

Farming Safely

& Efficiently with
Electricity





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FARM ELECTRICAL SAFETY

Things you should know about electricity and your farm

Electrical Safety is Important to All of Us

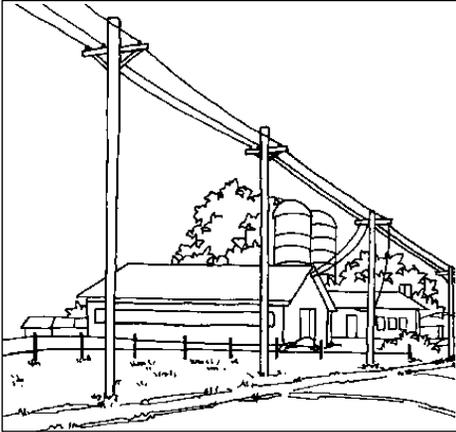
Research shows that farming is a hazardous occupation. These hazards include electric shock which can cause farm worker fatalities. Many farm workers have been seriously injured as a result of contacting power lines while moving or installing augers or lifting grain probes, irrigation pipe or well pipe.

With the widespread use of electricity on today's farming operations, we believe you should be aware of the potential dangers involved in using it. The electrical system on your farm, just like other equipment, must be installed and maintained so that it will operate safely.

This brochure provides basic information about farm electrical safety. This is not a wiring handbook.

For your safety and that of others, we recommend that all electrical work be completed only by qualified electricians who meet state and local licensing and/or certification requirements.





Electrical Facts & Principles You Need to Know to Farm Safely Near Power Lines:

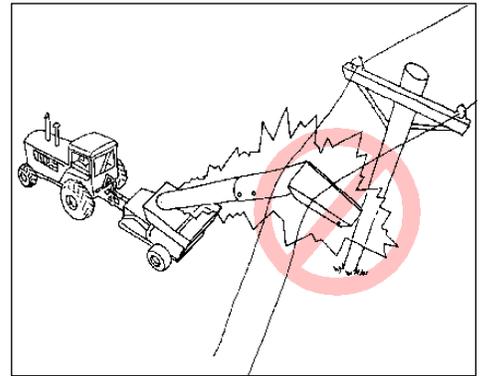
- ① Most overhead power lines have no protective insulation. Any contact with them could be dangerous.
- ② Non-metallic materials such as lumber, tree limbs, tires, ropes, straw and hay, will conduct electricity, depending on their moisture content and surface contamination.
- ③ Electricity will seek every available path to the ground.
- ④ When people or other objects get too close and touch a power line, there is an instant flow of electricity through them to ground.
- ⑤ The flow of electricity through the human body can burn, severely injure or cause death. Less than one ampere of electricity through the body can kill!
- ⑥ Because you can not see electricity, stay away from downed lines. The area around them including the soil, equipment or other objects, could be energized. If you see a downed line, call your utility.

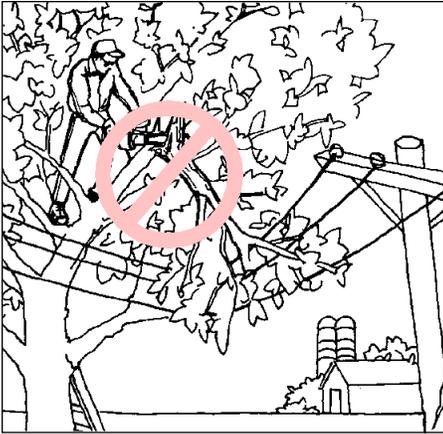
Take a Good Look Around...

Look around your farm and take note of the location of all overhead power lines. Also make sure you know where underground power lines are buried. Review your farm activities and work practices near these lines. Remember: If you contact a power line, a serious or fatal accident could occur.

Watch out for overhead power wires whenever you operate portable augers, movable conveyors or any other farm equipment!

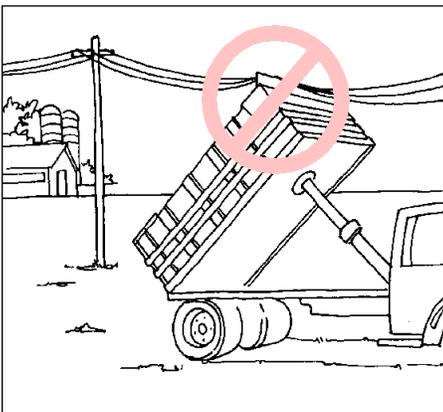
Be particularly careful when working near overhead and underground electrical power lines.





Basic safety rules:

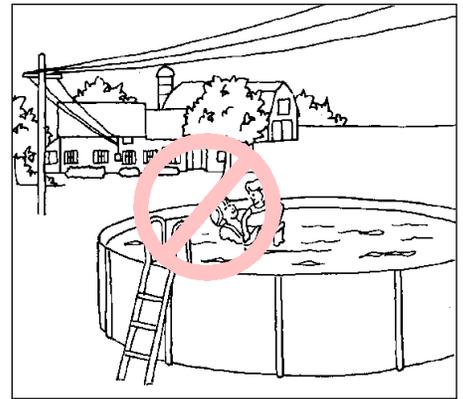
- ◆ Never touch power lines.
- ◆ Look up, power lines may be overhead. When moving farm machinery, hoppers, bins, sprayer booms, cultivator wings, grain augers, bale elevators, scaffolds and portable buildings avoid power lines. Never attempt to raise the power line yourself.
- ◆ Don't clear storm-damaged trees, limbs or other debris that are touching power lines or are close to fallen power lines. Call your power supplier.
- ◆ Look around, don't cut down trees or prune limbs that may fall into power lines.



