SEGMENT NINE - Electricity

After studying this segment you should have a greater understanding of the potential danger posed by electricity and the steps taken in the workplace to ensure that electrical safety is maintained.

AIMS OF THE SEGMENT

The main aim of this segment is to help you to understand the hazards and risks associated with electricity and be able to:

- Explain the need for installation testing and maintenance by competent personnel, and the need for immediate fault reporting;
- Give examples of methods for improving electrical safety;
- State the key aspects of dealing with electric shock.

INTRODUCTION

Where would we be without electricity? Our lighting would be gas lighting, there would be no televisions, washing machines would be hand operated. Electricity is something that we have all come to take for granted as something that is always available and always works.

Because it always seems to work we often forget that it can easily shock and kill. In a work situation electricity is the cause of few accidents, typically less than 2% of reported accidents involve electricity.

However, electrical accidents are much more likely to be fatal ones, twenty times more likely than many other forms of industrial accidents.

Another surprising fact about electrical accidents is that they are far more likely to happen to experienced and competent persons than other kinds of accidents.

Electricity – hidden danger

Part of the problem with electricity is that it cannot easily be sensed. It cannot be smelt, seen or heard and often the first indication that it is there, is when someone gets a nasty electric shock.

Perhaps this is the reason why so many fatal accidents involving electricity happen to people who are skilled and competent. They are the kind of people who will carry out maintenance on electrical equipment and are more likely to be exposed to live electrical contacts.

We cannot directly sense electricity, so we have to rely on *safe systems of work*. Here are a few simple, practical definitions that will help with the rest of this segment.

ELECTRICITY BASICS

Electricity is a form of energy, and like all forms of energy it can be turned into heat. Most electric shock damage is a form of burning, either surface burning to the skin or the more serious burn damage to internal organs that is often fatal.

Voltage and Current

The amount of energy carried by electricity depends upon both the voltage and the current.

The higher the voltage of the electricity the greater the shock you will receive. It is easily possible to receive a shock of thousands of volts and suffer no real injury. The shock from static electricity will make you jump, and it should, as it is often more than 2,000 volts. But as it has almost no volume or current then it cannot do much harm.

Let's look at two electric motors and see how they differ. The starter motor on my car operates at 12 volts. At that voltage the electricity cannot travel through my body so I am perfectly safe touching the positive terminal on my battery.

When I operate the starter motor the thick copper wires will carry a very large current (as much as 100 amps) at 12 volts to allow the motor to turn over the engine on my car. Starter motors are powerful and the wires that connect them are as thick as my little finger.

Another powerful electric motor is the one in my vacuum cleaner. This motor operates at 240 volts and uses about the same amount of energy as the starter motor. Because the voltage is about 20 times more, the current can be 20 times less than needed by the starter motor.

There are two other important differences to consider. Firstly, as the vacuum cleaner needs much less current (around 5 amps) to work, the wires connecting it can be much thinner. This is very useful for a portable device.

The other difference is that 240 volts will find it much easier to travel though my body than the 12 volts did. So I would get quite a jolt from the live contact on the vacuum cleaner motor.

It doesn't take a lot of current to cause damage to the human body, as the following table shows. These currents are at 240 volts.

Current	Typical Effect
Less than ½ mA[♣]	No sensation
Up to 2 mA	Slight tingle
Up to 10 mA	Painful shock
Up to 25 mA	Muscles clamp tight
Over 50 mA	Heart failure possible
Over 100 mA[♠]	Death

NB: it takes 1000 mA (milliamps) to make 1 amp. The 'weakest' fuse you are likely to find in a plug is 3amp or 3,000 mA !

It is worth noting that time is an important factor in the amount of damage done by electricity.

Even large currents (100mA) need time to do damage to the body and if the current can be cut off quickly enough then the shock need not be fatal.

Insulation and resistance
Resistance is a way of measuring how hard it is for electricity to travel though a material. Metals have low resistance which makes them good at conducting electricity. Most plastics and rubber have high resistance which makes them good insulators.

