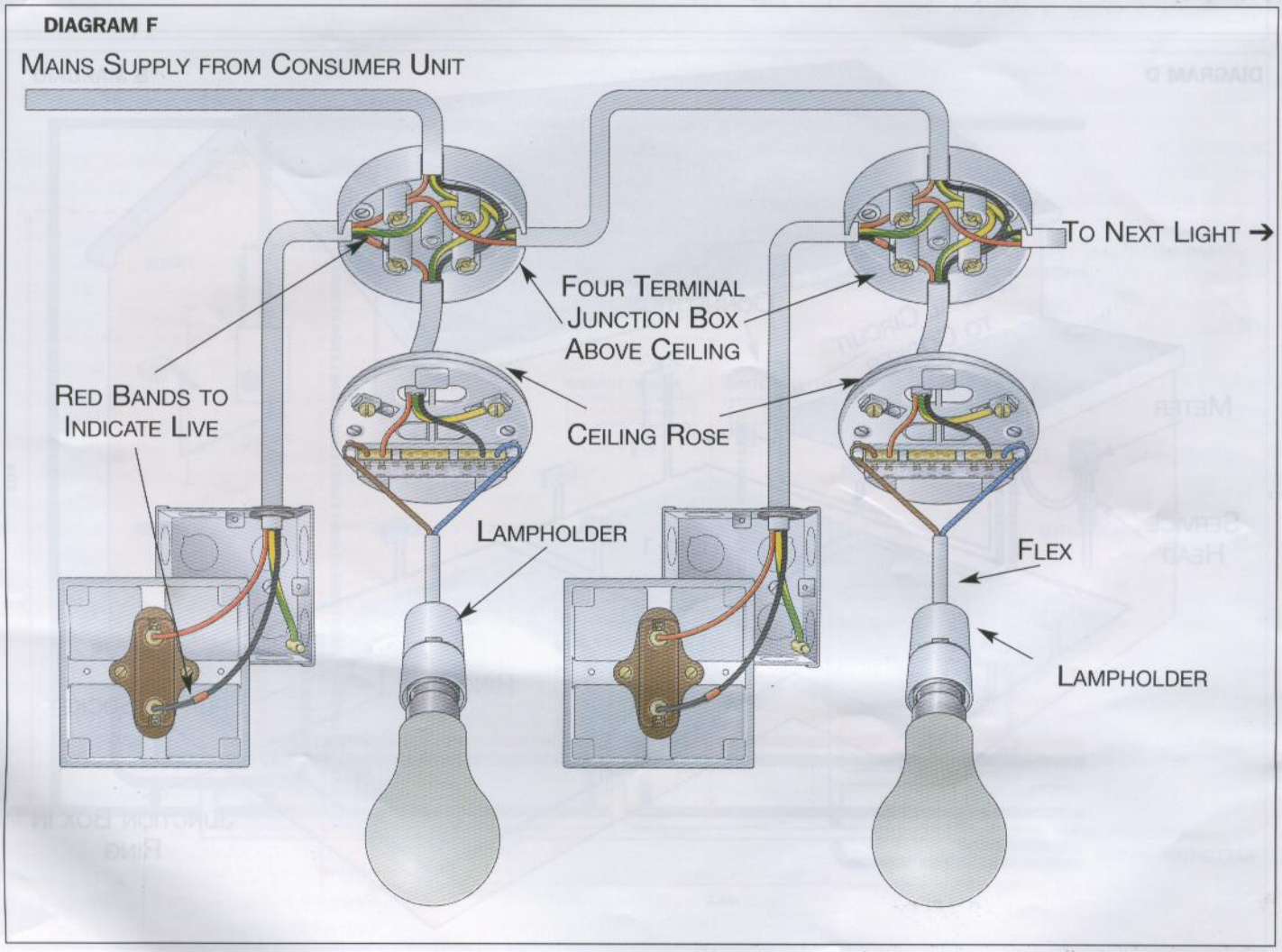


DIAGRAM G

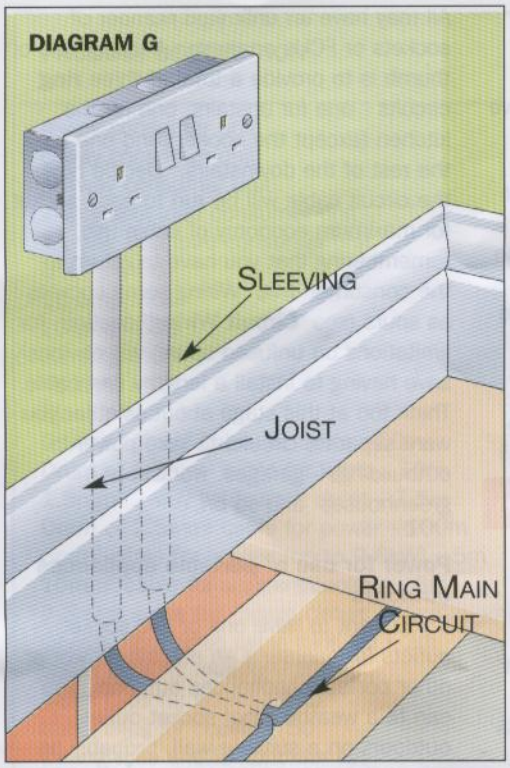
