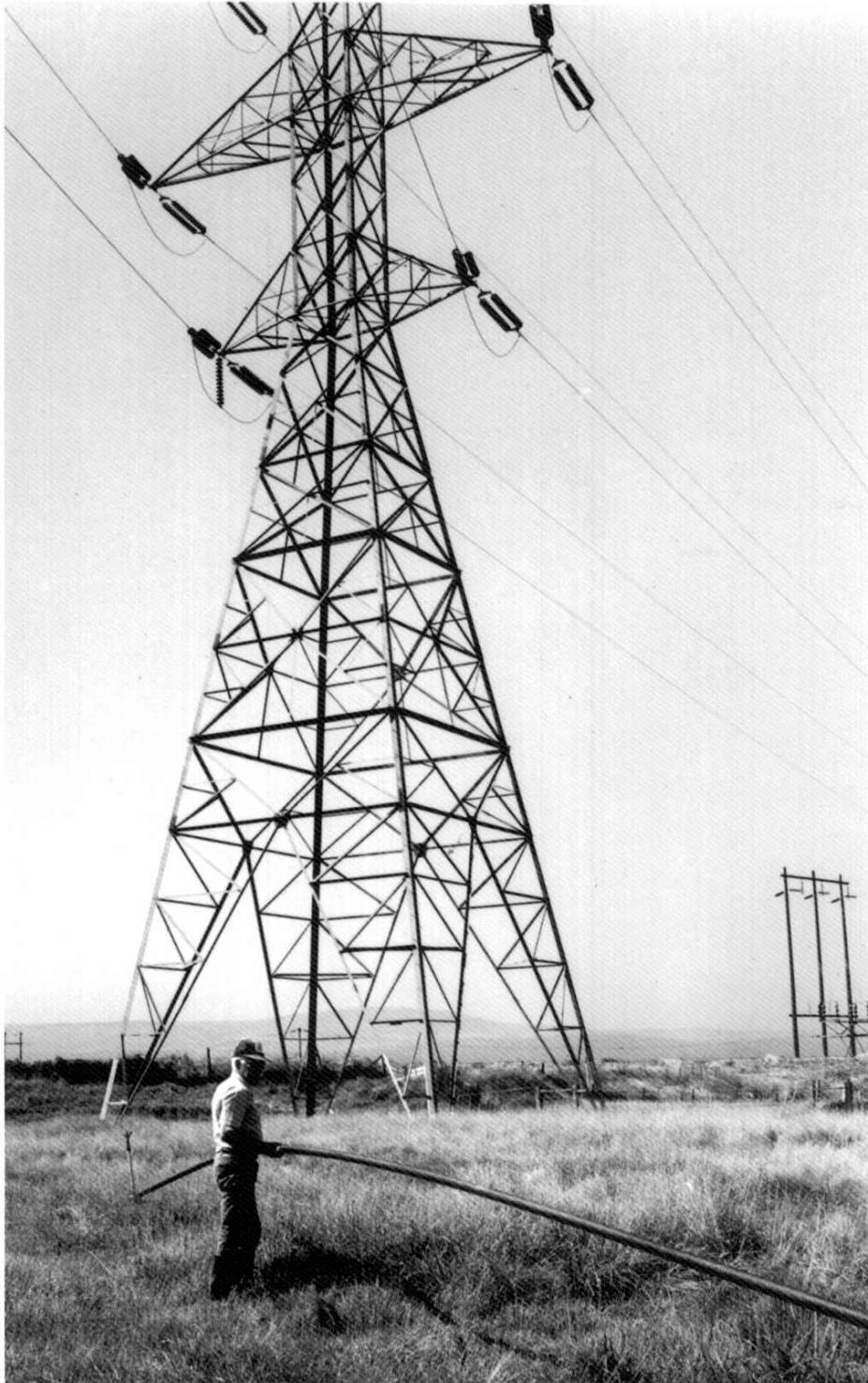

Appendix F Living and Working Safely Around High-Voltage Power Lines

JANUARY 1998

LIVING AND WORKING SAFELY AROUND HIGH-VOLTAGE POWER LINES



Dear Neighbor,

BPA, along with your local electric utility, is continually looking for ways to improve safety awareness and practices around electrical lines and equipment. We feel our efforts are best spent in reaching people like yourself – those most likely to be living and working around high-voltage power lines.

This booklet presents safe practices for work and recreation activities near high-voltage transmission lines. It documents and expands on information that has generally been available to the public.

Please take this opportunity to reacquaint yourself, members of your family, and others that use or have access to your property, with these safety precautions. If you have other questions, please feel free to contact your nearest BPA office (listed on page 1), or your local utility.

Thank you for taking the time to let us share how “working smarter” near power lines can save lives – even your own.

Sincerely,



FRED JOHNSON, CHAIRPERSON
Central Safety and Health Committee
Bonneville Power Administration

Table of Contents

- | | |
|---|--|
| 1 | BPA Regional Offices; Using the Easement;
General Safe Practices |
| 2 | Induced Voltages |
| 3 | Irrigation Systems |
| 5 | Underground Pipes and Cables |
| 6 | Wire Fences; Electric Fences;
Buildings; Vehicles |
| 7 | Lightning; Fires; Kite Flying and Model
Airplanes; Vandalism and Shooting;
Metal Objects; Climbing |
| 8 | Pacemakers; Trees and Logging; Explosives |
| 9 | Concerning Towers and Conductors;
Conclusion; Related Publications |