- ◆ Don't raise or carry ladders, poles, rods, or irrigation pipes into power lines.
- ◆ Stay clear of power lines while installing or removing a TV or CB antenna or satellite dish.
- ◆ Fly kites or model airplanes away from electric power lines.
- ◆ Don't shoot at electric power lines, poles or equipment.
- ◆ Don't start fires under electric power lines.
- ◆ When planning a new building, contact your power supplier. They can provide information on the minimum safe clearances from overhead and underground power lines.
- ◆ When moving large equipment or high loads near a power line, always use a "spotter" – someone to help make certain that contact is not made with the line.
- ◆ Always lower portable augers or elevators to their lowest level possible – under 14 feet – before transporting.

CAUTION: Swimming Pools!

If you are planning to erect a swimming pool, do not locate your pool under or near any electrical power lines! Play it safe: locate your pool elsewhere.



Before you dig:

Be aware of any underground gas lines, telecommunication lines, water lines or other underground utilities.

Whenever you are doing any kind of digging, call your power supplier.

Some states have toll free Digger's Hotlines. Look up the phone number and write it down in the phone list at the back of this book.

Compliance with electrical codes is critical to the safety of your farm's electrical system. While it isn't necessary for you to understand every detail of the electrical codes, *it's essential that your electrician does!*

For your protection, we recommend that you also have a general understanding of the portions of the *National Electrical Code (NEC)* that apply to farms. *The code is the rule book governing electrical wiring practices! In many states it has been adopted as law.*

If your farm is not wired in accordance with the NEC, your entire farming operation, including any livestock, and the health and well being of your family may be seriously jeopardized.

A good reference is the Midwest Plan Service Farm Building Wiring Handbook #28. A list of other references is provided in the back of this booklet.

Wiring Requirements Vary By Building Type

The NEC includes requirements for the three general types of agricultural buildings:

Damp Buildings

Animal housing, milk houses, and silos are vulnerable to high levels of moisture and corrosive dust and gases and require dust- and moisture-tight, non-corroding materials and wiring methods.

Dusty Buildings

Fertilizer, dry grain and hay storage buildings have relatively high levels of explosive dust and require "dust-proof and ignition-proof" materials and wiring methods.

Dry Buildings

Machine storage buildings, shops and unattached garages can be wired with the same variety of materials that are used in residential buildings. However, it's important that your qualified electrician implements the requirements outlined in the NEC.

Your electrical equipment may operate, but will not operate safely without proper grounding

The proper grounding of electrical equipment serves to protect you, your animals and your electrical system from costly repairs, fires, stray voltage and possibly fatal accidents. It's important that you consult with a qualified electrician to ensure that your farm's system is grounded in accordance with the National Electrical Code (NEC) standards.

A qualified electrician can ensure that the "service entrance panel" to each of your buildings, including your home, is properly grounded in order to provide this level of protection.

Your farm must have its own grounding electrode system in addition to any lightning protection grounding system.

Ground-fault Circuit Interrupters

With the inclusion of non-conductive plastic housings (double insulation), shock hazards have been greatly reduced in today's newer electrical machines and power tools. Although double insulation helps reduce shock, it has not eliminated shock hazards entirely.

The best protection against lethal shocks are ground-fault circuit interrupters (GFCIs). GFCIs act as buffers between an electrical source and the machinery it powers. If a ground fault occurs, the GFCI shuts off the current flow in time to prevent a lethal amount of electricity from reaching the user.

Helpful Tips:

- ◆ Tools with a three-wire power cord provide very good protection against ground faults.
- ◆ Use extension cords that have a grounding wire.
- ◆ Make sure that all the receptacles are grounded and in good working condition.
- ◆ Plug devices into GFCI receptacles or use extension cords with GFCI's.

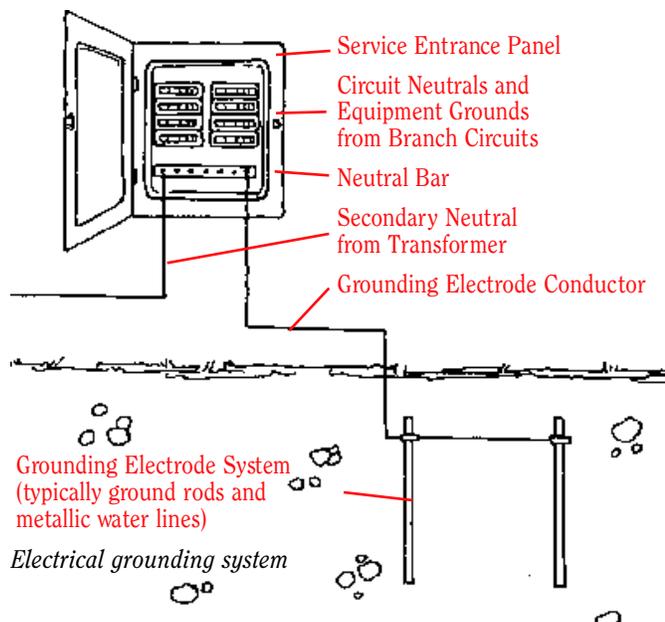
Grounding:

Ask your qualified electrician to make certain that the neutral wire and grounding wire are not connected together at any point in your electrical system other than the main service entrance panel. This is required by the NEC.