The purpose of an insulator is to provide a barrier between us and the electricity. As you can see from the table of currents above, insulation and resistance are very important if we are to remain safe around electricity.

Now that we have some idea of what is meant by voltage, current, insulation and resistance, we can move on to look at electrical safety in the workplace in more detail.

ELECTRICAL SAFETY

There are a several different ways of maintaining electrical safety in the workplace. Almost all of them rely on keeping the electrical current and us separate through the use of insulation.   When this fails to be enough, we have to rely on systems that shut off the electricity. In high risk areas where coming into contact with a live contact is possible, then we may use lower voltages as a safeguard against serious injury.

Let's look at the various hazards associated with electricity in more detail.

Electrical hazards and risks
Shock is the most obvious hazard we associate with electricity. As I said earlier, the

♣ This is half of a 1000th of an amp. My starter motor uses 200,000 times more current!
♠ My vacuum cleaner uses 50 times as much current as this.

higher the voltage, the more powerful the shock will seem.

Electric shock can happen if you come into contact with an electrical conductor carrying electricity. In this case, the contact is said to be a **direct contact**, as you come into contact with something that is supposed to be carrying electricity.

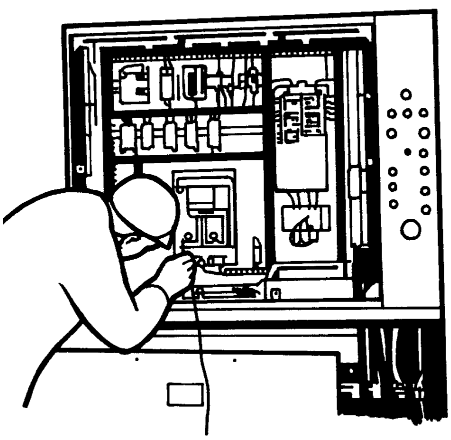
Electric shock can happen if you come into contact with something that is electrically live by accident. For example, if there is a short circuit or other fault in a piece of equipment and the outer case of the equipment starts to conduct electricity. In this instance the contact is an **indirect contact**.

Burns are another hazard of electricity. Arcing and flashover – when voltages are high enough the electricity can jump a small air gap and flash over, producing a spark or electrical arc.

A third hazard of electrical faults is **fire** or even **explosion**. Electric motors and wiring that are overloaded – perhaps because of a fault – can overheat and cause a fire. Electric sparks from motors, switches or faulty equipment can cause an explosion in certain circumstances. That's why if you smell gas at home (or anywhere else for that matter) you should not switch lights on or off, or use any electrical equipment that could produce a spark and cause an explosion.

Three steps to electrical safety
There are three simple steps to be taken to ensure that all of your electrical equipment and systems are safe to use and represent no significant risk to you or anyone else.

Step 1 - Selection
Make sure that the equipment selected for use is appropriate to the working conditions in which it will be used. This will include qualities such as the insulation, voltage, power rating etc. If the equipment is to be used in damp or wet environments then it must be rated as capable of operating safely in these environments. The electrical safety rating of tools and equipment is the ***'IP'*** rating.



Step 2 – Installation
When equipment is installed, it should be installed by a competent electrician, who will ensure that the installation meets all necessary safety standards, and will test the safety of the equipment before 'signing off' the work.

Step 3 – Maintenance
Again, this is something that should only be done by a qualified and competent person. Maintenance includes the regular (often annual) and routine checking of electrical equipment, particularly portable appliances. All portable appliances should be visually checked before use.

Maintenance will include the regular testing of safety devices such residual current devices (RCDs) fitted to some pieces of equipment and to all modern electrical supplies.

Portable RCDs are available to protect individual tools and equipment. Other safety devices such as cut off switches etc should also be tested on a regular basis.

If these three steps are followed carefully then there is only one other thing that needs to be done to ensure general electrical safety.

Anytime and every time that you or anyone else notices a fault it should be reported. This could include electric cable that is becoming damaged, covers of machinery that are damaged or loose, switches that work intermittently, in short anything out of the ordinary.