Preface

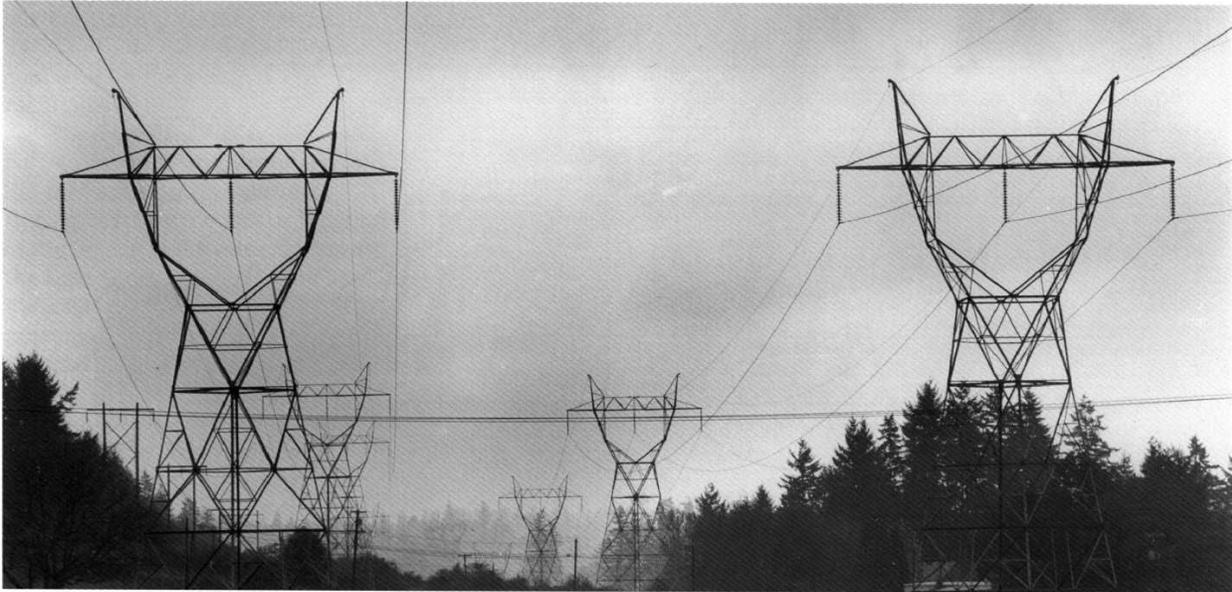
High-voltage transmission lines can be just as safe as the electrical wiring in our homes – or just as dangerous. The crucial factor is ourselves: we must learn to behave safely around them.

This booklet is a basic safety guide for those who live and work around power lines. It deals primarily with nuisance shocks due to induced voltages, and with potential electric shock hazards from contact with high-voltage lines. See last page for references on possible long-term biological effects of transmission lines.

In preparing this booklet, the Bonneville Power Administration has drawn on more than 50 years of experience with high-voltage transmission. BPA operates one of the world's largest networks of long-distance, high-voltage lines. This system has more than 400 substations and about 15,000 miles of transmission lines, almost 4,400 miles of which are operated at 500,000 volts.

BPA's lines make up the main electrical grid for the Pacific Northwest. The grid delivers large blocks of power to substations located near load centers. Public and investor-owned utilities and rural cooperatives take delivery of the power at these points and deliver it to the ultimate customers.

BPA's lines cross all types of property: residential, agricultural, industrial, commercial, and recreational. They traverse hundreds of miles of irrigated and non-irrigated farmlands.



If you have questions about safe practices near transmission lines, call the nearest BPA regional office listed below.

Due to safety considerations many of the practices suggested in this booklet are restrictive. This is because they attempt to cover all possible situations, and the worst conditions are assumed. Oftentimes, the restrictions can be tempered. To determine what practices are applicable to your case, contact BPA.

SNOHOMISH REGION

914 Avenue D
Snohomish, WA 98290
(360) 568-4962

OLYMPIA REGION

5240 Trosper Rd. S.W.
Olympia, WA 98512-5623
(360) 704-1601

EUGENE REGION

8600 Franklin
Eugene, OR 97405
(541) 465-6991

REDMOND REGION

3655 W. Highway 126
Redmond, OR 97756
(541) 548-4015

WALLA WALLA REGION

1520 Kelly Place
Walla Walla, WA 99362
(509) 527-6241

SPOKANE REGION

707 W. Main, Suite 500
Spokane, WA 99201-0608
(509) 358-7376

MONTANA REGION

2520 US Highway 2 East
Kalispell, MT 59901
(406) 755-6202

IDAHO FALLS REGION

1350 Lindsay Blvd.
Idaho Falls, ID 83402
(208) 524-8770

Using the Easement

Before a transmission line is built, BPA negotiates with the landowner for the right to cross the land as required for the construction, operation and maintenance of the line. Usually, BPA acquires easement rights to construct, operate and maintain a transmission line and the right to keep the easement clear of all structures, trees, brush, fire hazards and any other vegetation that may interfere with the operation or maintenance of the line. Almost all farm crops can be grown safely under transmission lines. Crops grown on trellises require special consideration. Call BPA before installing trellises.

Call the nearest BPA regional office if you plan to use the right-of-way for any use other than growing crops.

Ask for the *"Landowner's Guide to Use of BPA Rights-of-Way,"* which explains how to apply for permission to use a portion of a BPA right-of-way and easements for approved purposes.

Construction and maintenance of homes, sheds, machinery buildings or any other structures, are specifically prohibited within a right-of-way.

These arrangements also serve to eliminate possible hazards.