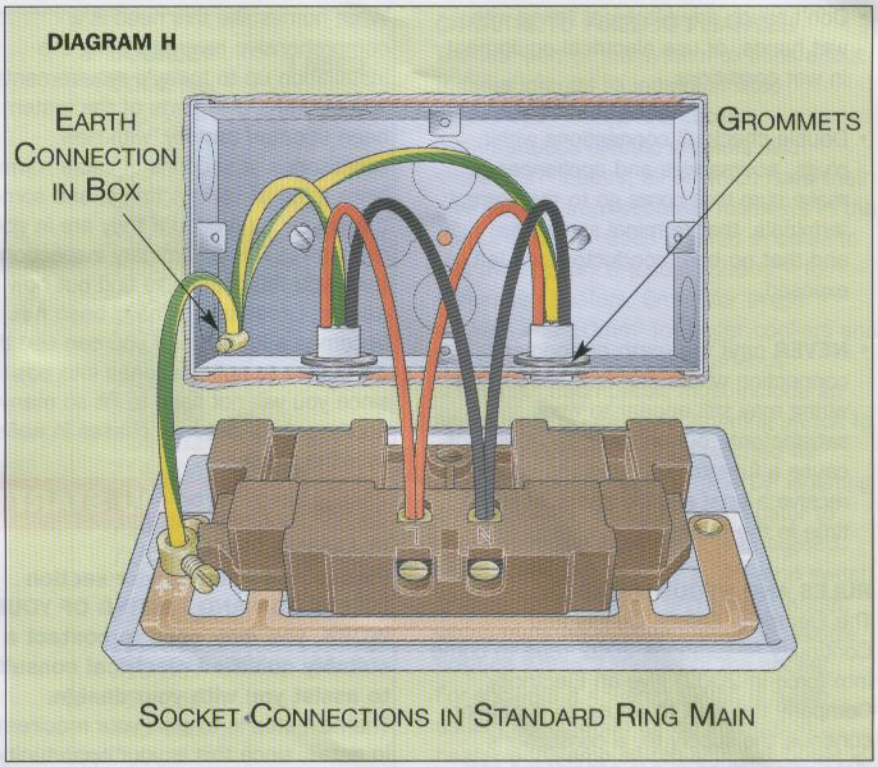
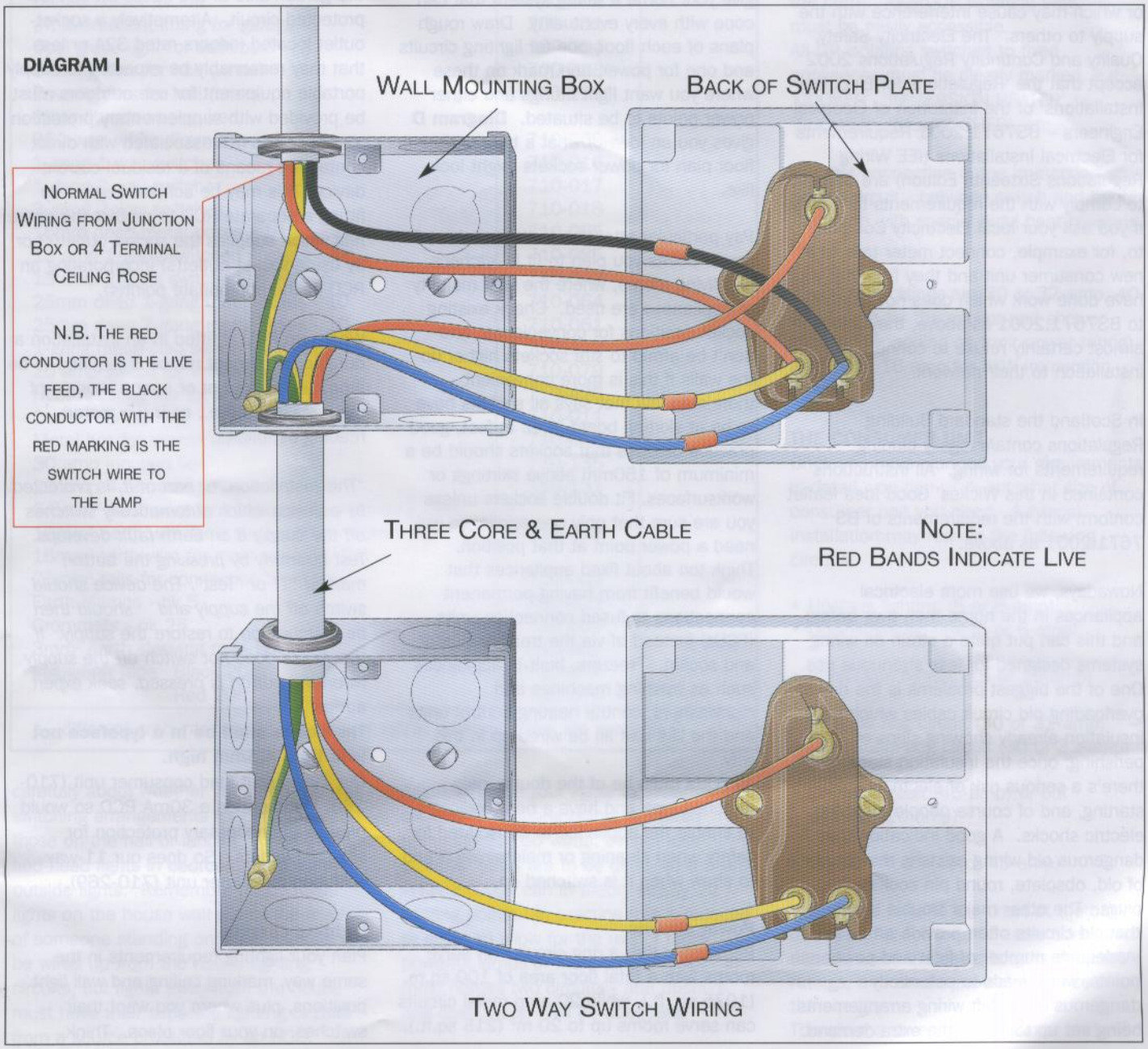