For more information on recommended agricultural system and equipment grounding practices, consult a qualified electrician.

An equipotential plane can be a very cost-effective method for reducing stray voltage and protecting you and your livestock from lightning and electrical faults.

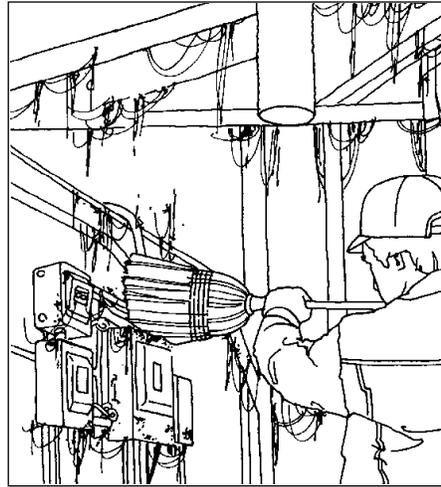
The 1996 NEC requires equipotential planes in all newly-constructed and extensively remodeled livestock confinement areas.



Wiring Deteriorates Over Time

Hazardous farm wiring conditions often result from deteriorated wiring and overloaded circuits. When wiring has been in service for many years, the insulation deteriorates and becomes brittle. If the deteriorated insulation fails, the result may be a fire, electric shock or an electrocution.

An electric circuit is no better than its weakest point. If you add electrical load, either permanently or on a temporary basis, you should first have your qualified electrician determine if your existing wiring is of adequate size.



Keep electrical equipment and service areas clean. Disconnect power before cleaning or contact your electrician.

Maintenance Reduces Downtime

Routine maintenance of electrical equipment and devices can reduce the possibility of an accident and costly downtime. Loose connections, switches lacking cover plates, accumulated dust, cobwebs or moisture should receive immediate attention.

- ◆ Wires not properly supported or protected from mechanical damage.
- ◆ Improper or inadequate grounding.
- ◆ Improper use of extension cords.
- ◆ Circuits not protected by properly sized fuses or circuit breakers.
- ◆ Fuses or circuit breakers not of an approved type.
- ◆ Switches not enclosed in approved boxes.
- ◆ Fixtures not properly secured.
- ◆ Lamp guards missing where required.
- ◆ Defective light sockets.
- ◆ Lights too close to combustibles.

If you have any questions regarding the common problems outlined here, please contact your qualified electrician or your power supplier.

Farm Electrical Safety Checklist

The following checklist is intended to help you assess the present level of electrical safety on your farm. *It is not intended to replace a thorough professional inspection by a qualified electrician.* He or she can help answer any

particular questions you may have. If you think that a condition exists which is the responsibility of your power supplier, please contact them immediately.

CHECKLIST

Yes	No	
✓	✓	<i>Each answer marked "no" may indicate that a safety problem currently exists on your farm. Many of your concerns will best be answered by a qualified electrician.</i>
		Was the electrical system installed by a qualified electrician?
		Was the electrical system inspected by an electrical inspector?
		Does each building have a single electrical service entrance?
		Is there at least 3 feet of clearance in front of all electrical panels and can all panel doors be opened at least 90 degrees?
		Is the service entrance at each building equipped with a grounding electrode?
		Are all enclosures, thermostats, switches, receptacle boxes and covers water-tight, dust-tight and made of corrosion-resistant materials?
		Are all cables and cable fittings of a type designed for use in a wet or damp environment?
		Is all conduit nonmetallic and surface-mounted?
		Is all metallic equipment properly grounded?
		Are all grounding and neutral conductors electrically separated except in the main disconnect panel?
		Are all light fixtures made of corrosion-resistant material and equipped with shatterproof covers or globes with proper gaskets?
		Do all cables and conduits enter boxes and enclosures from the side or bottom wherever possible?
		Are all motors totally-enclosed and rated for farm service?
		Are all electrically-heated waterers serviced with a cable or conduit equipped with an equipment grounding conductor?
		Are all metallic building components within 8 feet of the ground or floor bonded to the electrical grounding system?
		Are all agricultural buildings equipped with a lightning protection system?
		Do family members and all hired farm workers know where and how to disconnect power in case of an electrical emergency?
		Do family members and all hired farm workers know first aid for electrical shock and/or burns?