General Safe Practices

BPA designs and maintains its facilities to meet or exceed the rules set forth in the National Electrical Safety Code. BPA provides information on safe practices because serious accidents involving transmission lines can be avoided if simple precautions are taken. Every kind of electrical installation — from the 110-volt wiring in your home to a 500,000-volt transmission line — must be treated with respect.

The most significant risk of injury from a transmission line is the danger of electrical contact. Electrical contact between an object on the ground and an energized conductor can occur even though the two do not



Farm equipment or open large machinery 14 feet or less in height may be operated safely under all BPA lines in cultivated fields.

actually touch. In the case of high-voltage lines, electricity will arc across an air gap. The distance varies with the voltage at which the line is operated. Unlike the wiring at home, the conductors of overhead transmission lines are not enclosed by an electrical insulating material.

Injuries are more likely to result with lower voltage power lines (12,500 to 115,000 volts) than with higher voltage lines because contact is more likely. The electrical conductors of lower voltage lines are closer to the ground, smaller, and less noticeable. An injury from contact with a 12,500-volt line can be just as serious as that from a 500,000-volt line.

The most important safe practice is this:

Avoid bringing yourself, or any object you are holding, too close to an overhead line.

In other words, do not lift, elevate, build or pass under a transmission line any object, implement, facility or vehicle that could become near the energized conductors.

BPA does not recommend that anyone attempt to calculate how

close they can come to a transmission line. As a general precaution when under a line, never put yourself or any object any higher than 14 feet above the ground.

The National Electrical Safety Code specifies a minimum safe clearance for each operating voltage. BPA builds its lines so that the clearance between the conductors of a line and the ground meets or exceeds the minimum set forth in the code.

The minimum clearance to ground usually occurs midway between towers because the conductors sag. The clearance is usually greatest near the towers or poles.

Vehicles and large equipment up to 14 feet in height, such as harvesting combines, cranes, derricks and booms, can be operated safely under all BPA lines that pass over roads, drive-ways, parking lots, cultivated fields or grazing lands. The operators of equipment that can be extended, such as bale wagons, stack movers or cranes, should exercise extreme care when near a power line.

The 14 feet limitation is a general standard applicable in the worst possible situations. In some instances, it can be exceeded

without any problems. However, care must be taken since transmission lines sag, or droop, when they become heated. Having passed safely beneath a line in December with a piece of equipment higher than 14 feet does not automatically mean you can do so in July.

Instead of enumerating every situation or exception, we suggest, again, that you contact the nearest BPA regional office or your local utility, if you have need to exceed the 4-meter 14-foot limitation.

Induced Voltages

Under certain conditions, a perceptible electrostatic voltage can be induced on such objects as a large vehicle, a fence, metal building or irrigation system. This can happen when the object is near a high-voltage transmission line and is insulated from the ground.

When an induced voltage is present, touching a vehicle, wire fence, metal building or irrigation system can result in a sensation similar to the shock you may receive when you cross a carpet and then touch a door-knob. The static discharge from the rug is momentary. The sensation from a voltage induced by an alternating-

current power line is similar, but may continue to be felt as long as contact with the object is maintained.

The magnitude of an induced voltage depends on the voltage of the transmission line, distance from the conductor, size or length of the object, and its orientation to the line. Shocks caused by an induced voltage do not usually present a hazard; for this reason we refer to them as nuisance shocks. However, mitigation methods to remove the possibility of hazards are identified in sections of the booklet that follow.

