

# EMERGENCY PERSONNEL

Electrical Safety



# CONTENTS

## Electrical Safety

1. Electricity – Some Basic Facts . . . . .	2
2. Injuries Caused by Electrical Shocks . . . . .	6
3. Fallen Power Lines . . . . .	10
4. Trapped in a Vehicle by a Fallen Live Wire. . . . .	12
5. Problems Related to Kiosks . . . . .	14
6. Water and Electrical Fires . . . . .	15
7. Electrical Facilities and Wildfires. . . . .	15
8. Substation Fires . . . . .	16
9. Unauthorized Persons in Substations . . . . .	17
10. Fires and Explosions in Underground Electrical Vaults . . . . .	18
Emergency numbers . . . . .	22

# Safety Guidelines for Emergency Personnel

## How to cope with electrical hazards in rescue and fire situations

The information in this booklet is provided to assist police, fire, ambulance and emergency response personnel in emergencies involving electrical facilities before the arrival of SaskPower personnel.

SaskPower does not warrant the accuracy or completeness of the information and shall not be responsible or liable to any person in respect of loss, damage or injury resulting from the application of, reliance on or the misapplication of any of the emergency techniques described in this handbook.

For additional public safety information, please visit [saskpower.com/safety](http://saskpower.com/safety).

# 1 ELECTRICITY - SOME BASIC FACTS

While it's true that electricity always seeks the easiest path to the ground, that's not the only path it takes. Electricity takes every path to the ground, whether it comes from a household lighting circuit, a high power transmission line or lightning.

If a person touches two energized wires or touches an energized wire and the ground at the same time, he or she will become part of an electrical circuit, and may be killed or injured.

## **Electrical Installations**

Electricity is generated by power plants at voltages ranging from 2,300 to 20,000 V (volts). This voltage is stepped up for efficient transmission over long distances to switching stations. Some transmission lines operate as low as 72,000 V, others as high as 230,000 V.

At the switching stations, voltage is reduced and power is sent on distribution lines to industrial, commercial and residential customers.

Power plants, substations, underground vaults and other SaskPower installations differ greatly from other buildings. They present unusual hazards to emergency personnel that can endanger their lives. Emergency personnel entering any of these facilities will not be familiar with the surroundings and must use specialized techniques to ensure personal safety. Good communication and co-operation between SaskPower and emergency response agencies is crucial.

## **Common Electrical Terms and Definitions**

Many electrical terms that describe how electricity travels can be

likened to the passage of water. **Voltage** is similar to water pressure. It is the force that causes the flow of electricity. **Current** can be likened to the rate of flow of water in a pipe. **Resistance** is similar to the effect of friction on the flow of water in a pipe (water flows more freely in a large pipe than in a small one.)

Different materials have different resistances to the flow of electricity. Very high resistance materials are called **insulators**, while the low resistance materials are called **conductors**.

In an electrical system, the force or pressure is measured in volts and the current flow in **amperes (amps)**. Resistance is measured in **ohms**.

## **Insulators, Conductors and Semi-Conductors**

All materials conduct electricity in varying degrees. Materials classified as insulators conduct electricity in such small quantities it cannot normally be detected. On the other hand, materials classified as conductors conduct electricity readily in large amounts.

To cite two examples: Glass is an insulator. Metal is a conductor.

Some other materials are classified as **semi-conductors**. These include water, wood, earth and rubber tires. Depending on conditions, such as moisture content and contaminants, **semi-conductors** can conduct large amounts of electricity.

## **Low-Voltage Hazards**

Most electrical fires originate in equipment operating below 750V. In the electricity industry, this is referred to as low voltage. Home heating systems and home appliances operate at 240V or less. Although the hazard is greater with high voltage installations, it is important for emergency personnel to realize the hazards of even relatively low voltage.

## Voltage Gradient on the Ground Surface

Because electricity always takes every available path to ground, electrical systems use conductive grounding rods to ensure that any stray electricity is returned to earth safely. These rods are driven about 2.5 m (eight feet or more) into the ground to ensure deep dispersal of the current. However, if electricity is released into the ground surface, such as when a live wire lies on the ground, the electricity will fan out from the point of contact.

There is a rippling effect that can be likened to dropping a pebble into calm water. In the pool of water, the wave created at the point of contact gets smaller as it rings out. Similarly, in this pool of electricity, the energy is at full system voltage at the point of ground contact, but as you move away from the contact point, the voltage drops progressively. This effect is known as **ground gradient** – and a knowledge of how it works may someday save your life.

## Step Potential and Touch Potential

The ground gradient, or voltage drop, creates two problems known as step potential and touch potential.

Let us assume that an electrically charged wire is touching the ground and has created a pool of electricity. If you were to place one foot near the point of ground contact (at x voltage) and your other foot a step away (at y voltage), the difference in potential (voltage) would cause electricity to flow through your body. This effect is referred to as **step potential**. (See illustration #3 - next page.)