Obtain Complete Insurance Coverage to Protect Your Livelihood

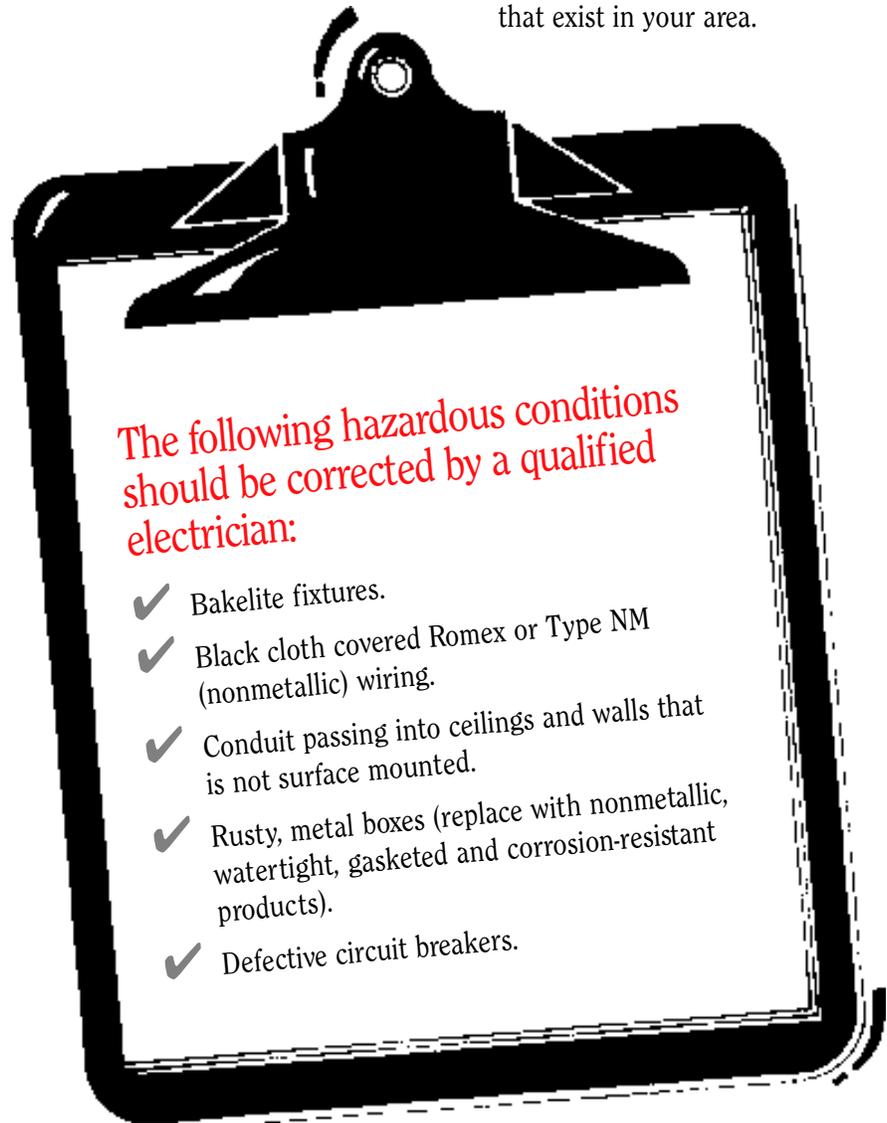
Since electrical systems cause about 70 percent of all farm fires, insurance companies may carefully examine the condition of your farm's wiring before approving coverage. Have a qualified electrician perform a complete checkup of the system and correct any problems that may exist.

AND REMEMBER: *Require that your electrician perform any work in accordance with the National Electrical Code.*

Make Sure That You're Covered

You should have your buildings covered for their *replacement value*. *In the event of a catastrophic disaster, replacement value insurance will help you replace all lost items.*

Be certain to consult with a structural engineer or other building contractor to ensure that all your buildings meet structural codes and are adequately built to withstand snow and wind loads that exist in your area.



The following hazardous conditions should be corrected by a qualified electrician:

- ✓ Bakelite fixtures.
- ✓ Black cloth covered Romex or Type NM (nonmetallic) wiring.
- ✓ Conduit passing into ceilings and walls that is not surface mounted.
- ✓ Rusty, metal boxes (replace with nonmetallic, watertight, gasketed and corrosion-resistant products).
- ✓ Defective circuit breakers.

Electric Fencer and Cow Trainer Safety

Electric fencing, electric crowd gates and cow trainer systems require just the right amount of power in order to operate safely: if there's not enough, your animals may escape; if there's too much, your animals may be injured.

You can help prevent these problems by following a few simple guidelines on the installation and maintenance of electric fencer and cow trainer systems.

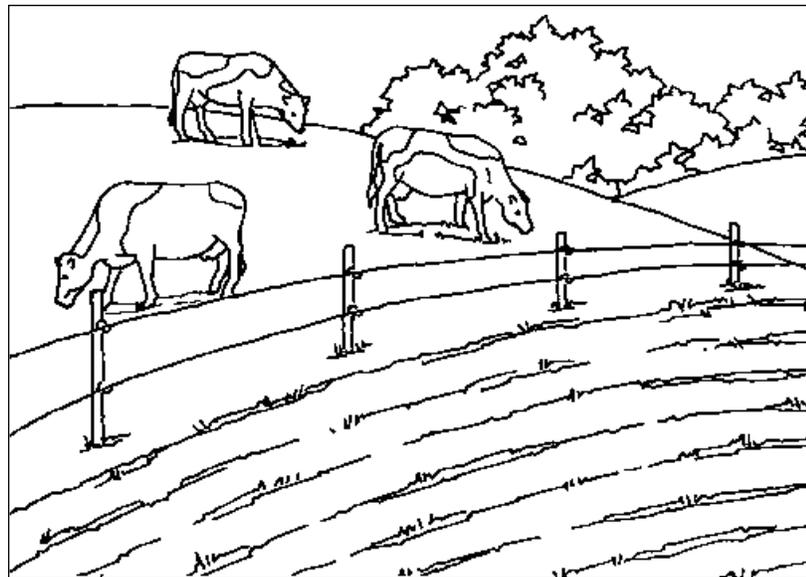
We suggest that you hire a qualified electrical contractor to install your electric fencer and cow trainer systems. Be certain that he or she follows the National Electrical Code (NEC) and manufacturer's recommendation.

