A problem with many installations, particularly domestic, is that

Every man and his dog has had a hand in it
The domestic electrical installation

• likely to have been originally installed by competent electrical contractor

• additions/alterations possibly undertaken by unqualified persons

• periodic inspection and testing to ensure continued safety is unlikely
To what standards should an electrical installation conform?

The Institution of Electrical Engineers Wiring Regulations
First Edition of the Regulations

Issued in 1882 and entitled ‘Rules and Regulations for the Prevention of Fire Risks Arising from Electric Lighting’
What about risk of electric shock and death by electrocution?
Jointly owned by the Institution of Electrical Engineers and B.S.I.

Latest edition

Came into effect

1st January 2002
Are these regulations statutory?

No, but they can be used as evidence of compliance with statutory regulations.

Limited value within the domestic installation in terms of enforcement.
Very few enforceable regulations apply to domestic installations
The commercial or industrial electrical installation usually under the control of competent persons.

Statutory measures in place to ensure a safe working environment. This includes the electrical installation and electrical equipment.
Failure to comply with statutory regulations within the workplace can lead to criminal prosecution
Other Interested Parties
Two organisations concerned with the quality and safety of all aspects of electrical installation work in including domestic
The Electrical Contractors Association

E.C.A.

National Inspection Council for Electrical
Installation Contracting

N.I.C.E.I.C.
Organisations only concerned with the competence and quality of work for those electrical contractors who are members of their organisation
What happens if an electrical contractor carries out work in an unsatisfactory manner?

If the contractors are members of the ECA or NICEIC, then appropriate action can be taken.

If not, the trading standards office, or local authority may be able to help.
With many domestic installations there is little or no maintenance undertaken to ensure continued safety.

In many cases, the integrity and safety of the installation is reduced by the D.I.Y. person!
The need for Inspection and Test
Installations should be inspected and tested

• before being put into service -
  *(initial verification)*

• at regular intervals thereafter -
  *(periodic)*

• on completion of any alterations or additions
The Initial Verification
For an initial verification

**BS 7671:2001** states:

- installed equipment to an appropriate standard, i.e. BS, BS EN etc.
- correctly selected and erected
- not visibly damaged or defective as to impair safety
The periodic installation inspection

BS 7671:2001 states

Periodic inspection and testing of an electrical installation shall be carried out to determine, so far as is reasonably practicable, whether the installation is in a satisfactory condition for continued service.
Generally, the main reason for undertaking an inspection and test is to ensure that the installation is safe to use.
What are the likely reasons for an installation failing to be safe?

• Age

• Wear and tear - may be considerable in rented accommodation

• Botched work by incompetent persons, or unscrupulous contractors
Periodic Inspection Report

Where is it required?

- expiry of current certificate
- change of ownership or use
- as a result of damage - flood, fire, etc
- mortgage/insurance purposes
Factors affecting the safety

Some common factors will include:-
Damage to equipment or accessories
Poorly installed equipment/accessories
Loose connections giving rise to shock/fire
Overloaded circuits
Inadequate protection of circuits against overcurrent
Circuit cables inadequate to safely carry load current
Inadequate earthing arrangements
The visual Inspection
For reasons of safety the supply should preferably be switched off prior to conducting the inspection.
Checking fixings of accessories and cabling
Loose connections may result in electric shock and fire.
circuit connections may be dislodged by movement of the socket outlet. Terminations should be checked before socket is secured. Remember, loose connections may give rise to fire and shock.
And before re-securing any accessory.
The supply must be isolated
circuit connections may be dislodged by movement of the joint-box.
That’s assuming they bothered to use a joint box in the first place.
Blimey he’s even left the screwdriver bit in the terminal block.

Potential fire/shock risk due to mechanical damage or loose connections.
Shock risk
Overheating due to loose connections
Correct connection of single-way switch

- Surface box secure
- Earth wire sleeved
- Terminations secure
Basic one-way lighting circuit

P

switch

Lamp

N
Switch connections for two-way lighting
When converting one-way to two-way lighting the earth wire used as live conductor

Very dangerous practice
When installing socket outlets
• accessory secure
• correct amount of sheath
• terminations secure
• appropriate standard BS 1363
• correct cable size
Fuses and Circuit Breakers
The purpose of a fuse or circuit breaker device is automatically to interrupt circuit current in the event of fault or overload conditions.
Excessive current may flow as a result of:

- overload (excessive connected load)
- short circuit between live and neutral
- earth fault (live or neutral to earth)
Overload
(excessive connected load)
Under normal circumstances, the fuse or circuit breaker should operate before the circuit cables reach dangerously high temperature.
If the fuse or circuit breaker is too high for the circuit, the cables may reach a dangerously high temperature resulting in fire
removing excessive load removes the problem
Short circuit

Phase and neutral conductors touching

Large fault current flows - fuse or circuit breaker should operate
Result of electrician fitting circuit breaker to live board
Combined main switch and r.c.d.

