

Earthing Plastic Pipes

By Paul Cook of the Institution of Electrical Engineers

You do not have to earth plastic pipes.

Plastic pipes make for a safer electrical installation and reduce the need for earthing. Festooning an installation that has been plumbed in plastic pipe with green and yellow earth wire is not necessary and is likely to reduce the level of electrical safety of the property, not increase it.

Everyone knows that water and electricity do not mix, that the risk of electric shock is greater when there is water around. They know that the risk and severity of an electric shock is increased as a result of the presence of water. This may be the reason for the concern that water in plastic pipes may conduct electricity and that bonding is required. Because of this, the IEE commissioned the Electrical Research Association to carry out measurements of the electrical conductivity of water in plastic pipes.

The ERA tests confirm that tap water in a plastic pipe is a poor conductor of electricity. One metre of 15 mm diameter plastic pipe filled with tap water from Leatherhead where the ERA are based, has a resistance of 100,000 Ω . This one metre of pipe will restrict currents to less than fatal values and of course in practice, there would be many metres of pipe between metal items of plumbing equipment and earth.

The resistance of water varies around the country, it is reduced by impurities, not all of which are harmful. The additives put into the water of central heating systems to reduce corrosion make the most difference, as can be seen from the table below.

Resistance of the water in 1 metre of plastic pipe

	Resistance Ω
15 mm diameter, tap water	115,000
20 mm diameter, tap water	65,000
15 mm diameter, water with double dose of inhibitor at 60°C	20,200

So why do wet hands and immersion in a bath increase the risk of electric shock?

The Human body plus clothes, particularly shoes has an impedance of about 3,000 Ω - see table in the next column. At 230 volts this will result in a

current of about 153 mA (153 thousandths of an amp). This is not nice, but it is unlikely to kill you. If there are no shoes and hands are wet, the impedance falls to 500 Ω and the current at 230 volts is 460 mA. This is getting decidedly unpleasant. Immersion of the body in a bath, in effect halves the impedance of the body and current at 230 volts would then be as high as 1,000 mA. This is dangerous, and can kill.

Situation	Body Impedance	Current at 230 V
Dry with shoes	3000+ Ω	76 mA
Dry	1500 Ω	153 mA
Wet	500 Ω	460 mA
Body ½ immersed	250 Ω	920 mA

Horny dry hands and feet are quite good insulators. However, if the hands are wet, salts and contaminants improve the contact and reduce the resistance of the skin. Dry skin has a high resistance, wet skin has a relatively low resistance.

The other reason why bathrooms and such places are relatively risky electrically, is the presence of earthed metal. Should you be unfortunate enough to touch the live parts of broken equipment and nothing else except say a well insulated floor, there would be little result. Electrical jointers and fitters regularly work live under such controlled conditions. However, if you touch a live part and an earthed metal pipe, then you get a very dangerous electric shock.

An earthy environment where there are lots of metal pipes is potentially less safe than an earth free environment. We can now start to see why plastic pipe installations are going to lead to safer installations. For a start, there is not all that earthed metal around.

The bonding requirements for plastic piped and metal piped installations is described below.

At the Service Position - Main Bonding

In each electrical installation, main equipotential bonding conductors (earthing wires) are required to connect to the main earthing terminal for the installation the following :

- metal water service pipes
- metal gas installation pipes
- other metal service pipes and ducting
- metal central heating and air conditioning systems
- exposed metal structural parts of the building
- lightning protection systems

It is important to note that the reference on the previous page, is always to metal pipes. If the incoming service pipes are made of plastic, they do not need to be main bonded.

If the incoming pipes are made of plastic, but the pipes within the electrical installation are made of metal, the main bonding must be carried out. The bonding being applied on the customer side of any meter, main stopcock or insulating insert and of course to the metal pipes of the installation.

The connections of the bonding wired to the pipes has to be made with a proper clamp to BS 951 complete with the label "SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE."

If the incoming services are made of plastic and the pipework within the building is of plastic then no main bonding is required. If some of the services are of metal and some are of plastic, then those that are of metal must be main bonded.