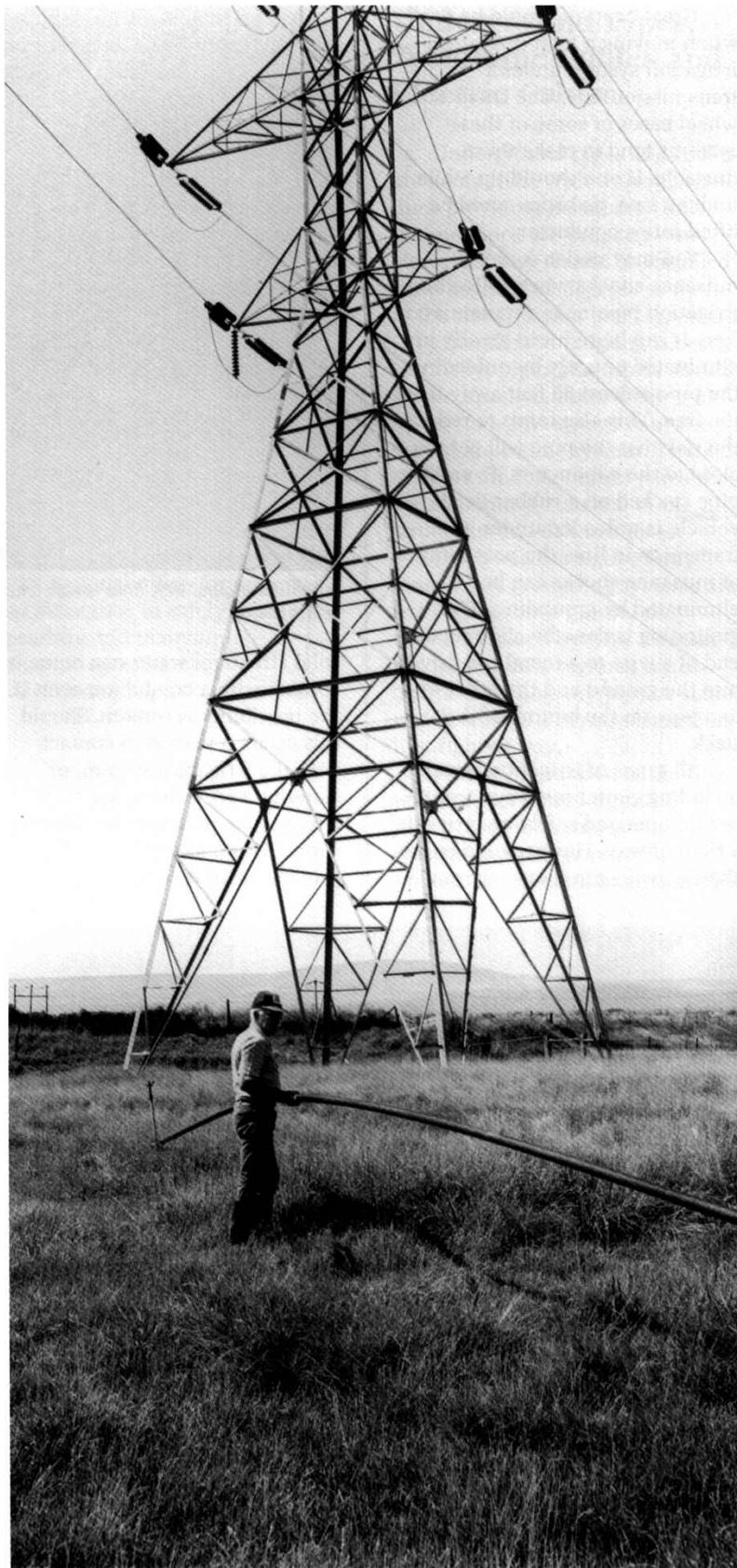
Irrigation Systems

All types of irrigation systems have been operated safely near BPA power lines for years. Nonetheless, caution should be used in storing, handling, and installing irrigation pipe, and in operating spray irrigation systems near power lines.

Irrigation pipe should be moved in a horizontal position under and near all power lines to keep it away from conductors overhead.

Again, we stress that the one critical hazard from overhead lines is the danger of bringing an object – in this case, a length of irrigation pipe – into close proximity to a conductor. One purpose of this booklet is to repeatedly make this warning.

As a precautionary measure, equipment used to install irrigation systems should be kept away from transmission lines. If you wish to, contact one of BPA's regional offices about your particular situation. If you are working near a line, it is wise to supplement normal precautions by assigning one person to act as a "safety watcher." This person simply stands by, watches, and warns the other workers against unsafe moves.

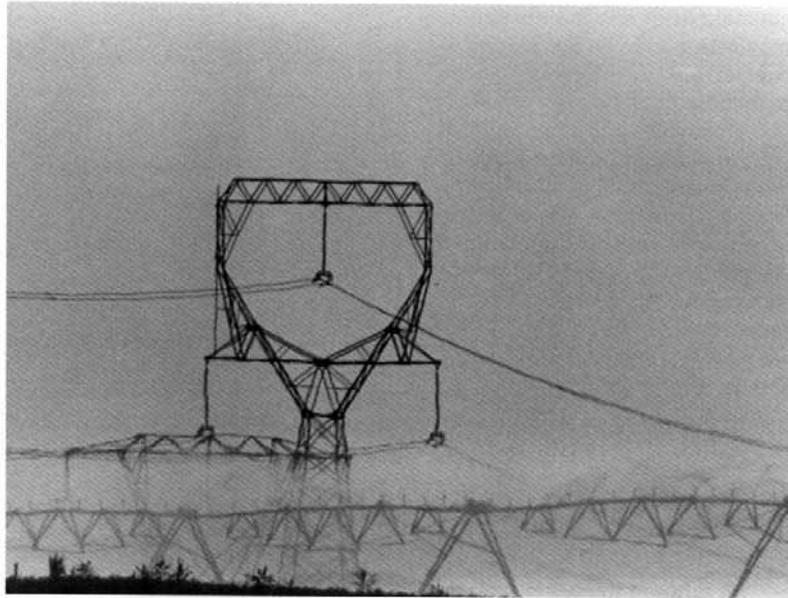


Irrigation pipe should be moved in a horizontal position under and near all power lines to keep it away from the conductors overhead.

Great caution should be used when moving a high-pressure irrigation system under a transmission line. The small wheel bases of some of these systems tend to make them unstable. If one should tip while under a line, its boom could be lifted into a conductor.

You may notice some nuisance shocks when unloading irrigation pipe near a transmission line. It can be reduced greatly or eliminated entirely by unloading the pipe at least 50 feet away from the line. This also tends to reduce the risk that the pipe will get too close to the conductors. Even if pipe stacked on a rubber-tired vehicle is unloaded under a transmission line, the possibility of nuisance shocks can be eliminated by grounding. The grounding is done by clipping one end of a wire to a metal rod driven into the ground and the other end to a pipe on the bottom of the stack.

All types of irrigation systems, including center pivot systems, can be operated safely near or on a right-of-way. However, irrigators should avoid situations where a