DIAGRAM H



SOCKET CONNECTIONS IN STANDARD RING MAIN

DIAGRAM I



TWO WAY SWITCH WIRING

- Don't touch any electrical fitting with wet hands, or use electrical equipment in wet conditions.

- Double-check all connections within plugs, accessories and appliances to make sure that cores go to the correct terminals, that terminal screws are tight and that no bare conductors are left exposed.

- **NEVER** omit the earth or bonding connection where one is required. The wiring may still appear to work satisfactorily, but an earth fault will not cause a fuse to blow and you could receive a fatal electric shock at some time in the future.

RULES AND REGULATIONS

The Electricity Safety, Quality and Continuity Regulations 2002 (due to come into force in 2002) give an Electricity Company the right to refuse to supply or continue the supply to, a consumer's installation which is not considered safe, or which may cause interference with the supply to others. The Electricity Safety, Quality and Continuity Regulations 2002 accept that the 'Regulations for Electrical Installations' of the Institution of Electrical Engineers – BS7671:2001 Requirements for Electrical Installations (IEE Wiring Regulations Sixteenth Edition) are deemed to comply with the requirements for safety. If you ask your local Electricity Company to, for example, connect meter tails to a new consumer unit and they find that you have done work which does not conform to BS7671:2001 as above, they will almost certainly refuse to connect your installation to their network.

In Scotland the standard Building Regulations contain legally binding requirements for wiring. All instructions contained in this Wickes' Good Idea leaflet conform with the requirements of BS 7671:2001 as above.

Nowadays, we use more electrical appliances in the home than ever before, and this can put quite a strain on wiring systems designed for less strenuous use. One of the biggest problems is the risk of overloading old circuit cables which have insulation already showing signs of perishing; once the insulation starts to fail there's a serious risk of electrical fires starting, and of course people receiving electric shocks. A good indication that dangerous old wiring exists is the presence of old, obsolete, round pin sockets and plugs. The other major trouble is simply that old circuits often provide an inadequate number of light and power points, which leads to potentially dangerous makeshift wiring arrangements being set up to satisfy the extra demand.

What homes like this need is a comprehensive rewire to bring the installation up to today's requirements. You may find that parts of the system have been updated anyway, with new accessories or sections of cable having been fitted at various times, and some of these may be reused if they are in good condition. This preliminary inspection also gives you the chance to find out how existing circuit cables have been run. Life becomes a lot easier if you can use the old cables to pull new ones into position, since you will not have to lift so many floorboards or cut new chases in walls all over the place.

BEFORE YOU START

PLANNING CIRCUITS

Please now check under section INSPECTION AND TESTING OF YOUR WORK, you may need to contact a suitably qualified electrical consultant to assist you with your design.

The next step is to plan your requirements in detail, since this is your opportunity to give your home a wiring system that can cope with every eventuality. Draw rough plans of each floor, one for lighting circuits and one for power, and mark on these where you want light fittings and either power points to be situated. **Diagram D** gives you an idea of what a typical ground floor plan for power sockets might look like.

Pay particular attention to the number of power points you plan to fit in kitchens and living rooms, where the vast majority of appliances are used. Check existing socket positions for convenience, and don't be afraid to site sockets higher up the walls if this is more convenient - there's no law that says all sockets have to be at skirting board level. In fact, good practice dictates that sockets should be a minimum of 150mm above skirtings or worksurfaces. Fit double sockets unless you are sure that only one appliance will need a power point at that position. Think too about fixed appliances that would benefit from having permanent connections to fused connection units (FCUs) instead of via the traditional plug and socket. Freezers, built-in appliances such as washing machines and dishwashers, central heating control units and the like can all be wired up in this way.

All FCUs must be of the double pole switched type and have a neon indicator to enable the appliance to be isolated for safety when cleaning or maintaining it and to show when it is switched on.

Power circuits

Remember that a ring circuit may serve rooms with a total floor area of 100 sq.m. (1075 sq. ft.), while 20-amp radial circuits can serve rooms up to 20 m^2 (215 sq.ft.). All may have an unlimited number of sockets or FCUs on them. A useful rule of thumb is to provide a total of three **ring** circuits - one for upstairs, one for the kitchen (except the cooker) and one for the rest of the downstairs. Decide how the circuit cable will be run to each socket for maximum economy of cable use, remembering that you have to return to the consumer unit. Wiring some sockets as spurs (see '**Circuit Wiring**' section for limitations on unfused spurs) will obviously save having to install a lengthy ring cable. Think too at this stage about whether you want separate circuits to take power to outbuildings - garages, workshops, greenhouses and so on.