## Faulty Electrical Equipment

It is obvious that electricity is safe when it's properly controlled. However, hazards are created when electrical equipment or wires have become faulty as the result of being:

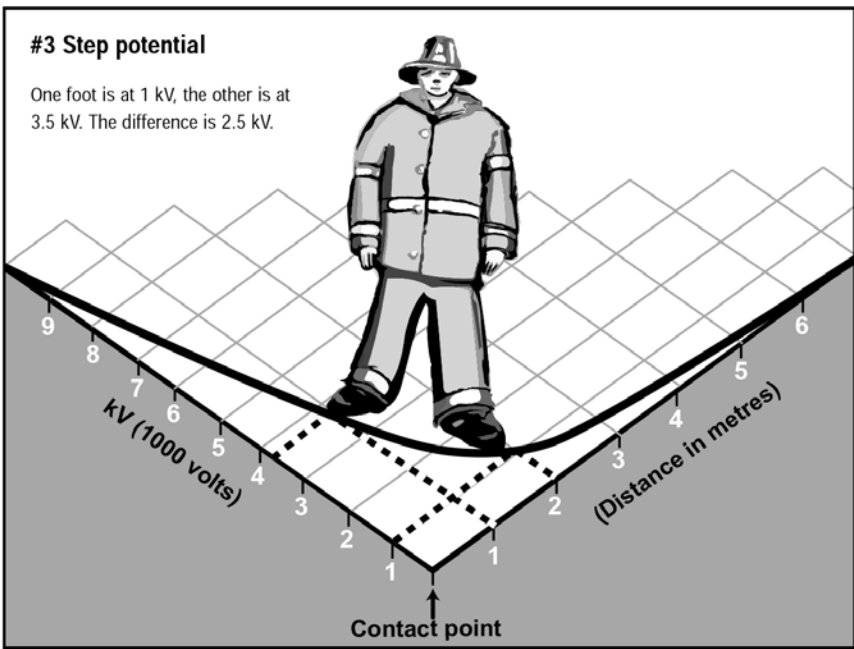
- worn out or deteriorated,
- improperly installed,

- improperly maintained,
- damaged or broken.

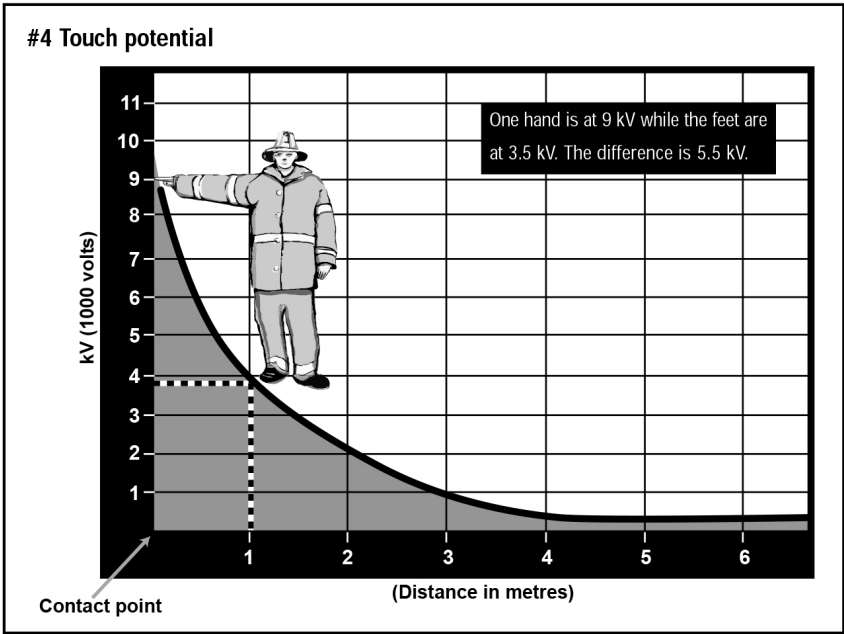
Any one of the above may cause arcing or overheating of electrical equipment – the two conditions that cause the majority of electrical fires.

An electrical arc is a sudden flash of electricity between two points of contact. An arc is extremely hot, and can ignite combustible material in the vicinity, including some insulation materials around the conductor. Hot material may be thrown into adjacent flammable material, starting a fire.

The majority of fires caused by overheating result from overloading electrical conductors and motors. When the amount of current exceeds that which conductors and equipment are designed to carry, dangerous situations are created.



If your feet were both at an equal distance from the source (both at x voltage) and you place your hand on an energized source, electricity would flow through your body. The difference in voltage in this case is referred to as **touch potential**. (See illustration #4.)