Note the following key points:

- ◆ Never use an electric fence energizer as a cow trainer!
- ◆ The fence energizer should be kept in a sheltered area – away from animals, yet as close to the fence as possible.
- ◆ The energizer should be covered to keep out dust and moisture.
- ◆ Use a 10,000-volt insulated wire to connect the energizer's "hot" lead terminal to the electric fence.
- ◆ Do not connect the "hot" lead terminal to anything not associated with the energized fence.
- ◆ A rubber or plastic PVC tube should be inserted over all insulated wires at locations where the 10,000 volt insulation can be worn down.

- ◆ A separate ground rod should be used to ground the fencer/trainer. *Do not connect fence/energizer or cow trainer ground wires to the electrical system ground or the water system. Maintain adequate separation between the two grounding systems.*

For more information on electric fencer safety, call your local qualified electrician, county extension agent or the Wisconsin DATCP publication on fencers and trainers.



A standby electrical power system can protect your livestock, your equipment – and your livelihood.

Electricity can be interrupted from time to time due to severe weather and other circumstances. Since power failures occur without warning, you can plan for such emergencies by having a standby power generating system installed on your farm.

What Equipment Will You Need?

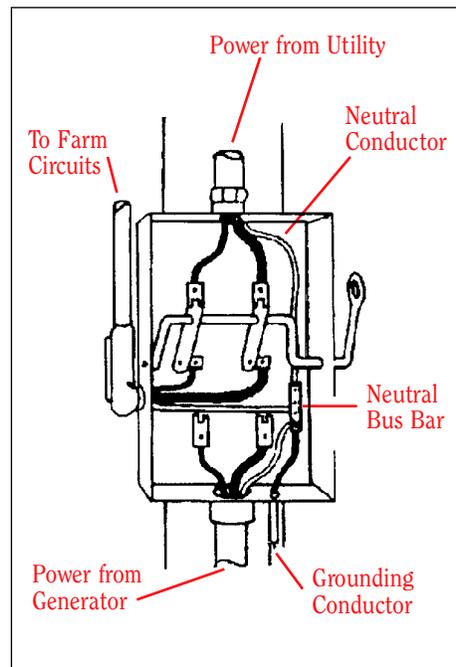
A standby generating system must match the electrical load that you need to operate during an outage (this is referred to as the “critical load”). The four basic components of the system are:

- ① A generator, which produces the electricity.
- ② A power source, that drives the generator. Some systems use the power take-off (PTO) shaft of a tractor; others use a separate engine. Make sure that PTO drives, engines and generators are properly shielded to prevent personal injury.
- ③ A volt meter to ensure proper line voltage.
- ④ A transfer switch that safely connects the generator to the farm wiring and prevents any inter-connection between the standby generator and power lines.

The standby system must be capable of providing adequate power at the correct voltage. *A qualified electrician can identify your system’s voltage, help determine your capacity requirements and advise you about correct electrical installation and connection.*

About the Transfer Switch

Electrical codes **require** that a suitable transfer switch be used to disconnect the electrical load from power lines and connect it to the standby generator – only!



Typical Double Pole, Double Throw Transfer Switch Installation for 120/240 V, Single-Phase Service

When properly installed, the transfer switch prevents the flow of electricity into power lines – *which could endanger the lives of people working on power lines miles away from your farm!* The switch also protects your standby equipment from being damaged by electrical “feedback” coming from the power lines once your regular electrical service has been restored.

Be Safe!

Don’t take chances with any electric generator. An improperly installed standby generator system can endanger the lives of the operator, utility employees and the general public. A carelessly installed and/or operated system could also severely damage your property.

Choosing the right electric motor for farm applications and installing the wiring and controls properly is important for farm electrical safety. Also make sure motors and drives are properly shielded to prevent injury. Lubricate motors according to manufacturer's recommendations to avoid premature failure.

Use Totally-Enclosed Motors

Because of the dirt and moisture associated with farming, use only totally-enclosed electric motors. The motors should be rated as "Farm Duty." To reduce the possibility of stray voltage problems, use 240V electric motors.

Soft Start?

Your ability to use larger motors, either single-phase or 3-phase depends on a number of factors related to your farm wiring and the utility's power lines. Often, larger motors that are allowed will require soft start mechanisms. Soft start enhances safety by reducing motor and electrical system stress. Soft start may increase equipment life expectancy and reduce annoying and sometimes troublesome light flicker. Additionally, soft start mechanisms on large motors can help reduce motor

starting transients that may be perceived by your livestock.

For information on allowable motor size and available starting mechanisms, contact your electrician and/or local power supplier.

Maintain Adequate Voltage

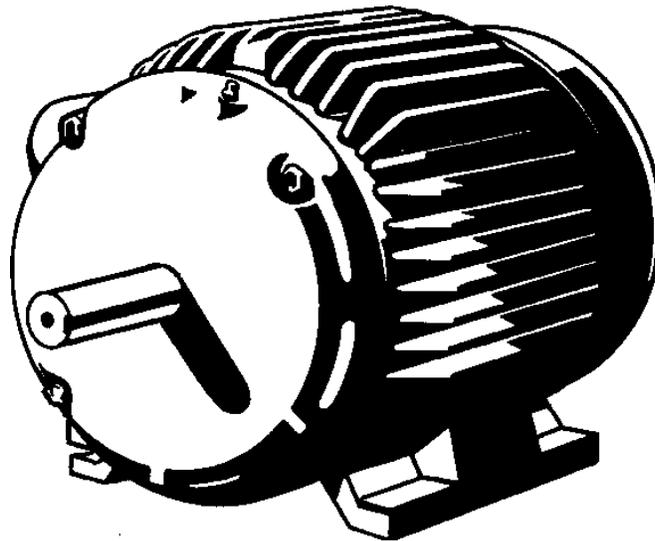
Adding new electrical loads to your farm system may reduce voltages on individual parts or on your entire system. Voltage reductions below 90% of that listed on the motor's nameplate can cause motors to overheat and become damaged. You should consult your motor dealer or qualified electrician for more information. To ensure proper life and reduce risks of premature failure, *keep motors clean and free of debris.*

Do You Need a Motor Starter?