Power for use of portable appliances outdoors

If you want to have one or two socket-outlets for operating an electric mower or other portable appliances outdoors, you can fit a weatherproof socket-outlet outdoors on a suitable wall, probably on the garden side of the house on an RCD protected circuit. Alternatively a socket-outlet located indoors rated 32A or less that may reasonably be expected to supply portable equipment for use outdoors must be provided with supplementary protection to reduce the risk associated with direct contact by means of a residual current device. This may be achieved either by fitting a separate RCD to protect the entire ring which supplies the socket-outlet(s) or by using socket-outlet(s) incorporating an RCD at the appropriate point(s).

Where an RCD is fitted in an installation a durable permanent notice is required to be prominently fixed at or near the origin of the installation (i.e., near the meter) reading as follows:

"This installation, or part of it, is protected by a device which automatically switches off the supply if an earth fault develops. Test quarterly by pressing the button marked "T" or "Test". The device should switch off the supply and should then be switched on to restore the supply. If the device does not switch off the supply when the button is pressed, seek expert advice".

The notice shall be in a typeface not less than 4.5mm high.

Our 7-way split load consumer unit (710-268) incorporates a 30mA RCD so would provide the necessary protection for selected outlets. So does our 11-way split load consumer unit (710-269).

Lighting circuits

Plan your lighting requirements in the same way, marking ceiling and wall light positions, plus where you want their switches, on your floor plans. Think

PRODUCT DESCRIPTION	BOOKLET CODE No.	I NEED
4-way consumer unit	710-265	
6-way consumer unit	710-266	
10-way consumer unit	710-267	
7-way split load consumer unit	710-268	
11-way split load consumer unit	710-269	
6 amp MCB	710-272	
16 amp MCB	710-274	
20 amp MCB	710-276	
32 amp MCB	710-277	
45 amp MCB	710-278	
Blank plate	710-280	
Drum of 1mm² cable for lights - 50m	714-002*	
Drum of 1.5mm² cable for lights - 50m	714-004*	
1.5mm² 2-way lightswitch cable - 7.5m	710-450*	
Drum of 2.5mm² cable for power - 100m	714-001*	
6mm² cable for cooker (up to 9.6kW) - 5m	710-409*	
10mm² cable for showers/cookers - 5m	710-454*	
2.5mm² cable for garage circuit - 10m	710-026*	
Conduit for buried cable runs 10 x 2m	710-831	
Cable clips for lighting - 100	710-367	
Cable clips for power - 100	710-362	
Cable clips for cooker - 50	710-188	
Ceiling rose and lampholder set	710-127	
Batten holder for loft	710-002	
4ft fluorescent fitting for garage	700-401*	
Opal globe light for bathroom	700-204	
Downlighters for hall (white)	700-298*	
Downlighters for hall (brass)	700-299*	
Other fittings as required		
250-watt white dimmer switch	710-060	
1-gang 1-way switches	710-016	
1-gang 2-way switches	710-017	
2-gang 2-way switches	710-018	
16mm deep metal boxes - 10	710-065	
13 amp 1-gang switched sockets - 10	710-085	
13 amp 2-gang switched socket - 5	710-042	
25mm deep 1-gang metal boxes - 10	710-064	
25mm deep 2-gang metal boxes - 10	710-061	
1-gang metal-clad switch for garage	710-122	
20 amp switch for immersion heater	710-079	
Heat resisting flex for immersion heater	710-426	
Cooker control unit	710-011	
Metal box for cooker control unit	710-068	
30 amp junction box	710-135	
20 amp 4-terminal junction box	710-131	
2.5mm² earth wire for supplementary bonding -5m 10mm² earth wire for main bonding - 10m 16mm² earth wire for main earthing -2m	710-428	
25mm² tails for connection to meter	710-003	
Earth clamps - pk 5	710-811	
Grommets - pk 25	710-809	
3mm² earth sleeving roll - 5m	710-807	
Insulation Tape Black 20m	710-074	
Red 20m	710-070	

* - different amounts, and in the case of lights, different styles are available

carefully about whether you need two-way switching arrangements for certain lights - those on the hall or landing, for example, bed-head lights in bedrooms and even outside lights. Remember that outside lights on the house wall out of the reach of someone standing on a wet surface can be wired up from the house lighting circuits, but lights away from the house must have their separate lighting circuits from a source protected by an RCD.

Again, allocate your lights to separate circuits. All lighting points are rated nominally at 100 watts, even if less powerful bulbs are to be used, so a 5-amp lighting circuit can in theory supply 12 lighting points. In practice this is reduced to eight, to allow for the use of more powerful lamps or multi-lamp fittings. In most homes two circuits - one upstairs, one downstairs - will be adequate.