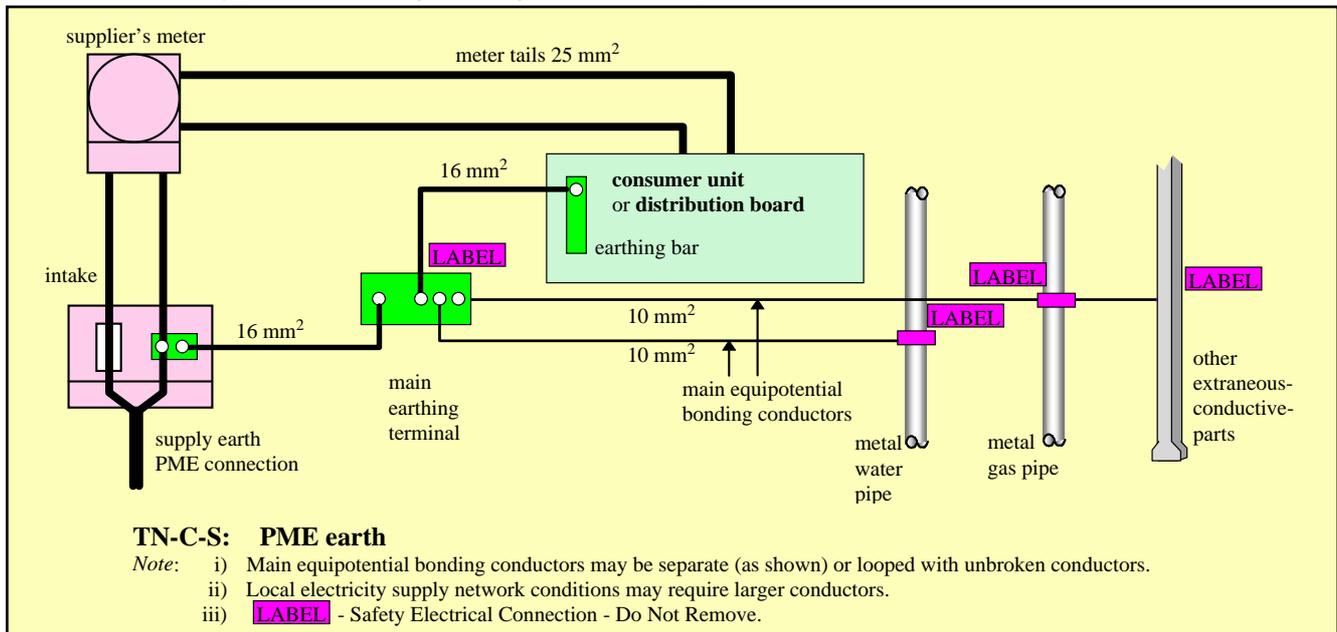
bonding and metal fittings attached to these plastic pipes also would not require supplementary bonding.

It seems to be the practice of some builders to effect all the plumbing in plastic except for those bits of the pipework that are visible. These short lengths of metal pipework supplied by plastic pipes or metal taps connected to plastic pipes, metal baths supplied by plastic pipes and with a plastic waste do not require supplementary bonding.

However, electrical equipment still does require to be supplementary bonded and if an electric shower, or radiant heater is fitted, they will require to be supplementary bonded as usual.

Supplementary bonds are required to be connected to the protective conductor of all circuits supplying electrical equipment in the bathroom e.g. at a flex outlet or switch.

Typical earthing arrangements and protective conductor csa - TN-C-S



In the bathroom - Supplementary Bonding

Supplementary or additional equipotential bonding (earthing) is required in locations of increased shock risk. In domestic premises the locations identified as having this increased shock risk are rooms containing a bath or shower (bathrooms) and if you are lucky enough to have one, in the areas surrounding swimming pools.

Please note, there is no specific requirement to carry out supplementary bonding in domestic kitchens, wash rooms and lavatories that do not have a bath or shower. That is not to say that supplementary bonding in a kitchen or wash room is wrong (it would be wrong for plastic pipes) but it is not necessary.

For plastic pipe installations within a bathroom the plastic pipes do not require supplementary

Figure 1 shows the supplementary bonding in a bathroom where the house is plumbed with metal pipes and Figure 2 shows the supplementary bonding required in a bathroom where the pipework is plastic.

Metal radiators supplied by plastic pipes should not be supplementary bonded. It is not safer to supplementary bond them, it is safer not to. Locations generally are safer if the location is earth free as discussed earlier.

There are many possible combinations of metal and plastic pipe arrangements in a bathroom. To try and answer questions regarding the supplementary bonding required in a number of permutations of copper and plastic pipe, Table A below has been prepared.