## 2 INJURIES CAUSED BY ELECTRICAL SHOCKS

### Effects of Electricity on the Body

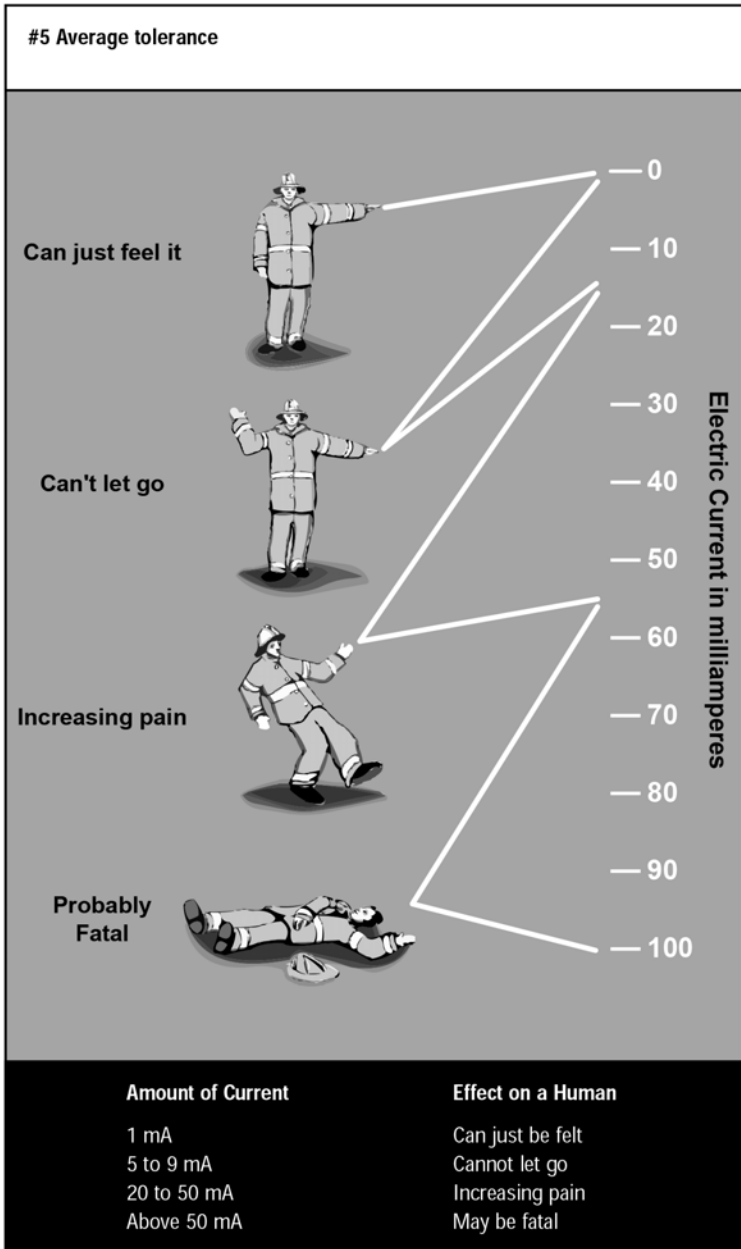
The effect of electricity on the body is dependent on the amount of current and the length of time the body is exposed to it. The higher the current, the less time a human can survive the exposure.

The path of electricity through the body is also critical. For example, current passing through the heart or brain is more life-threatening than current passing through the fingers.

Most common household currents are one to two amps.



For example, it takes approximately one amp of current to run a 100-W light. That's 1,000 milliamps (mA) and even a fraction of that for a few seconds or more can be fatal. (See illustration #5.) Here are the effects you can expect from just a few seconds of current.



It is the amperage that kills or injures. But the voltage, which pushes the current through the body, also has an important effect.

When a person is exposed to household voltages, he or she may suffer a muscle spasm and become locked onto the electrical source until the circuit is turned off, or until the victim falls clear from the weight of his or her body. Relatively long periods of contact with low voltage are the cause of many electrical fatalities in the home.

At very high voltages (on power lines, for example), the victim is often quickly blasted clear of the circuit. This may result in less internal damage, but terrible surface burns at the entrance and exit points of the current.

A person exposed to a large electric arc can be injured by the intense heat or by ultraviolet rays which can cause serious eye damage.