In general, a motor starter is required for any 3-phase motor, or for any single-phase motor above 2 hp.

For all others, the National Electrical Code (NEC) says:

<i>Motor Type:</i>	<i>You Need:</i>
◆ 1/3 hp or less & portable.	Plug and socket – no separate controlling device required.
◆ 1/8 hp or less & stationary.	"Branch-circuit protective device" (circuit breaker or fuse).
◆ Others	For 2 hp and 300 volts or less, general use switch is required.



Electrically Heated Waterers

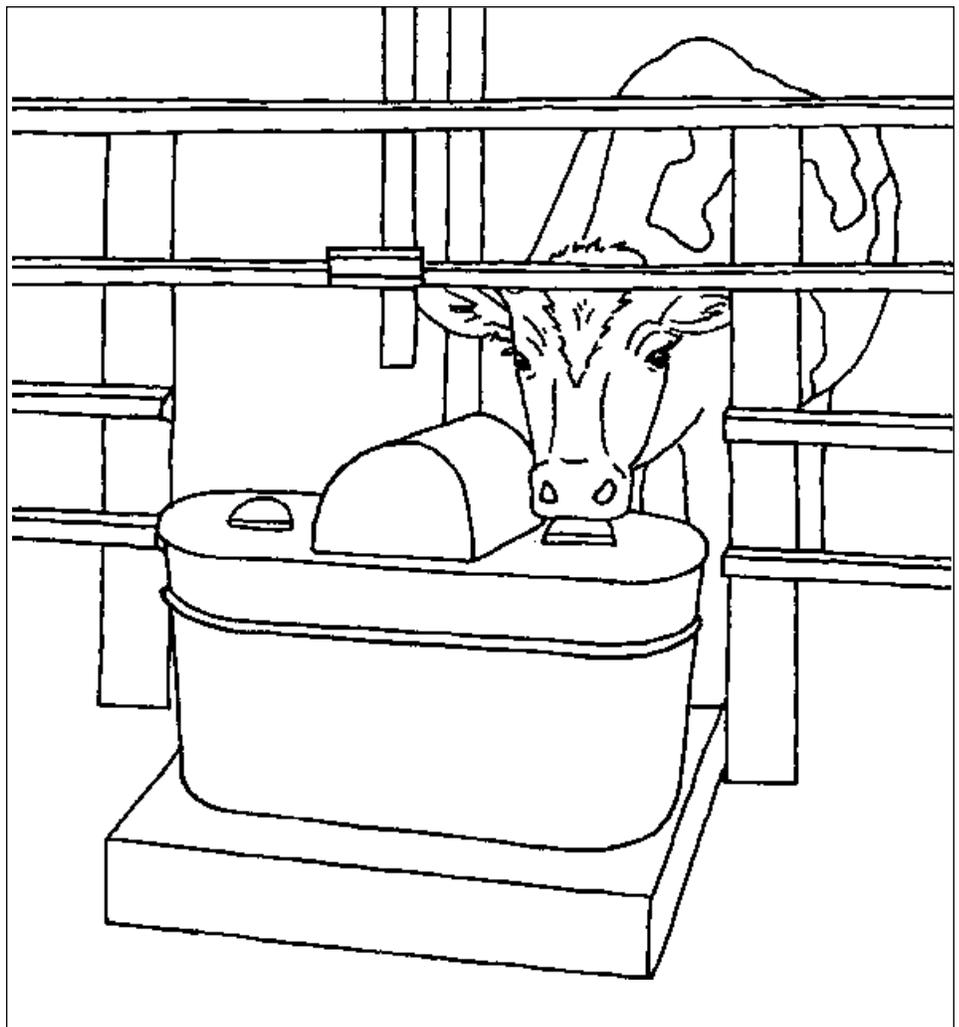
Electrically-heated stock waterers are commonly used for livestock watering. Safety in operation depends on proper installation and grounding. Make certain that you install waterers with the following guidelines:

- ① The heater should be listed by Underwriters Laboratory (UL) or another recognized testing organization. It should be installed according to the manufacturer's directions.
- ② The waterer should be installed on a firm platform or foundation incorporating an equipotential plane.
- ③ The waterer should be wired in accordance with the National Electrical Code.
- ④ Every waterer should have a disconnecting switch with over-current protection.
- ⑤ Switches and conductors should be protected from physical damage.
- ⑥ All metal parts on the waterer should be bonded together and grounded.

Energy-Free Stock Waterers Save Money!

Properly sized, insulated stock waterers can keep water from freezing and eliminate the need to use electricity.

By installing an energy-free stock waterer correctly, you can provide clean, fresh water to your livestock year-round, and reduce your energy costs. You can also *eliminate* the possibility of stray voltage at the waterer and risk of electrical shock.



Adequate lighting can help protect your farm from accidents, trespassers and vandalism. Energy efficient lighting can save you money. High levels of moisture and corrosive dust and gas can quickly corrode standard electrical equipment. Livestock facilities require special materials and wiring methods.