Apart from this being common sense, you have a legal responsibility to report anything that could lead to a failure of health & safety, and a faulty piece of electrical equipment certainly falls into this category.

GOOD WORKING PRACTICES

Common Sense

Everyone who uses and operates electrical equipment at work has a moral and legal responsibility to use it in a reasonable and common sense manner. If the equipment is not working properly then it is either faulty or nor being used correctly. In each case expert help should be sought.

Well maintained and tested

Keep equipment in good working order. Avoid damage to cables, cases and switches.

Permanent installations should be tested at least every five years, or more frequently if required. Ensure testing is carried out by a qualified person and is certificated.

Portable equipment requires more frequent testing. Visual checks should be carried out every time the portable equipment is used.

Appropriate voltage and safety devices

Equipment can be **reduced voltage** – 110 volts – as this provides some protection against fatal shock.

Equipment can be **extra low voltage** – less than 50 volts - as this is thought to be inherently safe. Sometimes this type of equipment is called SELV or Safety Extra Low Voltage equipment.

Residual Current Devices – may be found on the electrical supply and can be fitted to extension leads etc. The **RCD** will protect a person from a fatal electrical shock by rapidly shutting off the power if a fault develops.

Earth Protection. Connecting the outside of equipment (case for example) to the earth connection of the electrical supply allows a fuse to be used as a safety device. If the equipment develops a fault then electricity should flow to earth and this should blow the fuse and shut off the supply. If equipment keeps blowing a fuse then find out what the fault is, don't simply put a larger fuse in.

On its own a fuse is not a proper safety device – it is designed to protect the wiring, not you. It is perfectly possible for you to receive a fatal electric shock without blowing the smallest fuse used in equipment or tools. However, it is important to have the correct fuse fitted to all items of equipment as this will protect against overloading and earth faults and can protect against fires caused by wiring faults.

Electrical Insulation protection
PVC is the material that covers most, if not all, electrical wires. It is a very good insulator for most of the voltages used in industry and, except where higher temperatures are to be found, it is perfectly adequate.

Enclosing the live parts of equipment in an insulating body is another effective way of ensuring safety. Many appliances are doubly insulated for added safety.

Double insulation is the commonest way of ensuring most domestic appliances are safe. However, this form of protection is not usually available for equipment used in the workplace in most seafood processing factories, where the equipment is made to withstand hard knocks and damp/wet conditions. In these circumstances enclosed waterproof motors and effective earth protection are the main ways of ensuring electrical safety.

Sometimes it is not possible to insulate the live conductor. The overhead power lines that carry electricity at high voltages are not insulated, instead they rely on remaining out of reach to remain safe. It is only when these cables reach the pylons that an insulating connector is used to support them.

Portable Tools and Appliances
Portable appliances present particular risks to users as there is little control over where they are used and they are often abused. Here are some things to do and a few to avoid.

Dos	DO NOT
Treat with care. Carry out user checks before use. Carry out other equipment-specific checks. Keep clean and store correctly. Use the right tool for the right job. Use a RCD whenever possible. Use ear, eye and mouth protection when appropriate. Always fully unwind an extension lead cable to avoid overheating in use.	Damage cable by dragging, cutting abrasions etc. Strain joints and connections. Service equipment without disconnecting first. Use without checking safety – visual user checks. Use faulty tools. Leave exposed to weather or damp conditions. Adjust, repair or maintain tools unless you are competent.

♦ Typical *User Checks* for Portable Appliances - An informal check by the user before using. User should check for:

- cable damage and plug damage;
- poor joints – taped joints for example;
- poor cable security to plug or appliance;
- casing damaged or partly missing;
- evidence of overheating;
- evidence of contamination – oil, water, paint etc.

More formal checks by an appointed person (the *appointed person visual checks*) can be carried out and recorded by a suitable person. These checks are the same as the *User Checks* and will also include removal of the plug casing so the fuse rating and connections can be checked

Other ways of improving electrical safety which are particularly appropriate for workplaces include **Isolation** and **Permits to Work**.

Isolation

This is not merely switching off an item of equipment at the socket. It involves the physical removal of a link in the supply chain. Perhaps the removal of fuses, the unplugging of a supply cable or the operation of an isolation switch.