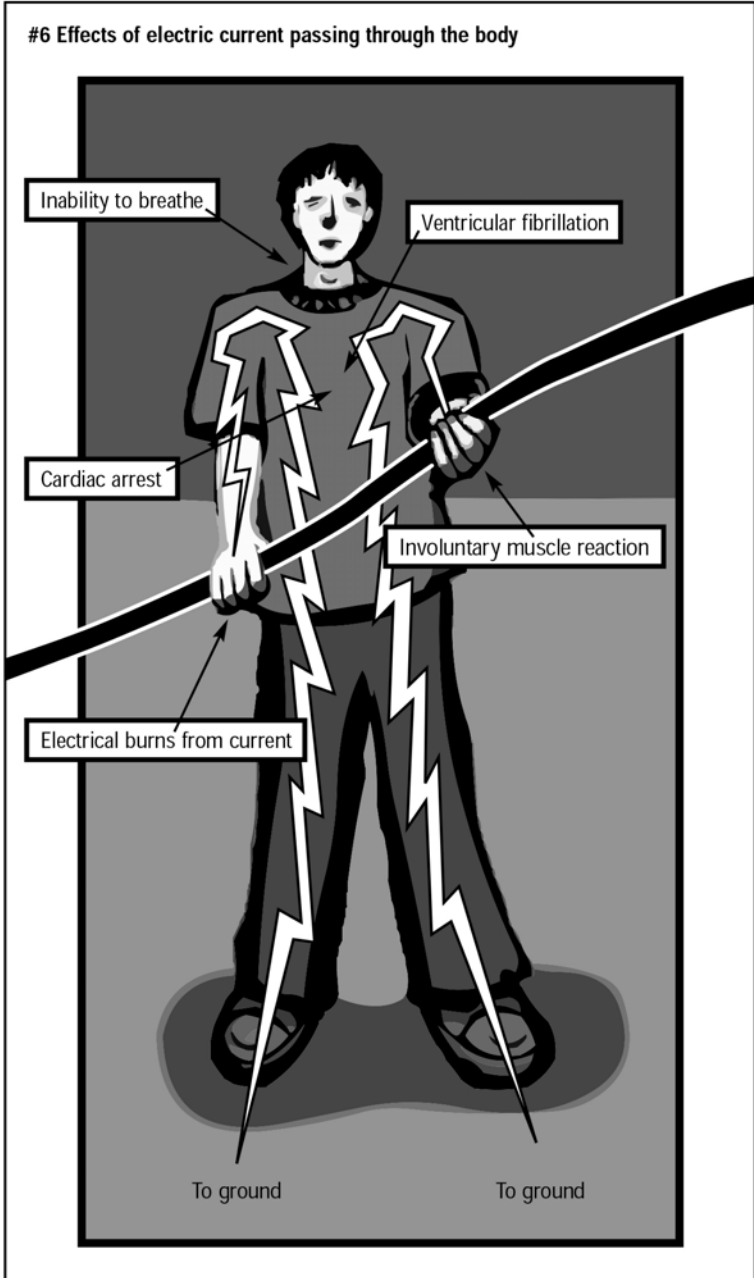
The effect of electricity on the body also depends on the condition of the skin, the area of skin exposed to the electrical source and the pressure of the body against the source. Severity of the shock will be increased if the electric current touches moist or broken skin.

Any victim of electrical shock should be examined for the following effects on the body:

1. cardiac arrest;
2. temporary paralysis of the respiratory centre, causing breathing failure;
3. ventricular fibrillation of the heart (mainly resulting from lower voltages);
4. burns to tissue at the current entrance and exit points (mainly resulting from higher voltages);
5. fractures caused by muscle spasm. (See illustration #6.)

Keep in mind that the **danger must be removed** before any treatment can be given to the patient. In some cases, the circuit can be turned off; in other cases, it cannot.

Electricity always seeks every available path to ground. If you touch an energized wire and the ground at the same time, you may be killed or injured.



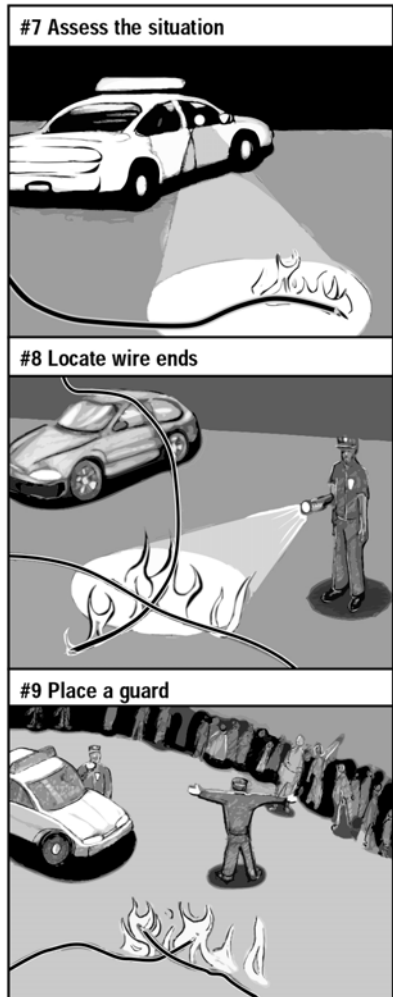
# 3 FALLEN POWER LINES

Electrical distribution wires may be broken by storms and ice, or as the result of vehicles striking power poles.

If, during your work, you come across broken or fallen wires, do not expose yourself to needless risks while trying to eliminate the danger. **Always assume that the wires are energized and capable of injuring or even killing people.** Inform SaskPower personnel and a representative will be sent to remedy the situation.