CIRCUITS TO FIXED APPLIANCES

The last part of the system to think about is radial circuits to individual fixed appliances - things like cookers, instantaneous electric showers and immersion heaters, all of which have their own circuits from separate fuseways in the consumer unit. Each is wired in cable to suit the appliance (usually 2.5mm² for immersion heaters, 6mm² for single cookers and 10mm² for larger cookers and some very powerful instantaneous showers). Each circuit must include an appropriate double-pole isolating switch to allow the appliance to be isolated for maintenance or repairs. The DP isolating switch should have a neon indicator to show when the equipment is energised. For cookers this may be a 45-amp switch or a combined switch and socket-outlet, which must be mounted in an accessible position within 2 metres of the cooker. For showers a 45-amp switch is again usually used, while for an immersion heater a 20-amp switch with flex outlet is the norm. Again DP isolating switches must be easily accessible.
All DP isolating switches to fixed appliances must be clearly marked, e.g. 'COOKER', 'IMMERSION HEATER', 'SHOWER', 'DISHWASHER', etc.

The last connection in the immersion heater circuit - between switch and heater - is made with special butyl heat-resisting flex.

Circuit fuse ratings are 30 or 32-amp, 40 or 45-amp for the cooker and shower circuits (depending on their power rating), and 15 or 16-amp for 3kW immersion heaters.

THE CONSUMER UNIT

Once you have planned your requirements in detail, you can work out what size of consumer unit you need. A typical installation may require the following circuits:

- Upstairs lighting (5 or 6-amp)
- Downstairs lighting (5 or 6-amp)
- Immersion heater (15 or 16-amp)
- Upstairs ring circuit (30 or 32-amp)
- Downstairs ring circuit (30 or 32-amp)
- Shower circuit (45-amp) or out building (20-amp)
- Cooker circuit (40 or 45-amp)

You should refer to the chart at the back of this leaflet for specific cable sizes which depend upon the cable lengths and circuit ratings, and on the protective device of the circuits.
Therefore a seven-way consumer unit will

be required, and the type chosen should incorporate miniature circuit breakers (MCBs) rather than old-fashioned rewirable fuses. MCBs are much more sensitive to overloading than wire fuses, and offer the added convenience of allowing you to isolate individual circuits at the flick of a switch for maintenance or repair work. In addition to the MCBs, you should also plan to have the previously mentioned additional safety feature called a residual current device (RCD) fitted to your system. This device monitors your system 24 hours a day, and will cut off the current if it detects a flow of current to earth resulting from faulty connections or a break-down in the system's insulation. It also provides added protection against electric shock, by disconnecting the supply very quickly if an appliance becomes faulty.

Our 7 and 11 way split load consumer units have 3 and 5 ways respectively RCD protected.

At this stage you should also check the capacity of your house main service fuse. This is probably rated at 60 amps, but you may need it upgrading to 80 amps to cope with the likely extra current demand of your rewired system. Get the Electricity Company to check this when you call them in to reconnect your new consumer unit. More about this reconnection later.

PROJECT SHOPPING LIST

The planning you carried out earlier will make it easy for you to add up the numbers of the various wiring accessories required for your rewire.
The checklist below lists all the Wickes' electrical fittings and accessories you are likely to require. Use it to produce your own shopping list for the project.

WORK SEQUENCE

1. Rewire upstairs lighting circuit.
2. Rewire downstairs lighting and upstairs power circuits.
3. Rewire to immersion heater (and any instantaneous shower).
4. Rewire ground floor power circuit.
5. Wire to cooker.
6. Wire to any outbuildings.
7. Work on earth bonding.
8. Check all circuits for continuity.
9. Fit the new consumer unit.

CABLING NOTES

Where any cable is installed above a ceiling or under a floor it must be run in such a location that it is not likely to be damaged by contact with the structure or its fixings. Where cable passes through timber joists, under floorboards or above a ceiling, the cable must be at least 50mm away from the top and/or bottom of the joist edges. Alternatively, cable may be encased in earthed metal conduit or otherwise protected by fixed heavy gauge steel strong enough to prevent penetration of the cable by screws, nails, etc., driven into the floor or ceiling. Plastic conduit is no protection against nails, screws or other fixings.
It is important to run the cables with care, ensuring no damage occurs to the cable sheath or conductor insulation. Where a cable route involves changes in direction, it should be carefully pulled in section-by-section, taking care to avoid strain and hardening of the copper cores by excessive flexing.
Where a cable is to be concealed in a solid wall or timber stud partition wall at a depth of less than 50mm from the surface it must be installed horizontally within 150mm of the top of the wall or, at wall corners, vertically within 150mm of the corner. When then run to an accessory on the wall such as a switch, socket or light, the cable must be run in a straight line precisely vertically or horizontally.
Where a buried cable in a wall cannot be run truly vertically or horizontally as above it must be not less than 50mm below the surface or be enclosed in earthed steel conduit or otherwise protected by earthed metal strong enough to prevent penetration of the cable by screws, nails, etc., driven into the wall. Plastic conduit is no protection against nails, screws or other fixings.
Mains voltage cables must be separated from telephone or other telecommunications cables by at least 50mm unless the mains cable is enclosed in earthed metal conduit. To prevent overheating and damage no cable should run within 75mm of a heating or hot water pipe.