There are three types of lights common on farms: **incandescent, fluorescent and high intensity discharge (HID)**. Each offers varying properties of light output, color options, efficiency standards, and costs.

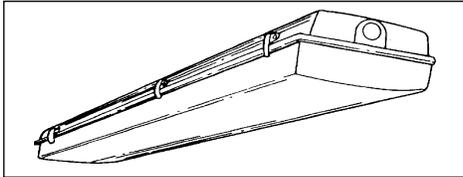
Incandescent Lighting Pointers:

USES: Recommended when light is needed for short periods of time and/or turned on and off frequently.

PRO • Low initial cost.

CON • Low efficiency levels and expensive operational costs.

Fluorescent Lighting Pointers:



USES: Indoors.

PRO • Reduced lighting energy costs.

- Produce 3-5 times more light than incandescent bulbs.
- Last up to 10 times longer.

CON • Initially more expensive (but longer life easily makes up for this).

CAUTION:

- Fluorescent lights may make some rotating objects, such as fan blades, appear as if they are standing still.

High Intensity Discharge (HID) Pointers:

USES: Feedlots and outdoor lighting.

PRO • Energy-efficient, long-life.

- Operate well in cold temperatures.

CON • Lights take approximately 5-15 minutes to activate.

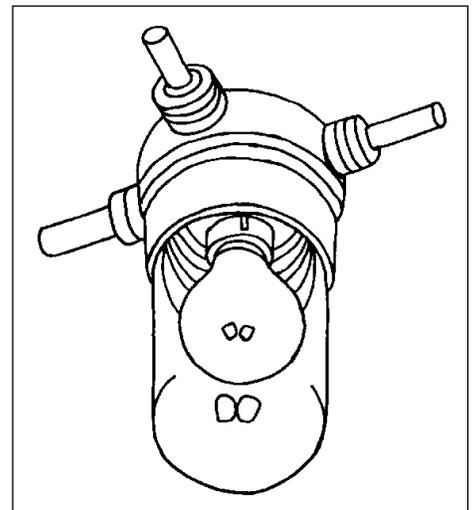
Guidelines for Locating Lights

Important points to remember:

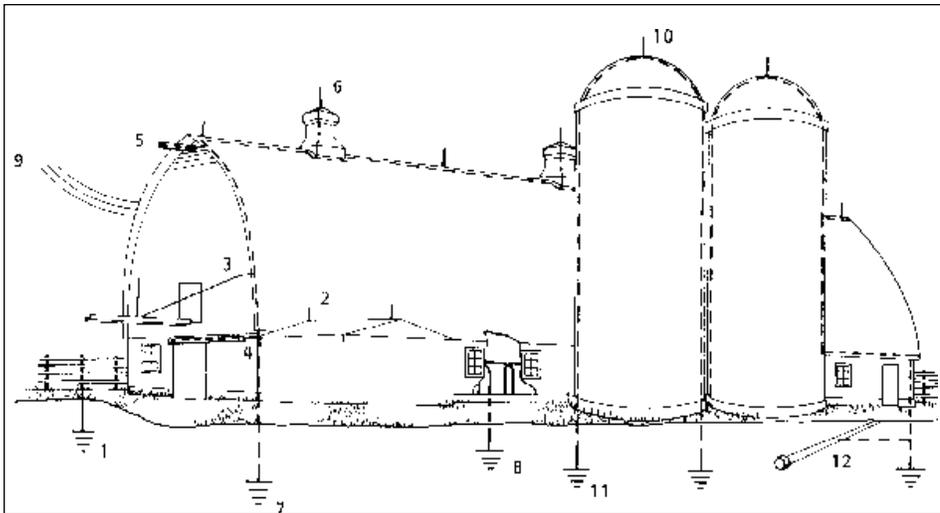
- ◆ Ease of bulb replacement.
- ◆ Potential for problems with bugs, birds and mechanical damage.
- ◆ Proper placement for illumination of work surfaces.

For additional guidelines and regulations for positioning lights in selected agricultural buildings, consult MWPS Farm Building Wiring Handbook #28 and your local codes inspector.

Dust and moisture tight non-corrosive



fixtures and materials are required by the NEC in animal confinement facilities.



Lightning Protection for Barns. (1) Ground attached wire fence; (2) extend system to an addition; (3), (4) and (5) run secondary conductors to litter, metal door, and hay tracks; (6) install terminals on cupolas, ventilators, etc.; (7) provide at least two grounds for barn; (8) tie in metal stanchions; (9) install arresters on overhead wires; (10) provide at least one terminal on each domed silo and at least two on each flat-roof or unroofed silo; (11) ground silo; (12) connect to metal water pipes; and protect all buildings—valuable or not—within 50' on barn

Lightning is a major cause of farm fires. Agricultural buildings that are especially vulnerable to lightning include barns, loafing sheds, and other livestock buildings.

Lightning Protection Systems

If properly designed, installed and maintained, a lightning protection system provides excellent protection to buildings. You may also benefit from lower fire insurance costs, too. Sophisticated systems can be built to increase protection of farm structures.

There are four ways lightning can enter a building:

- ◆ By directly striking a building.
- ◆ By striking a metal object extending out from a building such as a television antenna, cupola or track.
- ◆ By striking a nearby tree and leaping over to a building for a better path to the ground.
- ◆ By striking and following over head farm wiring or the utility power line or by striking an ungrounded wire fence attached to a building.