Least sensitive of the two devices and protects circuits feeding fixed equipment.
Earth fault

a fault condition that exists between live conductors and earth

Excess current should cause fuse or circuit breaker to operate
rewirable fuse - most widely abused
Most likely reason for device failing to operate

Incorrect size of element
a fuse failing to operate under fault conditions may well result in fire
The Rewirable fuse is an antiquated device. Even with the correct rating of fuse element it may not safely interrupt high levels of fault current.
Cartridge fuses to BS 1361

- scattering of hot metal particles contained within cartridge thus reducing fire risk during operation
- operates much closer to its current rating when compared to the rewirable fuse
• has the ability to interrupt high levels of fault current
• less likelihood of premature failure due to oxidisation when compared to the rewirable
Selection of fuses used in consumer units
Circuit-breakers to BS EN 60898

- most widely used type of overcurrent protective device, particularly for domestic applications

Thermal-magnetic operation

- thermal - overload
- magnetic - short circuit conditions

Older ‘miniature’ circuit breakers to BS 3871
## Circuit-breakers to BS EN 60898

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The Residual Current Device (r.c.d.)

Provides protection against earth faults in terms of:

• electric shock, and

• fire of an electric origin
Why bother with an r.c.d. when a fuse or circuit breaker can provide protection against earth fault conditions?
an r.c.d. can operate in the region of milli-amps

in fact a r.c.d. rated at 30mA can provide protection against electrocution
fuses and circuit breakers require relatively high currents in order to operate

for example, for a 30A rewirable fuse requires approximately 200A to operate within a safe time period
Types of r.c.d.
Socket outlet incorporating r.c.d. protection

High level of personal protection against shock, particularly when using portable electrical equipment outdoors.
Domestic consumer unit with two r.c.d.’s

Extensively used in conjunction with an earth electrode earthing system
Second r.c.d. has greater sensitivity and is used to protect socket outlet circuits
Combined r.c.d. circuit breaker (RCBO)

single device provides protection against both overload, short circuit and earth fault currents
Combined r.c.d. circuit breaker (RCBO)

An r.c.d. is a device which can provide protection against:

- fire resulting from earth faults
- earth faults where circuit resistance is too high for protection by conventional devices, i.e. circuit breakers or fuses
- where greater protection against electric shock, for example socket outlet circuits likely to supply portable equipment outdoors
fuses and circuit breakers are totally unable to provide this level of shock protection
The best thing since sliced bread
What rating of r.c.d. are generally available and where would they be used?

as a guide
30mA for personal protection socket outlet circuits

100mA or above for protection against fire
verification of polarity

most importantly, at socket outlets
Correct polarity is essential.
socket outlet correctly wired
the earth pin of the socket connects directly to the exposed metalwork of the appliance
What happens when the phase and earth connections are reversed?

incorrect polarity can lead to death by electrocution
The phase and c.p.c. reversed
the phase conductor is directly connected to the exposed metalwork of the appliance

From supply
Correct polarity

Correct polarity of Edison-type screw fittings essential if shock is to be avoided.
Centre contact must always be connected to the phase conductor of the supply
neutral phase
Phase and neutral connections reversed
Reversed polarity

A person removing an Edison-screw lamp could receive a serious electric shock if they touched the lamp thread before it had completely been removed from the fitting.
Verification of polarity can be quite a complex affair and generally only undertaken by competent persons.
However! If common sense is applied rudimentary testing may be undertaken at socket outlets by using a socket tester
The socket tester

useful but limited in its application
All lights green indicates correct polarity
red - red - green indicates P-E reversed
The socket tester will INDICATE

THE PRESENCE OF SUPPLY

IDNETIFY THE CORRECT POLARITY OF THE PHASE CONDUCTOR

THAT SOME FORM OF EARTH CONNECTION IS PRESENT AT THE SOCKET OUTLET
The socket tester will NOT INDICATE

A HIGH RESISTANCE EARTH PATH

A REVERSED NEUTRAL EARTH CONNECTION
NEVER USE A SOCKET TESTER TO PROVE THAT A CIRCUIT IS ISOLATED, (dead).
Earthing

In order to prevent electric shock the exposed metalwork of electrical appliances, metal conduit etc should be earthed.

In the majority of cases the earthing facility is provided by the local electricity supplier.
Inadequate earthing arrangements may lead to electric shock or death through electrocution
Earthing arrangements
Typical domestic intake

- Meter
- Consumer unit
- Service cutout
- Main incoming earth
- Earth terminal
Earth connection is obtained from suppliers sheath (main incoming cable)

This method of earthing is still widely used and is reliable
Modern earthing arrangement where the earth is connected to the incoming neutral at the service head

Rapidly becoming the most widely used supply arrangement
Widely used in agricultural/rural areas. Earthing relies on earth electrode (rod/spike)

Gradually being phased out wherever possible.
Earth rod and typical enclosure
Problems with earth electrodes

• generally does not provide a very good earth return path

• liable to corrosion and mechanical damage