1. Upstairs lighting circuit

Start work in the loft on the upstairs lighting circuit, since access will be easier than to the downstairs one and you will gain experience with less effort. Isolate the existing circuit at the main fuse box, and arrange a portable light fitting on an extension cable in the loft so you can see what you are doing.
Position ceiling roses first, then run circuit cables between them, using junction boxes if it saves on cable. Diagram E shows the connections for a loop-in wiring system both as described previously in this leaflet.
No ordinary switch can be fitted in a bathroom, unless it is outside the Zones 1 and 2. A pull-cord operated ceiling switch complying with BS 3676 should be used if a switch is needed in Zones 1 or 2. No switch can be used in Zone 0. Now refer back to **'Electrical installations and earth bonding of bathrooms containing shower cubicles'** to make sure you understand these rules.

If you do not already have a permanent light and switch in the loft now is the time to install one perhaps using a fluorescent fitting or a batten lampholder.

If old switch positions are being retained, try to use the old switch cables to draw the new ones down existing conduits. Run the circuit cable back to the main fuse box, disconnect the old circuit cable and temporarily connect in the new one so you can restore the power to the new circuit. Leave extra cable adjacent to the consumer unit to allow for subsequent connection to the new consumer unit which may not be in precisely the same place. Clip cables to joists, preferably to the sides so that they cannot be trodden on or tripped over. Keep them above the level of any loft insulation.

2. Downstairs lighting and upstairs power circuits

Tackle the wiring at first floor level next - the upstairs power circuit and the downstairs lighting circuit, both of which are generally run in the void between floor and ceiling. Isolate existing circuits at the consumer unit, using extension leads from the downstairs power circuit to provide power to, for example, drive power tools. You should have light from the already completed upstairs lighting circuit.

Position first-floor sockets and downstairs light fittings as required, lifting floorboards for access and using the old cables to draw the new ones into position. If extra sockets are being installed it will probably be necessary to drill through flooring joists for the additional cable runs. Where a cable is installed under a floor and/or above a ceiling it must be placed so as not to be liable to damage by floor or ceiling fixings. Cables must be at least 50mm from the top or bottom of a joist, as appropriate, or be enclosed in earthed steel conduit. Remember that on some occasions two cable thicknesses will have to go through one hole to maintain straightforward runs for the ring. **Diagram G** shows such a situation.

Chop out holes for new boxes with a club hammer, bolster, and cold chisel. Chop out only to the depth of the box plus about 2mm to ensure clearance. Secure the box with at least two screws. Boxes should be a minimum of 150mm above floor level. Never try to re-use or open up old holes in skirting boards, since these are far too low. Block them up completely once you have cut new holes above and have also cut channelling for the cables.

Socket outlets are not permitted in bathrooms or rooms containing a shower, except special shaver sockets complying with BS EN 60742, which are permitted in Zones 2 and 3. If you are intending to install appliances such as heaters or extractor fans in bathrooms or rooms containing a shower, remember that special rules apply both to what you may install and where it may be installed. Refer back to **'Electrical installations and earth bonding of bathrooms containing shower cubicles'** to make sure you understand these rules.

Connect to sockets as shown in **Diagram H** bearing in mind that the precise location of terminals will not necessarily be exactly as shown but all terminals will be marked L for live, N for neutral, and either E or the symbol ⏚ for earth. Cable core insulation should be stripped carefully to length so that no part of the copper wire is visible when it is inserted and firmly gripped in the terminal. Slip lengths of green-and-yellow earth sleeving over bare earth wires before connecting them to their terminals.

Make sure that cables entering metal boxes set in the wall are protected from chafing against the bare metal entry points by grommets.
There should always be a little slack in the cables to sockets to enable the face plates to be eased clear of the boxes to make connections more accessible.
NOTE: Remember that a ring circuit starts and finishes at the consumer unit and that its two ends must be connected to the same fuse or MCB and the same neutral and earth terminals respectively. Radial circuits start at the consumer unit but finish at the most remote outlet.
The wiring of two-way light switches between upstairs and downstairs should also be done at this time. Note that you require either 1-gang 2-way or 2-gang 2-way switches at each switch point and also sufficient 3-core and earth cable to run between the switches. **Diagram I** shows how to make the connections. The 2-gang switches would only be needed if another light needed to be operated from the same point either upstairs or downstairs.
When the circuits are complete, disconnect what is left of the old circuits at the consumer unit and temporarily connect the new cables remembering to leave excess cable in case the new consumer unit is not to be in the same place.

3. Immersion heater (and any instantaneous shower)
At first floor level, run in new radial circuits to the double pole switches for the immersion heater and any instantaneous shower, each one being totally separate and wired to its own fuse or MCB. Mount the switch units in convenient locations (Take great care to follow the Zone rules stated earlier in **Electrical installations and earth bonding of bathrooms and rooms containing shower cubicles**), and run cable tails back to the consumer unit position. Connect the new immersion heater cable to the existing 20-amp fuseway; leave the shower cable unconnected unless a fuseway already exists for it.

4. Ground floor power circuit
Run cable beneath floors wherever possible and use spurs to save on unnecessary cable use. Remember that the total number of unfused spurs on the circuit must not be not greater than the number of sockets and fixed equipment already connected to the main circuit. Again isolate existing circuits first, providing light and power from the upstairs power circuit. Connect selected appliances like the dishwasher, waste disposal unit, washing machine, etc., to DP switched fused connection units.