Figure 1: Supplementary bonding in a bathroom - metal pipe installation

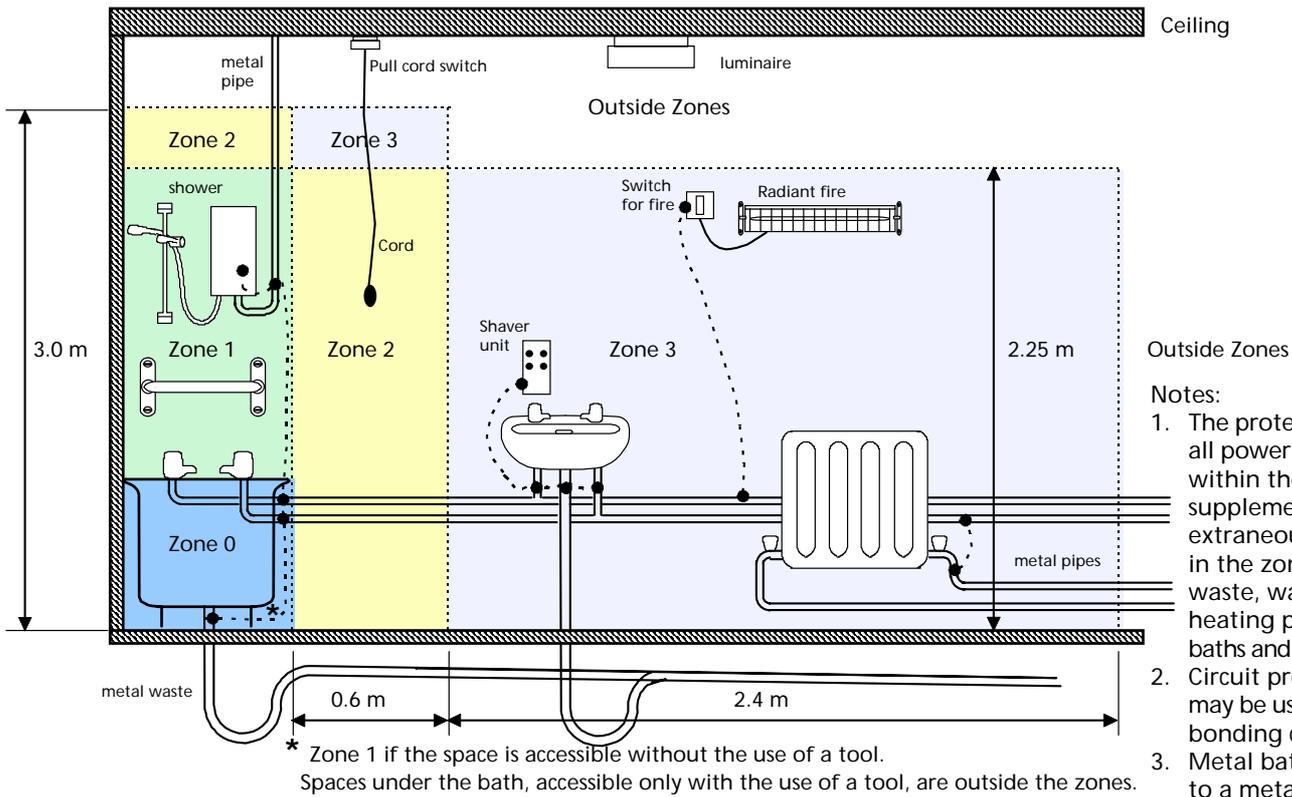


Figure 2: Supplementary bonding in a bathroom - plastic pipe installation

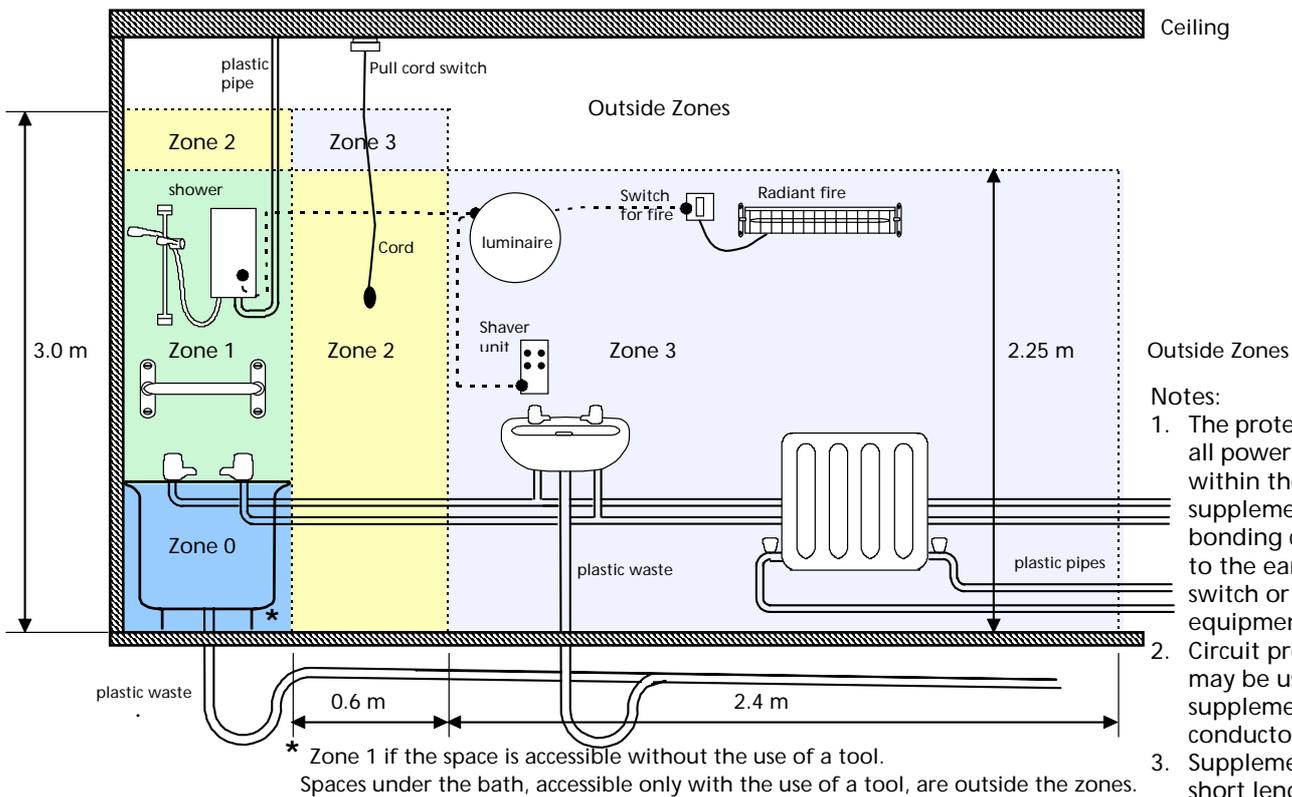


Table A: Supplementary bonding in a number of permutations of copper and plastic pipe

Pipework material					Supplementary bond required between	Comments
	Waste Pipes	Cold Water	Hot Water	Central Heating		
1	Metal	Metal	Metal	Metal	All metal pipes, earth terminals of protective conductors of class I and class II equipment, and accessible exposed-conductive-parts of the building structure.	Metal pipes can be used as bonding conductors if joints are metal to metal and electrically continuous.
2	Plastic	Plastic	Plastic	Plastic	Earth terminals of protective conductors of class I and class II equipment and accessible exposed-conductive-parts of the building structure.	Bonding of metal taps, metal radiators or metal baths is not required unless the bath is connected to the metallic building structure.
3	Plastic	Plastic	Metal	Metal	Hot water pipes, central heating pipes, earth terminals of protective conductors of class I and class II equipment and accessible exposed-conductive-parts of the building structure.	A bond is not required to the taps either hot nor cold, or to metal baths unless connected to the metallic building structure.
4	Plastic	Plastic	Plastic	Metal	Central heating pipes, the earth terminals of protective conductors of class I and class II equipment and access to exposed-conductive-parts of the building structure.	Bonding of metal water taps is not required, nor metal baths unless connected to the metallic building structure.
5	Plastic	Metal	Metal	Metal	All metal pipes, earth terminals of protective conductors of class I and class II equipment, and accessible exposed-conductive-parts of the building structure.	Metal pipes themselves can be used as bonding conductors if joints are metal to metal and electrically continuous.
6	Plastic	Metal	Metal	Plastic	All metal pipes, earth terminals of protective conductors of class I and class II equipment, and accessible exposed-conductive-parts of the building structure.	Metal central heating radiator does not require bonding.

Notes:

1. Supplementary bonding is carried out to the earth terminal of protective conductors of class I and class II equipment within the bathroom. A supplementary bond is not run back to the main earth,
2. Metal window frames are not required to be supplementary bonded unless they are electrically connected to the metallic structure of the building.
3. Metal baths supplied by metal pipes do not require supplementary bonding if all the pipes are bonded and there is no other connection of the bath to earth
4. All bonding connections must be accessible and labelled "Safety Electrical Connection - Do Not Remove".