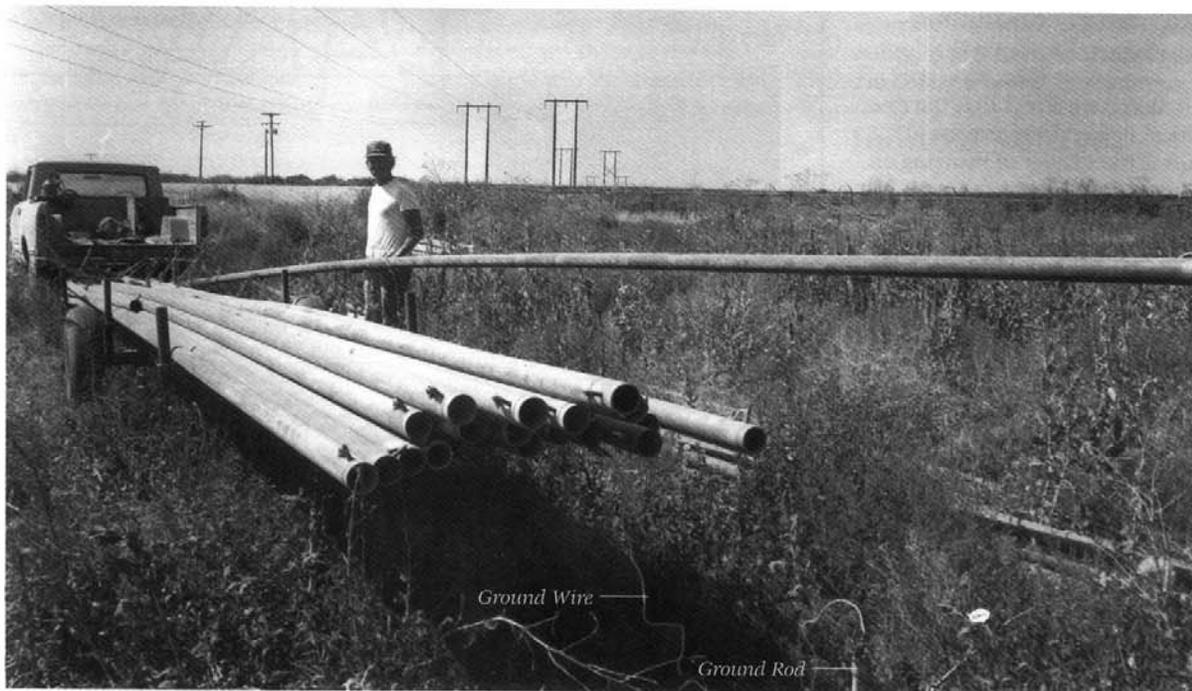


Irrigation around BPA lines is safe when proper precautions are taken on the rights-of-way.

solid stream of water can come in contact with a conductor, even if the possibility is remote. Should this occur, a person in contact with the irrigation system, or standing very near it, say 5 feet or so, may receive a severe shock. When asked, BPA will provide assistance as to the proper

installation or operation of an irrigation system to avoid hazardous situations.

If a sprinkler malfunctions and a solid stream of water reaches a conductor, turn off the water at its source — by switching off the pump — before attempting to correct the problem.



The possibility of nuisance shocks can be eliminated by grounding metal pipe when unloading near BPA lines.

All nozzle risers in the vicinity of a transmission line should be equipped with spoilers or automatic shutoffs. This will prevent a solid stream from striking a conductor if a nozzle breaks or falls off.

Equipment with smaller diameter or fine mist spray nozzles do not usually present a problem. Ordinarily, a broken spray will not conduct a significant amount of current. However, spray containing fertilizer is much more conductive. Therefore, additional precautions should be taken to avoid spraying water with fertilizer into contact with transmission line conductors.

High-volume irrigation systems which use large nozzles and high pressure to sprinkle big areas are of special concern. Nozzle diameters vary from 3/4 inch to 1-15/16 inches and water pressures range from 80 to 100 psi. Thus, a solid stream discharged from one of these nozzles may reach heights of 30 to 35 feet and go as far as 200 feet. When such a system is in operation, a safe distance must be kept between it and a transmission line. If requested, BPA will gladly help you determine what a safe distance is for your equipment. Contact the nearest BPA regional office, listed on page 1, if you want help.

Nuisance shocks may be experienced when touching mobile pipe-type and wheel-type irrigation systems located near transmission lines. These shocks can occur when soil conditions are dry and there is a long section of irrigation pipe parallel to and within 15 meters (50 feet) of the transmission line centerline. Simple grounding procedures can prevent nuisance shocks on these types of systems. Contact BPA for assistance or information about your particular situation.

Central pivot circular irrigation systems installed near or under transmission lines can develop hazardous shock

potentials during operation and maintenance. To eliminate these hazards:

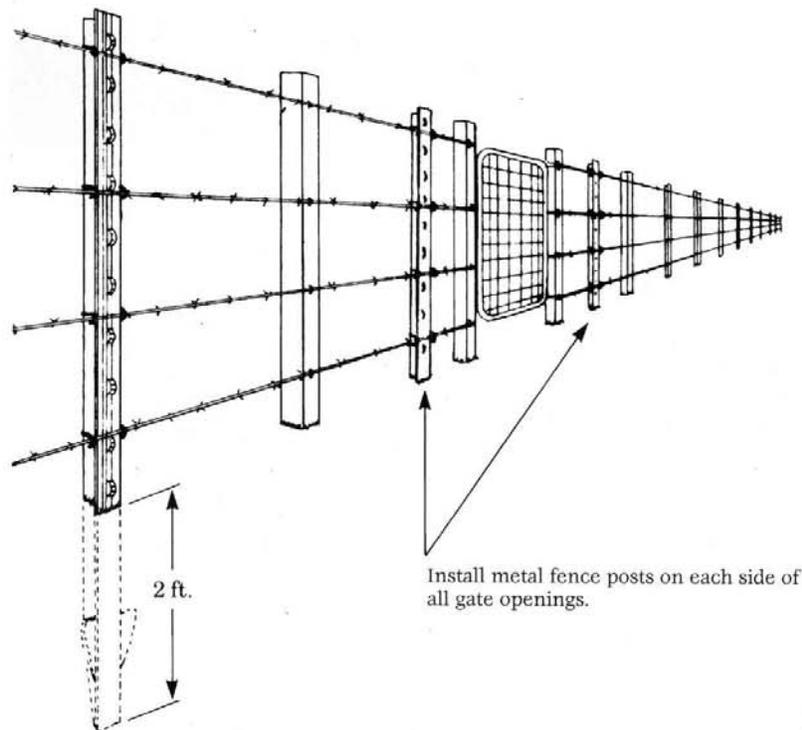
- Provide a good electrical ground for the pivot point.
- Do not touch the sprinkler pipe or its supporting structures when the system is operating under or parallel to and near a transmission line.
- Maintain the system with the sprinkler pipe perpendicular to the transmission line.