5. Wire to cooker
Wire the radial circuit to the cooker, running the circuit cable back to the fuse box and connecting it to the appropriate fuseway.

6. Wire to any outbuildings
Wire up the new circuit to an outbuilding, if one is being installed. For a detached outbuilding, depending on distance from the house, this will involve the use of 2.5mm² toughened cable run from a junction box inside the house and probably close to the consumer unit, underground perhaps at a depth of 500mm in cultivated ground or 300mm under paving, to a consumer unit in the outbuilding with switched MCBs for lighting and power.

Power to the junction box will be supplied in standard 2.5mm² twin and earth cable supplied through a 15A or 16A fuse or MCB in the consumer unit. Connections in the outbuilding would be as for power or lighting circuits in the house.
As a socket-outlet in an outbuilding is likely to be used for equipment outdoors it must be protected by a 30mA RCD. This is another good reason for installing a consumer unit incorporating an RCD. As the cable run to an outbuilding may be fairly long, check that it does not exceed the maximum length allowed in the **Cable Selection and length chart** (see below) for a 15A or 16A circuit.

7. Work on earth bonding
Cross-bond all exposed metalwork in kitchens and bathrooms to earth if you have not already done so. The cross-section of the cable need be no greater than the cross section of the circuit cable subject to a minimum of 2.5mm² where the protective conductor is mechanically protected, or 4mm² where it is not. The main equipotential bonding of the main gas and water supply pipes to the main earth terminal must be carried out using 10mm² cable as shown in Diagram A. The main equipotential bond to metallic piped services must be connected to hard metal, before any branch pipework, within 600mm on the consumer's side of any meter or insulating insert, or at the entry to the building where the meter is external. The necessary earthing clamps are available from Wickes. All paint or other surface finish should be removed from the bonded metalwork at the point of connection of the bonding conductor.

Regulations also require that a permanent and durably marked label reading **'Safety Electrical Connection - Do Not Remove'** must be permanently fixed in a visible position at or near the point of connection of every bonding conductor to an extraneous-conductive part, e.g. to a bath, bathroom pipework, etc, and to the main bonding connections to incoming metallic service pipes.

Remember too that all equipotential bonding conductors must be either sleeved or insulated green-and-yellow.

8. Check all circuits for continuity
Double-check all wiring connections, and test for circuit continuity. Circuit testers are inexpensive and easily available. All protective conductors, i.e. earthing and bonding should be checked.

9. Fit the new consumer unit
Install the new consumer unit, ensuring that it has all the necessary MCBs of the correct amperage. Each fuse, MCB and RCD must be identified by a label, or on a chart adjacent to the consumer unit, to indicate the circuit that it protects. At this point you must plan to not only transfer all the circuit cables to it but also get a qualified, approved, electrician or your Electricity Company to disconnect the meter tails from the old consumer unit and reconnect them to your new consumer unit. Arranging all this on one day so that you are not without power or lighting can take some doing but if you have planned your work carefully and have made an appointment for an electrician to call on the right day there should be no problems. The electrician, private or from the Electricity Company, will test your circuits, carry out tests for the polarity, earthing continuity, earth loop impedance and insulation resistance to ensure that the new system complies with the requirements of the IEE Wiring Regulations - BS 7671: 2001, and that all protective devices work properly.

INSPECTION AND TESTING OF YOUR WORK

The electrician carrying out the inspection and testing should then complete an **Electrical Installation Certificate** on your behalf. This document will contain details of the installation, and may be required by your local Electricity Company staff if your electricity supply is to be re-connected at that time and needs their attendance.

The electrician will have to inspect and test the installation fully. It is therefore advisable to obtain the certificate before decorating over the wiring or re-concealing it under floor-boards, within walls, behind units etc. You will be expected to pay the tester for his services.

At one place in the document you will be expected to confirm that your installation has been designed and constructed in accordance with BS7671; 2001 ("the Regulations"). Reasonable endeavours have been made in this Good Idea Leaflet, to provide you with guidance which will enable you to carry out simple construction work in accordance with the Regulations. The circuit ratings and details based on the Regulations are intended to enable you to carry out simple designs in owner-occupied domestic premises. However, for ring circuit designs, it is beyond the scope of this leaflet to account fully for the effects of possible concentrations of electrical loads (e.g. in kitchens) .

In the case of a ring circuit design, or if you have any doubts whatsoever about your design or the construction of your installation, or if you are unsure whether you have been able to follow these notes precisely - you will need to seek the advice of an Electrical Consultant. This is to confirm that the design and construction is in accordance with the Regulations and enable the **Electrical Installation Certificate** to be completed. It may well be that the electrician who carries out the inspection and testing is able to do this for you, however if not, you can obtain the services of an independent Electrical Consultant by applying for a list of suitably qualified consultants to the Institution of Electrical Engineers, Savoy Place, London WC2R 0BL. You will be expected to pay the consultant for his services.

If the work you have carried out is simply an addition to an existing circuit, a full **Electrical Installation Certificate** is not required and in that case the electrician who carries out the inspection and testing could complete a **Minor Electrical Installation Works Certificate.**

The completed **Electrical Installation Certificate** or **Minor Electrical Installation Works Certificate** should be kept in a safe place for future reference, as a record of the electrical work you have carried out.