## Action to be Taken on Arriving at the Scene

1. Assess the situation before getting out of your vehicle. Make sure you are parked well away from fallen wires. At night, use a flashlight to examine the surroundings carefully from the car or truck window. If you are parked over or near the fallen wires, move your vehicle out of harm's way. (See illustration #7.)
2. Locate all wire ends. Always assume fallen power lines are live, whether they are on the ground or hanging in mid-air. If a live wire touches a vehicle, or any other object made of metal, that object will be



capable of killing people. So will a pool of water if a live wire has fallen into it. You must supervise the public to prevent any contact with energized objects. (See illustration #8.)



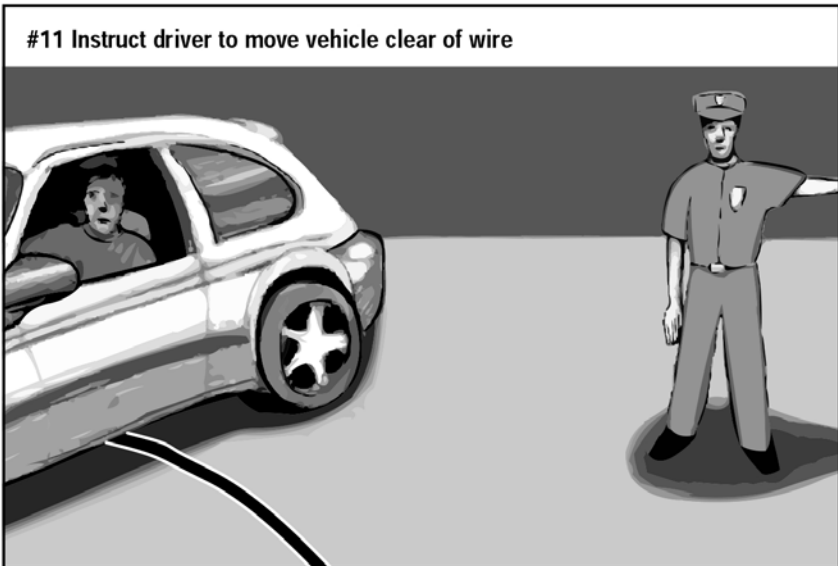
3. Place a guard around the danger zone and call SaskPower for help (See illustration #9.)
4. Keep people away from the broken or sagging wires or other electrically charged objects. Live wires in contact with objects on the ground may burn through, and one end may then curl up or roll along the ground causing injury. (See illustration #10.)

If a wire has fallen on a metal fence or other metal object, electricity may be conducted to other points. In fact, the ground itself can be energized to a dangerous level near the fallen wire.

5. Wait for SaskPower to arrive – do not attempt to move fallen wires.

# 4 TRAPPED IN A VEHICLE BY A FALLEN LIVE WIRE

Wherever possible, SaskPower personnel will handle these situations. However, if SaskPower personnel are not yet on the scene, use the following guidelines for these emergency situations:



Situation 1 – A fallen wire lies under a vehicle, with one or more people inside.

## Action

- If the driver is unhurt and can move vehicle (See illustration #11.)

Do not touch any part of the vehicle. (You could be electrocuted.)

Instruct the driver to move the car away from the wire, providing no further system damage will occur. Make sure you and all onlookers are in a safe place. When the vehicle moves, the wire may spring up.

Situation 2 – A fallen wire lies across a vehicle with one or more people inside.