BPA has prepared a guideline for the installation and operation of irrigation systems near high-voltage transmission lines. A copy will be provided when you contact BPA's regional office for approval and assistance in safely locating, operating and maintaining irrigation systems near transmission lines.

Underground Pipes, Telephone Cables and Electric Cables

Underground pipes and cables are compatible with transmission lines providing installation and maintenance are properly done. However, they should be installed at an angle of 60 degrees or more to the transmission line centerline (a perpendicular crossing is best). Normally, pipes and cables should not be installed closer than 50 feet to a BPA structure or the buried grounding system. These systems are long buried wires that are sometimes attached to the structures and can run up to 300 feet along the right-of-way. Since these grounding systems are not visible above ground they must be located by BPA. Contact the nearest BPA regional office before installing any pipe or cable which crosses a BPA transmission line right-of-way.

Proper orientation of the line with respect to underground pipes, telephone cables and electric cables is required to prevent an accident in an extreme



case when a fault on the transmission line might cause electricity to arc from the conductor to the tower and go to ground. This could produce a dangerous voltage on an underground piping or cable system.

Wire Fences

Barbed wire and woven wire fences insulated from ground on wood posts can assume an electrostatic voltage when located near transmission lines. Normally, the voltage will not be noticeable. If you are having a problem, call BPA for an investigation. The fence may need to be grounded if it:

- crosses the right-of-way;
- parallels the line within 125 feet of the outside conductor and is longer than 150 feet; or
- parallels the line 125 to 250 feet from the conductor and is longer than 6,000 feet.

These fences should be grounded at each end and every 200 feet with a metal post driven at least 2 feet into the ground. Attach all wire strands of the fence to the metal post. Install the grounding posts at least 50 feet from the nearest transmission tower. If nuisance shocks are experienced when contacting a fence or gate, or if you have any questions about the need for grounding, call the nearest BPA regional office.

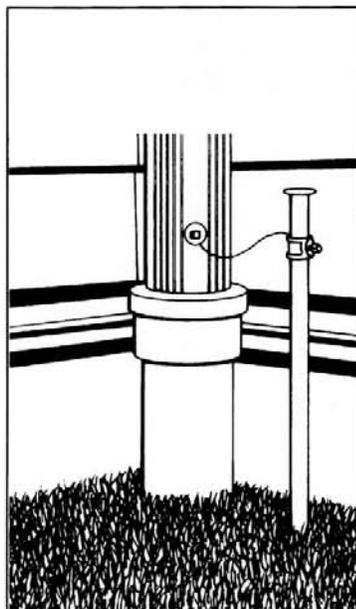
Electric Fences

In certain situations, BPA provides electric filters to ground 60-Hz voltages induced by a power line. These filters will allow the charging voltage on the fence to be effective. BPA provides these filters if the electric fence:

- crosses the right-of-way;
- parallels the line within 60 feet of the outside conductor and is longer than 1,000 feet; or

- parallels the line within 125 feet of the outside conductor and is longer than 2,500 feet.

Do not use fence chargers that are not approved by Underwriters' Laboratories, Inc. They may carry voltages and currents that are hazardous to anyone touching the fence — even if transmission lines are not present. For more information about fences, fence chargers or filters, call the nearest BPA regional office.



Buildings

This section applies to buildings outside BPA's rights-of-way, since BPA prohibits buildings within a right-of-way.

Metal buildings are buildings whose frame, roof or walls consist of substantial amounts of metal. A voltage induced on a metal building is usually drained away through the building's plumbing, electrical service, metal sheeting or metal frame. Nonetheless, BPA's present practice is to ground any

metal building near a 500,000-volt line when:

- it is within 100 feet of the outside conductor;
- it has more than 2,000 square feet of metal surface and is within 100 to 150 square feet of the outside conductor; or
- it is used to store flammable materials and is within 250 feet of the outside conductor.

One grounding rod is adequate for a building with less than 2,000 square feet of metal surface. Two grounding rods are used if a building's metal surface exceeds 2,000 square feet of metal surface. Two grounding rods are used if a building's metal surface exceeds 2,000 square feet. Even if the metal surface is less than 2,000 square feet, an extra grounding rod is useful in case one is damaged or develops a high-resistance contact.

Aluminum windows, downspouts, gutters or other metal parts on buildings constructed of wood or other insulating materials may also require grounding as shown above.

Again, call BPA if you have any questions about grounding a building.

Vehicles

Under some high-voltage lines, vehicles can carry a nuisance shock. This is particularly true if the vehicle is parked on a nonconductive surface such as dry rock. You can drain the shock from your vehicle to the ground by attaching a chain that reaches the ground to the vehicle or by leaning a metal bar against your vehicle. The only way to be sure you won't get shocked is to park your car away from the power line.