WARNING

Improperly executed work could cause fires and potentially lethal electric shocks. Do not attempt any electrical work unless you are confident that you know what you are doing, you fully understand how to carry it out. Otherwise, call in a qualified electrician to do the work for you. He should be a member of the Electrical Contractors Association (ECA) or on the Roll of the National Inspection Council for Electrical Installation Contracting (NICEIC); you can obtain lists of registered members, or direct from the bodies mentioned (ECA: 020 7313 4800; NICEIC: 020 7582 7746). In Scotland contact SELECT, 0131 445 5577

CABLE SELECTION AND LENGTH CHART

For any circuit the permissible minimum size and maximum length of the cable is determined by several factors, some of which are interdependent. The minimum size of the cable is governed mainly by the normal current rating of the protective device and also by the size of the possible short-circuit current and by the time for which it is allowed to flow, which in turn is governed by the type of protective device. The maximum length of cable is limited by the allowable drop in voltage, which it causes. It is also limited by the amount of short-circuit and earth fault current that can flow in the cable. The calculations are complex, so to save you the time and trouble of doing them they have been done for the types of circuit that are normally used in domestic electrical installations and put into the table of RECOMMENDED CIRCUIT RATINGS AND DETAILS below. This table is based on the following conditions:

- **The main earth termina**l is provided by your Electricity Company and is connected either to the supply cable sheath (CSE in the table) or, in most modern supply systems, to a Protective Multiple Earthing conductor (PME in the table). You should ask the Electricity Company which system is used on your supply. If the earth terminal is not provided by the Electricity Company or is connected to an earth rod in the ground then the table cannot be used and you should consult the Electricity Company or a qualified electrician.
- **Cable lengths** are measured from the consumer unit to the furthest point on the circuit. On a ring circuit the length is measured from the consumer unit around the ring and back to the consumer unit. Where a spur is connected to a ring the length is measured from the point of connection to the ring to the end of the spur *plus* one-quarter of the length of the ring.

- **PVC-insulated and sheathed** flat twin and earth cable is used and is installed by one of the following methods:

A) clipped directly to the surface or embedded in plaster

B) run in conduit either clipped to the surface or embedded in plaster

C) run in conduit embedded in a thermally insulated wall or ceiling, **but in contact with the inner face of the wall or ceiling**. Where the conduit is totally surrounded by thermal insulating material the cable rating is halved, e.g. for a 15A circuit a cable rated for 30A must be used.

RECOMMENDED CIRCUIT RATING & DETAILS

Circuit type	Rating (amps)	Cable size (mm²) Live/earth	Protective Device	Maximum Length (metres) CSE	PME
Lighting	5	1.0/1.0	Cartridge fuse or rewirable fuse	43	43
	5	1.5/1.0	Cartridge fuse or rewirable fuse	72	72
	6	1.0/1.0	MCB Type B	35	35
	6	1.5/1.0	MCB Type B	53	53
Ring circuits	30	2.5/1.5	Cartridge fuse or rewirable (*a) fuse	88	88
	32	2.5/1.5	Rewireable fuse	85	85
Radial circuits	20	2.5/1.5	Cartridge fuse, MCB Type B	26	26
	20	4.0/1.5		45	45
Immersion Heaters	15	2.5/1.5	Cartridge fuse, or rewirable fuse (*a)	35	35
	15	4.0/1.5	Cartridge fuse or rewirable fuse	61	61
	16	2.5/1.5	MCB Type B	35	35
	16	4.0/1.5	MCB Type B	61	61
7.5kW (240V) Instantaneous showers	30	6.0/2.5	Cartridge fuse (*b)	32	42
	30	6.0/2.5	Rewireable fuse (*b)	27	42
	30	10.0/4.0	Cartridge fuse	69	69
	30	10.0/4.0	Rewirable fuse	43	51
	32	6.0/2.5	MCB Type B	42	42
	32	10.0/4.0	MCB Type B	69	69
8.5kW (240V) Instantaneous showers	40	6.0/2.5	MCB Type B	31	34
	40	10.0/4.0	MCB Type B	51	56
	45	10.0/4.0	Cartridge fuse	NP	32
	45	10.0/4.0	Rewirable fuse	NP	34
9.5kW (240V) Instantaneous showers	45	10.0/4.0	Cartridge fuse	NP	32
	45	10.0/4.0	Rewirable fuse	NP	34
	50	10.0/4.0	MCB Type B	20	50
14.4kW Cookers with or without 13A socket-outlet	30	6.0/2.5	Cartridge fuse	31	42
	30	6.0/2.5	Rewirable fuse (*b)	NP	42
	30	10.0/4.0	Cartridge fuse	51	69
	30	10.0/4.0	Rewirable fuse	43	69
	32	6.0 /2.5	MCB TypeB	42	42
	32	10.0/4.0	MCB TypeB	69	69
15.58kW Cookers with or without 13A socket-outlet	40	10.0/4.0	MCB Type B	51	53
	40	16.0/6.0	MCB Type B	78	88
	45	10.0/4.0	Cartridge fuse (*a)	NP	32
	45	10.0/4.0	Rewireable fuse (*b)	NP	34

NOTES NP - Not permitted
(*a) - Permitted only for installation methods (A) and (B)
(*b) - Permitted only for installation method (A)