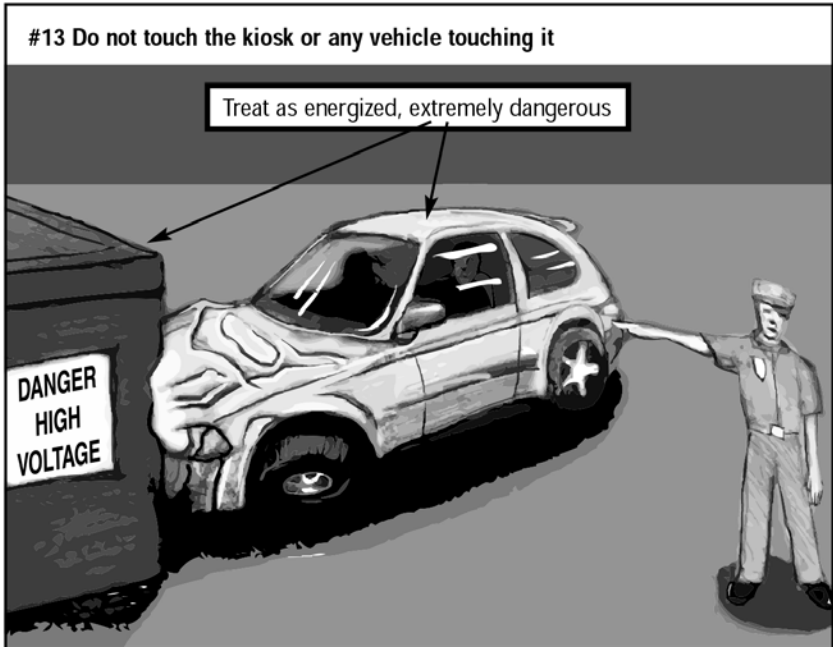
### Action

- If the driver is injured and cannot move his vehicle. Instruct the driver to stay in place until the SaskPower crew arrives.
- If occupants are uninjured but the vehicle has a fire which cannot readily be extinguished, and the vehicle cannot be moved (See illustration #12.) Instruct the occupants to get out by a standing jump. Tell them: “Keep your feet together as you jump. Do not touch the car and ground at the same time. Continue to hop or take short, shuffle steps away from the car.” This can be very dangerous and should only be used as a last resort.



# 5 PROBLEMS RELATED TO KIOSKS

Kiosks are metal boxes, installed at ground level, which protect underground electrical installations.



## Situation

- A kiosk shows evidence of being tampered with, such as hacksaw marks or severe dents.
- A kiosk is damaged in a vehicle accident. (See illustration #13.)

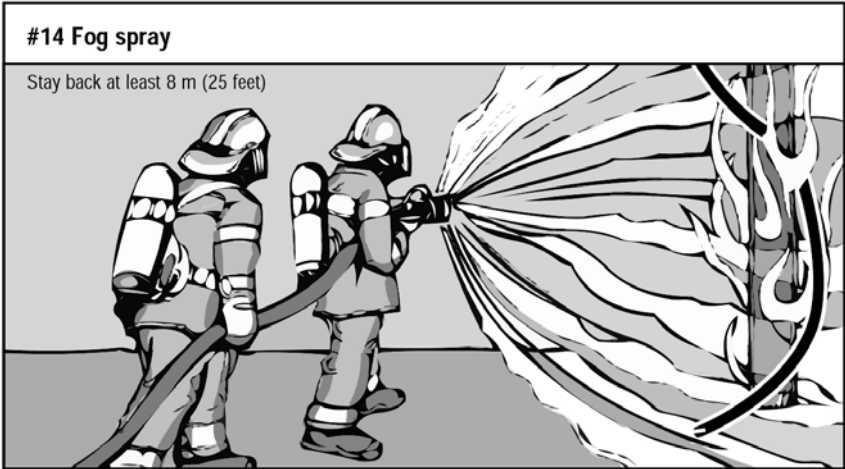
## Action

Call SaskPower with details of the location.

Do not touch the kiosk or any vehicle that may be touching the kiosk. Treat it as an energized object. Instruct the driver to move the car away from the kiosk if possible. If not, warn occupants to stay in car. Call SaskPower.



# 6 WATER & ELECTRICAL FIRES



## Situation

- Broken wires are tangled around a power pole, creating arcs and setting the pole on fire. (See illustration #14.)

## Action

Douse the fire with a mist/fog spray. Do not shoot a steady stream of water on an electrical fire, conductor or apparatus unless under the direct supervision of SaskPower personnel.

# 7 ELECTRICAL FACILITIES AND WILDFIRES

Most rural farms, acreages and rural businesses are dependent on electricity for the operation of fire suppression equipment such as water pumps. When a forest, bush or prairie fire occurs in areas where electrical lines and facilities will be affected, SaskPower will

attempt to keep the power lines and facilities live after ensuring it is safe to do so. If necessary, SaskPower will facilitate shutdowns; however, always assume that the power is still on – never assume that it is not live.

**Situation**

**Action**

- A grass fire erupts and engulfs a transformer.

Douse the fire with a mist/fog spray, not a steady stream of water. Stay at least 8 m (25 feet) away until consulting with SaskPower personnel.

# 8 SUBSTATION FIRES

Substations contain large quantities of oil, energized electrical equipment and, in some cases, cylinders of compressed gas.

On arriving at a substation fire, emergency personnel should be prepared to protect adjacent properties. SaskPower will advise when the substation has been made electrically safe. Emergency personnel can then proceed with conventional firefighting equipment.

If a SaskPower representative is not present when the firefighter arrives, contact the utility to make sure one has been dispatched.

SaskPower representatives are familiar with the substations they serve and can identify the areas that are electrically safe.