Theoretically, it is possible that an electric spark from an induced voltage could ignite a gasoline vapor that is created during refueling of a vehicle. BPA has never had a report of a

refueling accident near our lines. Such an accident could occur, but the vehicle would have to be insulated from ground and the fuel and air would have to mix together in proportions that would have to be almost exactly right for an explosion. The chance that all these conditions would occur simultaneously is remote.

However, because such an accident is theoretically possible, BPA recommends that you not refuel your vehicle in close proximity to a transmission line.

Lightning

Lightning will usually strike the highest nearby object. In rural areas, this may be a power line tower or conductor. Transmission facilities are designed to withstand lightning strikes by channeling them to ground at the tower. When lightning strikes a tower, the damage is usually much less than if a barn or tree had been hit.

Play it safe. Stay away from power lines and other tall objects during electrical storms. Lightning is dangerous if you are standing near where it enters the ground.

Fires

Smoke and hot gases from a large fire can create a conductive path for electricity. When a fire is burning under a transmission line, electricity could arc from the conductor to the ground, endangering people and objects near the arc.

Field burning and other large fires in and around transmission lines can damage transmission lines and cause power outages. Water and other chemicals used to extinguish those fires should never be directed toward a transmission line.

Kite Flying and Model Airplanes

BPA discourages anyone from flying a kite or model airplane

anywhere near a power line. However, if your kite or model airplane is about to touch a power line, drop the string or handline instantly, before it touches the line. Do not try to pull the kite or airplane down or climb up after it. Call the nearest electric utility.

Vandalism and Shooting

When hunting in remote areas, do not shoot at transmission lines.

Insulators are, for the most part, made of porcelain or glass and are easily broken. Not only can broken insulators cause flashovers, an insulator string hit by gunfire could pull apart and let the conductor fall to the ground. This could be a serious hazard to anyone close to the line. It could also cause a power outage and possible a fire in dry areas.

Unfortunately, most insulator damage from gunfire is the result of simple vandalism.

Hunters sometimes assume that the land under a transmission line belongs to the federal government and is therefore public property. This is rarely the case. Most land beneath power lines — except in national forests or on Bureau of Land Management lands — is privately owned.

Those who cause willful damage to BPA transmission facilities or property along easements can be prosecuted by the federal government, the property owner, or both.

Remember, insulators and conductors are not fair game. Do not use them for target practice. To do so is illegal and can be extremely hazardous.

Please report broken insulators and conductors, or any other damage you see, to BPA's Crime Witness program by calling **1-800-437-2744**. Crime Witness allows you to report, confidentially, an illegal activity that you witness against BPA's transmission system, property or personnel.

This includes:

- Shooting at power lines, transmission towers or substation equipment.
- Dumping of any waste or material on BPA property.
- Vandalism to BPA property, buildings and vehicles.
- Theft of BPA equipment, supplies, tools or materials.

The program offers rewards of up to \$1,000 for information leading to the arrest and conviction of the persons causing the damage.

Metal Objects

As a precautionary practice, do not raise any metal object more than 14 feet in the air underneath a transmission line.

When you mount an antenna on a large vehicle that you plan to operate on a BPA easement, do not let it extend more than 14 feet above the ground.

Before you sail a boat on a lake or river, check the allowable clearance under any transmission line. We recommend that all masts or guy wires above the deck be connected electrically to an underwater metallic part such as the keel or centerboard. This precaution, which protects against lightning or accidental contact with a power line, may save your life.

Swimming pool skimmers should not be raised vertically under any power line. BPA strongly discourages the building of swimming pools within BPA easements because of the possibility of an accident.

Climbing

Climbing on power line poles, towers or guy wires can be extremely hazardous. Don't do it under any circumstances.

Pacemakers

Under some circumstances, voltages and currents from power

lines, and household and other electrical devices may interfere with the operation of some implanted cardiac pacemakers. However, we know of no case where a BPA line has harmed a pacemaker patient.

As a precaution, persons who may have reason to be very near high-voltage facilities should consult with a physician to determine whether their particular implant may be susceptible to 60-Hz interference.

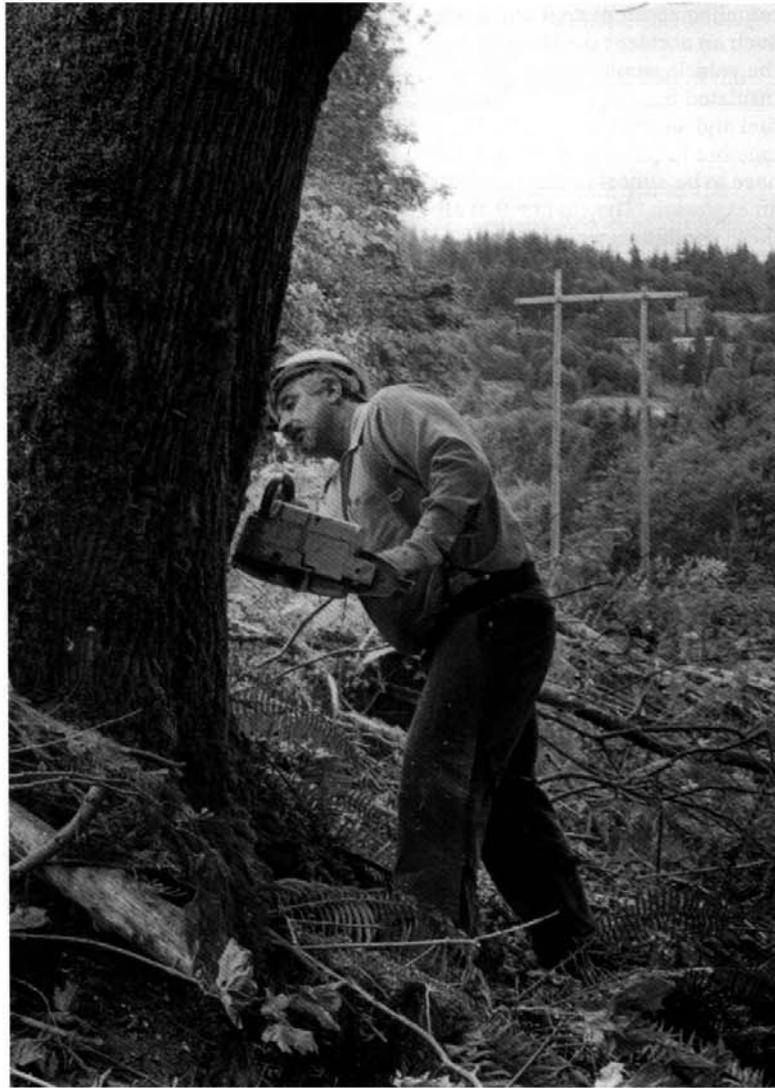
If a person with a pacemaker is in an electrical environment and the pacemaker begins to produce a regularly spaced pulse that is not related to a normal heartbeat, the person should leave the environment and consult a physician.