To ensure that someone else does not reconnect the electrical supply while the machine is faulty or being maintained, isolation will need to be supported by some or all of these:

- a warning notice explaining the equipment is not to be reconnected;
- an isolation switch that is padlocked in the off position;
- the removed fuses are kept by the maintenance engineer;
- permits to work.

Permits to Work

Briefly, a permit to work system is a formal way of ensuring that everyone who needs to know that an item of plant or equipment is to be shut down is informed. The permit to work will also state what steps are to be taken to make the workplace safe for whatever work is intended and may also highlight the hazards involved in the planned activity.

Permits to work are generally used when essential work is to be carried out which presents risks unless the hazards are carefully controlled. Permits to work may be used for maintenance work, cleaning, for entry into confined spaces and many other activities in the seafood manufacturing sector. Permits to work are much less common outside of the manufacturing industry and factory environment.

On the whole, most seafood processing companies have excellent records relating to electrical hazards and risks, mainly due to general recognition that wet conditions offer the potential for danger – there are generally no feelings of complacency!

The rules to follow are simple.

- Use of isolator switches and power cables that can be isolated.
- Specially designed socket outlets.
- Plugs should be doubly insulated.
- Cable should be armored or installed in conduit.
- Cables should be regularly inspected, maintained and replaced when necessary.
- All equipment and plant regularly maintained.
- Main switches are accessible and clearly identified.
- Everyone informed of emergency procedures in event of shock etc.
- Portable electrical equipment should be used from a safety isolating transformer, or connected through a residual current device.
- Portable equipment should be User Visual Checked each time it is issued/used.

DEALING WITH ELECTRIC SHOCK

When all our safeguards and procedures fail and someone is involved in an electrical accident we need to know how to react and deal with an electric shock victim.

Each critical action is marked by a ➲ and may be followed by an explanation or more detail.

Critical Actions in dealing with electric shock

➲ Do Not Touch the victim until the current is switched off.

You must not become a victim yourself. Your safety is vital if the victim is to survive.

➲ Switch off the current and raise the alarm.

Shout so that others are aware of the incident.
Keep shouting until others respond to your calls
Switch off the current at the source.
If this cannot be done then try and prise the victim away from the electrical contact by using a **non-conducting** lever
(plastic or wooden tool – broom handle for instance).

➲ Once you and the victim are safe from further shocks attempt recovery.

Airways – check their airway is unobstructed –have they swallowed their tongue?
Check victim's breathing, if not breathing start mouth to mouth resuscitation.
Someone should call the emergency services.
Continue mouth to mouth until relieved by a professional.

➲ If the victim starts breathing before professional help arrives then place them in the recovery position.

➲ Continue to monitor the breathing of the victim until professional help arrives.

Victims of even a mild shock can collapse some time after the incident. Any accident that causes unconsciousness (even for the shortest time) is serious and an ambulance should be called.

CONCLUSIONS

The Health & Safety Executive reports that three quarters of all reportable electrical accidents involved fixed plant and equipment, while a quarter involved portable appliances.

Most injuries are due to shock, but many involve burns from arcing and fires.

Typical hazards leading to accidents involve faulty flexible cables, extension leads, plugs and sockets. Hazards associated with fixed plant include faulty earth protection leading to touching a conducting surface which is live under fault conditions, missing or damaged guarding/casing and exposure to live parts during repair and maintenance.

Complacency appears to be a significant contributor to accidents.

SUMMARY

This segment deals with electrical safety and demonstrates the vital importance of using competent persons to install, test and maintain electrical equipment. The nature of electrical faults was examined and the key role of immediate fault reporting in maintaining electrical safety explained.

The use of insulation, reduced voltage, residual current devices, regular checking and maintenance and the use of equipment earthing and fuses to deliver electrical safety was explored.

The key actions in treating a victim of electric shock are to do all possible to save the victim without becoming a victim yourself. If you have done a first aid course you will remember ABC, Airway, Breathing, Cardiac (heart).