## Conservators

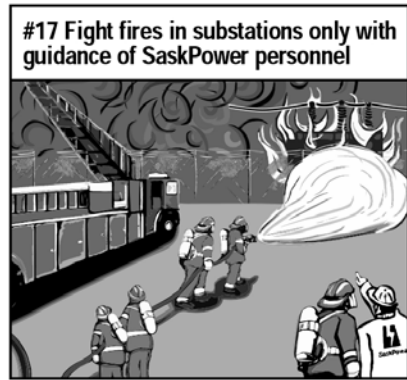
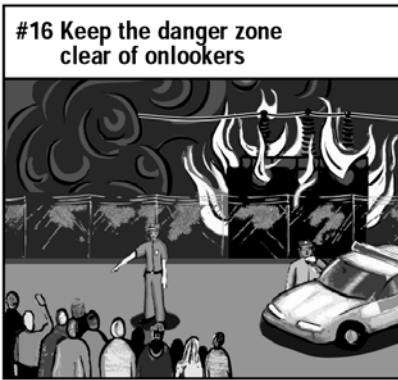
These large tanks located at the top of transformers allow for expansion and contraction of the oil when the transformer is carrying load. There will be no large build-up of pressure, but if one of these tanks were ruptured, it could provide a large supply of fuel in the event of a fire.

## Situation

- You have been called to a substation fire. (See illustrations #16 & #17.)

## Action

Do not enter the substation. Keep the danger zone clear of onlookers. Do not spray the fire with water or any other liquid. Await the arrival of SaskPower personnel to shut off the power and give you guidance.



# 9 UNAUTHORIZED PERSONS IN SUBSTATIONS

Another dangerous situation arises from people playing around electrical installations and equipment.

## Situation

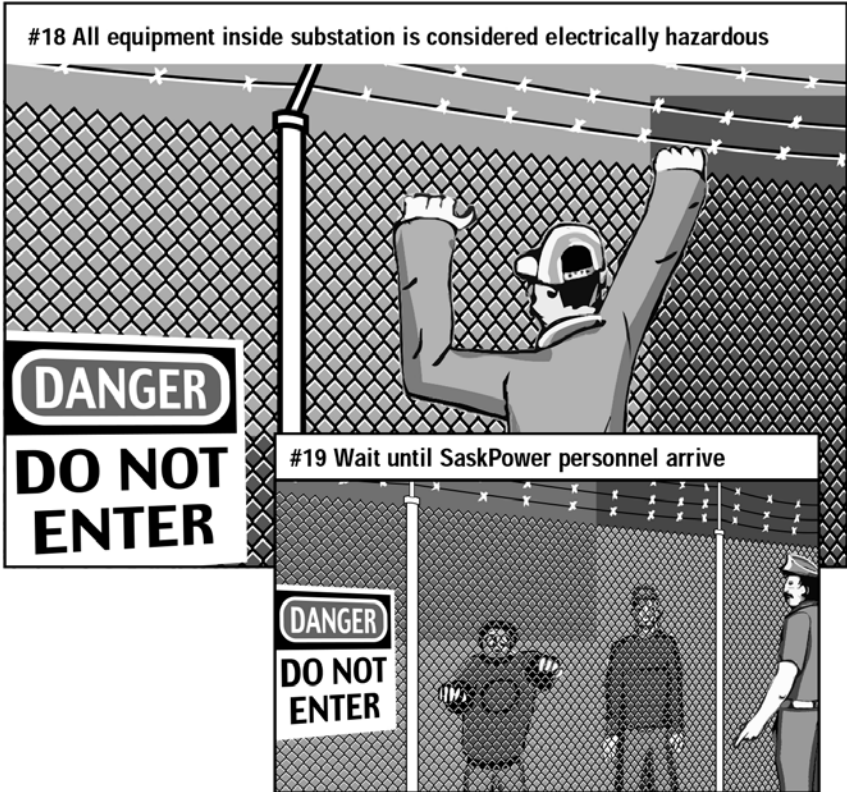
- People are seen climbing over a fence into a substation. (see illustrations #18 & #19.)

## Action

Ask them to remain by the fence. Warn them of the danger and call SaskPower for assistance.

- If the person in the substation is injured.

SaskPower cannot be responsible for any action you might take without SaskPower's direct guidance.



# 10 FIRES AND EXPLOSIONS IN UNDERGROUND ELECTRICAL VAULTS

In high-density areas of every city, and in many residential subdivisions, electrical distribution wires run through cable tunnels located under the pavement.

Transformers and switchgear for these circuits are situated underground in concrete vaults, with access provided to each vault by a manhole.

Underground electrical systems are designed to withstand great stress. However, earth movement can crack the concrete walls of cable tunnels, as well as adjacent sewer pipes, natural gas pipes and water mains. Hazardous conditions can result, including accumulation of explosive and toxic gases, and dangerously high water levels.

Electrical failure of a cable may result in an explosion or fire, which could damage insulation and energize all metal parts within the vault.

Firefighters and police should consult their OH&S confined space rules and regulations for guidelines regarding rescue.