Trees and Logging

No logging or tree cutting should be done within BPA's easement without first contacting the nearest BPA regional office. In many cases BPA owns the timber within its easements. Additionally, logging near transmission lines can be very hazardous and requires special caution. Since trees conduct electricity, if one should fall into or close to a line, the current could follow the tree trunk to the ground and endanger anyone standing near its base. Here are two simple rules: If you should come upon a tree which has fallen into a power line, stay away from it. If you should accidentally cause a tree to fall into a line, run for your life! Do not go back to retrieve your saw or equipment. Call BPA or your local utility immediately.

We suggest if you have trees either on or close to the easement which need to be cut and could fall on or close to a transmission line, that you contact BPA. It may be safer to have BPA remove the trees than to do it yourself.

Since transmission line rights-of-way are usually not owned by BPA, but are acquired through easements from the landowner,



Cutting trees within power line rights-of-way can be dangerous. It may be safer to have BPA do it for you.

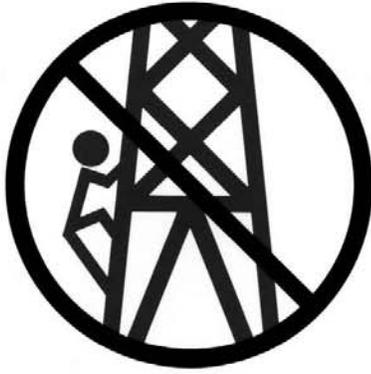
trees or logs stacked within or alongside them are not public property. People removing trees and logs without permission are stealing and can be prosecuted.

In addition, there are special considerations for growing Christmas trees, orchards and other tall-growing vegetation. Ask for the *'Landowner's Guide to Trees and Transmission Lines'* and the *'Landowners Guide to Use of BPA Rights-of-Way.'*

Explosives

If you plan to detonate explosives near a BPA transmission line, notify BPA well in advance. See the list at the front of this booklet for the address and telephone number of the BPA office nearest you. BPA will tell you if any special precautionary measures must be taken at a particular blasting site.

As a general rule, do not use electric detonating devices when blasting within 1,000 feet of a power line. Nonelectric methods of detonation will avoid the



**NEVER
climb towers or poles.**

danger of accidentally discharging an electric blasting cap.

If you are blasting within 1,000 feet of a power line and there is no reasonable alternative to the use of an electronic detonating device, you must clear the layout of the electric detonation circuit with BPA.

Concerning Towers and Conductors

- Do not climb towers.
- Do not shoot or otherwise damage insulators.
- Never touch a fallen line.
- Do not attempt to dismantal tower steel members.
- Do not apply additional loads to tower members for temporary support of a structure or vehicle.
- Stay away from towers and lines during extreme wind storms, thunder storms, ice storms or under other extreme conditions.

Preventive measures include:

- Stay away from and report broken or damaged insulators to BPA or your nearest electrical utility.
- Stay away from and report broken, damaged or abnormally low-hanging lines to BPA or your nearest electrical utility.

Conclusion

We live in an age of electric power. Almost everything we do requires it. Consequently, high-voltage power lines have become about as commonplace as the wiring in our homes — and just as safe. Nevertheless, every year people are killed or seriously injured by power lines and wiring. In almost every case, lives could have been saved and injuries avoided if the basic safety practices outlined in this booklet had been followed. BPA and your local utilities make every effort to design and build power lines that are safe to live and work around. Ultimately, however, the safety of high-voltage lines depends upon people behaving safely around them. No line can practicably be made safe from a person who, through ignorance or foolishness, violates the basic principles of safety. So, please, take time now to learn the practices outlined in this booklet. And share your knowledge with your family, friends and colleagues. Your own life, or that of a loved one, might well hang in the balance.

Related BPA Publications

Call BPA's document request line at **1-800-622-4520** and ask for the following publications:

- 1) For information on possible long-term biological effects of transmission lines: *"What We Know (and don't know) About EMF"* (DOE/BP-2059)
- 2) For information on using the land under a BPA right-of-way: *"Landowner's Guide to Use of BPA Rights-of-Way"* (DOE/BP-1678)
- 3) For information on growing trees on a BPA right-of-way: *"Landowner's Guide to Trees and Transmission Lines"* (DOE/BP-2868)

Bonneville Power Administration
PO Box 3621 Portland, Oregon 97208-3621

DOE/BP-1821 APRIL 1998 3M