Lightning protection systems provide a direct, easy path to the ground to help prevent damage, injury or death.

A lightning protection system consists of five components:

- ◆ air terminals (lightning rods)
- ◆ main conductors
- ◆ secondary conductors
- ◆ lightning arresters
- ◆ ground connections or rods

A lightning protection system should only be installed by licensed electrical contractors using materials listed with Underwriters Laboratory (UL) or the Lightning Protection Institute (LPI). See your local electrical contractor or your power supplier for more information. For detailed requirements regarding lightning protection, see the *MWPS Agriculture Wiring Handbook #28* and the *National Fire Protection Association Code for Protection Against Lightning (NFPA)*.

Lightning Safety Tips

- ◆ Stay indoors during electrical storms.
- ◆ If you're caught outdoors, get down in a ditch or low area.
- ◆ Stay off of farm machinery and away from hills, trees, fences or sheds.
- ◆ Refrain from using the telephone during electrical storms.

Fan Performance and Efficiency for Animal Ventilation Systems

Good quality fans are essential for proper performance of any mechanical ventilation system.

Fan selection is the important first step in designing the ventilation system. It is very important to choose fans that are performance-tested and energy efficient.

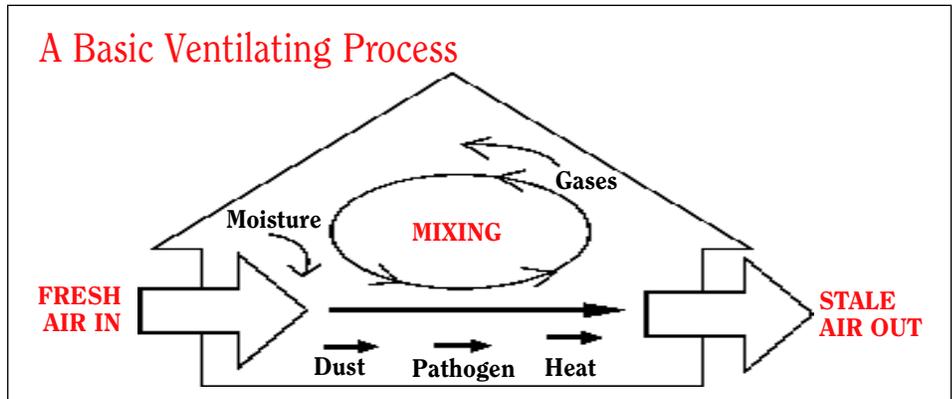
Energy efficient fans will pay for themselves from the electrical energy savings within a few years.

When a fan operates, it creates a static pressure difference between the inside and outside of a building.

The air moving capacity of a fan (cfm) depends on the design of the fan and the operating static pressure difference. As static pressure increases, cfm is reduced until there is no airflow.

A well designed ventilation system will operate at a static pressure of 0.03 (3/100)" to 0.10 (1/10)" of water. Select a fan that delivers the desired cfm against 1/10" - 1/8" water static pressure.

Another important characteristic when selecting fans for an animal ventilation system is energy efficiency. This is expressed as airflow per unit of input energy, or cfm/watt.



Recommended Efficiency Standards

Blade Diameter	Minimum *Cfm/Watt
48" or larger	19
36" or larger	18
24" or larger	13

* @ 0.05" H₂O

Maintenance of Fan Systems

Fans operating in animal housing units are exposed to dust and moisture. Dust accumulates on blades, louvers, and shrouds. Fans should be cleaned regularly and lubricated with graphite to prevent dust accumulation and airflow reduction.

Size of Openings

Although fans are a necessary part of a ventilation system, they are not the only thing to consider. Also needed is some way to bring air into a negative pressure system (inlets), or to allow its escape in a positive pressure system (outlets). The standard rule for sizing air openings is to provide one square foot of area for every 800 cfm of fan capacity. For more detailed information on designing a mechanical livestock ventilation system, refer to the MidWest Plan Service handbook entitled "Mechanical Ventilating Systems for Livestock Housing" (MWPS-32).

Additional sources of information:

Your local Cooperative Extension agent.
Midwest Plan Service
Iowa State University
Ames, IA 50011

*Farm Building Wiring Handbook #28
& Assorted Farm Planning Guides*

National Fire Protection Association
Batterymarch Park
Quincy, MA 02296

To order the National Electrical Code Handbook, call toll free 1-800-344-3555

“A Guide to Identifying Stray Voltage on Your Farm” and “A Guide to Electric Fencer Safety,” contact:

Wisconsin Department of Agriculture Trade and Consumer Protection Division
P.O. Box 8911
Madison, WI 53708

NIOSH (National Institute for Occupational Safety and Health)
1-800-356-4674

Information on a wide variety of farm related health and safety topics

National Food and Energy Council Inc. 409 Vandiner West, Suite 202
Columbia, MO 65202

Agricultural Wiring Handbook, Wiring for Livestock and Poultry Facilities Handbook and Video

Wisconsin Department of Industry, Labor and Human Relations
Safety & Buildings Division
P. O. Box 7969
Madison, WI 53707

Wisconsin Electrical Code, certification of electrical inspectors, licenser of journeyman and master electricians

This publication was developed by the Wisconsin Farm Electric Council

The mission of the WFEC is to initiate, develop, support and coordinate education, research and communication programs on significant and emerging rural energy issues for the consumer, energy suppliers and allied industries through cooperative efforts of council members.