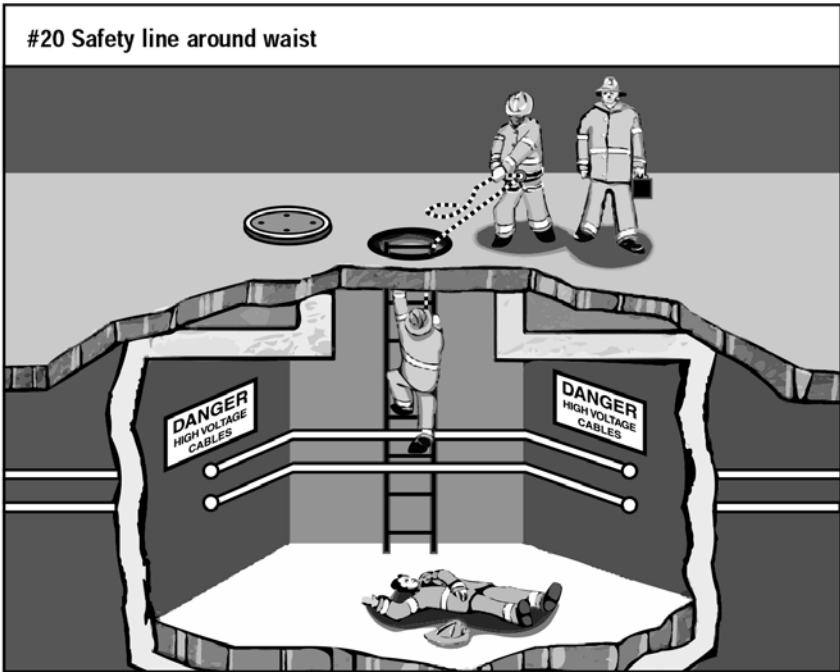
**Situation**

**Action**

- If a victim is lying unconscious at the bottom of an open manhole. (See illustration #20.)

1. Call SaskPower and indicate the location and number of manholes involved. Request assurance that the cable will not be energized.
2. If there is a fire in the hole use only non-conducting fire extinguishing substances.
3. Attach a non-metallic safety line.
4. Do not touch any electric components.
5. Give first aid and wait for help to remove victim.

6. Check air quality before accessing.
7. If monitor is not available utilize self-contained breathing apparatus (SCBA).



**Situation**

**Action**

- You have been called to the scene where smoke is escaping from the holes in a manhole cover.

1. Call SaskPower and give the location and number of manholes.
2. Stop traffic and keep the public at a safe distance.
3. Do not attempt to remove the cover. It may produce a spark and cause an explosion if gases are present.

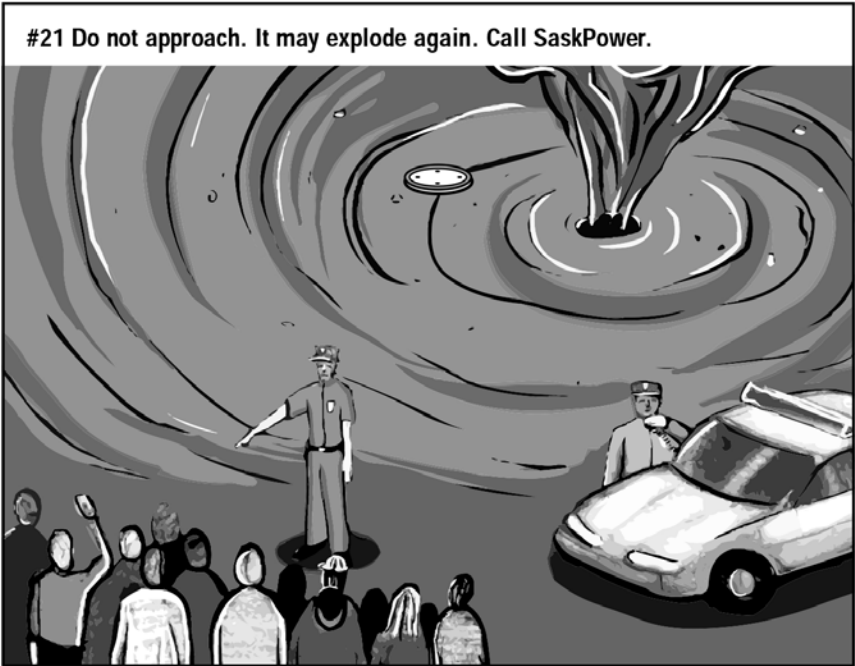
4. Maintain precautions until conditions have been evaluated.

## Situation

- You have been called to the scene of an explosion in the street. Manhole covers have been blown off their seatings. (See illustration #21.)

## Action

1. As above, but in this case you may have to identify or aid a victim. Approach an open manhole with caution. Beware! It may explode again.



# EMERGENCY NUMBERS

**Police/RCMP:**

---

**Fire:**

---

**Ambulance:**

---

**Hospital:**

---

**SaskPower: 310-2220** (report outages or power related emergencies)

**Safety, Environment and Security Care Line: 306-566-6200**

**SaskEnergy: 1-888-700-0427** (report natural gas smell or leaks)

**Occupational Health and Safety:**

- **Regina (South): 1-800-567-7233**
- **Saskatoon (North): 1-800-667-5023**









