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Is Your Wiring System Safe and Energy Efficient?

Kenneth L. McFate and Fred M. Crawford
Department of Agricultural Engineering

Electricity is a safe and convenient source of energy for heat, light and power in your home and on your farm, provided it is distributed in correctly sized and properly protected conductors. Good wiring systems are safe and energy-efficient.

Because of their convenience, households have accumulated many electrical appliances. While these labor-saving devices are helpful in the home, property owners often fail to give proper attention to the wiring system that serves them. In our desire to reduce human work loads, we very often overwork the electrical home wiring system and its control devices. Energy-efficient appliances should always be served by good wiring systems.

Many older homes and service buildings are not adequately wired to serve today's electrical loads. Some new homes fall into this category, too. The safety of the system depends first on how well you have maintained the safety valves — your electrical fuses or your circuit breakers. It also depends upon the care taken by the home builder or electrician in the placement of electric cables. All cables in attics should be placed on top of attic insulation materials. It is especially important that circuit conductors that carry near-capacity current are on top of attic insulation so that heat generated within cable jackets will not be trapped. Where a circuit carries near-full load (90 to 100 percent of rated capacity) for long periods of time and heat is trapped by attic insulation, the conductor insulation could deteriorate.

Solutions are:

- Avoid covering conductors with insulation.
- Derate circuit amperage by using next lower size fuse or breaker (for instance, fusing a number 12 conductor with 15 amp protection and adding additional circuit capacity as needed).

Every safe home wiring system should equal or exceed the requirements of the National Electrical Code. But more than that, every system should be designed for economy of installation, operation, expandability and maintenance. The code itself is chiefly concerned with safety. Thus, it is usually desirable to install systems that exceed code standards. It is more economical to plan an adequate and easily expandable system than it is to rewire after your home has been built.

Detect poor wiring

Any system should avoid excessive voltage drop, wasted energy and overheated wires. You need not have a fire or an appliance failure to discover overloaded circuits, and you need not be an expert to determine whether your home wiring system needs attention. Look for symptoms of poor wiring:

- Fuses blow or circuit breakers trip often.
- Too few switches, outlets and lights.
- Extension cords frequently used.
- Lights dim and TV picture shrinks when refrigerator or other equipment starts.
- Toaster and electric iron heat slowly.

Fuses or circuit breakers of greater amperage will not correct too-small wiring or low-voltage problems, but proper circuit protection will ensure safe use of what you have. If you don't have enough circuits to serve all of your electrical equipment, consult an electrician or power supplier; you will probably need a larger service entrance. If rewiring becomes necessary, develop a wiring layout with help from local electrical specialists.

Identify circuits

In new home construction, the electrical contractor should identify each circuit and the size of conductors used should correspond with fuse size. The contractor should attach this record to the inside of the service entrance panel with each circuit numbered, identified and described. No one should accept a new wiring system without such a record. If your home wiring circuits are not so identified, the time required to make up such a record will be saved many times over as fuse replacements, fixture alterations and other repairs become necessary. Consult an electrician, if necessary, to determine the exact size of circuit wiring to be sure that all circuits are properly protected against overloads.

Protect with the proper fuse

When you overfuse or remove all protection, as with a penny behind a fuse, heavily loaded wires overheat. Insulation hardens and flakes off, with current-carrying conductors becoming bare in spots. Wires may then heat enough to burn dust, wood, paint, etc., causing a serious home fire. Proper fusing protects against such hazards. For 115-volt circuits, the Type-S plug, tamper-resistant fuse is a logical, economical protective device. It is recommended by the latest edition of the National Electrical Code as a replacement; it is required in new homes where fuse panels are used.

Types of plug fuses

Three types of plug fuses are commonly available

- The ordinary fuse
- The regular, Edison-base, time-delay, dual-element fuse
- The tamper-resistant, time-delay, dual-element, Type-S fuse with adapter.

The ordinary fuse is recommended only as a replacement in existing installations. It is satisfactory for circuits that serve incandescent lighting and heating loads if the correct size is used. All fuses have their ampere rating clearly marked on top and bottom. With little time lag built into ordinary fuses, they become less satisfactory on general purpose circuits that serve portable appliance motors. If the circuit is partially loaded, the additional momentary current drawn by a motor while starting may blow this kind of fuse. This is especially true when the motor-starting current is high, as with many vacuum cleaners.

The time-delay, dual-element, Edison-base fuse was developed to meet the need for circuit protection, yet permit normal momentary motor overloads without blowing the fuse. But when a short circuit develops, the flat metallic fuse link will blow. If a motor overloads the circuit, the special alloy "glob" in the fuse will melt. The attached spring will then disconnect the electrical circuit. Regardless of their ampere rating, these fuses screw into any regular Edison-base fuse receptacle without an adapter. One disadvantage in its use, then, is that an unknowing person might replace the correct size of time-delay Edison-base fuse with one that is too large to provide proper circuit protection.

The tamper-resistant, time-delay, dual-element Type-S fuse was designed to protect circuits more adequately than either of the above. The latest code requires this type in all new construction that has fused service entrance panels. It makes overfusing by an unknowing person much more difficult. Each Type-S fuse must be equipped with a matched adapter that is first turned into each circuit fuse receptacle.

Three common sizes of adapters are available for home wiring circuits — these are for 15-ampere circuits, 20-ampere circuits and 30-ampere circuits. Each of these adapters differs in length and in thread type, making it impossible to insert a fuse of higher amperage into an adapter, once that adapter has been locked into place. Such fuses are also available in smaller sizes to protect individual fractional horsepower motors from needless burnout. Burned-out motor replacements are expensive in terms of dollars and energy for manufacturing.

Circuit breakers provide the same type of time-delay features that equal-size time-delay fuses provide. Either type of protection is permitted by the National Electrical Code. Because of a circuit breaker's time-delay feature, it may not need to trip for months, even years on circuits with light loads. Therefore, it is good practice to switch each breaker in your main panel off and on at least once every six months to keep them in good operating condition.

Replacing with the correct fuse

If your circuits are not now identified on your entrance panel, you can make up your own identification record by following this procedure:

- Turn on all lights in the house.
- Go to fuse box. **Stand on a dry board** and remove one fuse. (Check type and size.)
- Tour the house; note the lights that have gone out and check with a test lamp (or small portable electric tool) for duplex outlets that have gone dead.
- Make a record of lights and outlets served by this circuit.
- Replace the fuse with the right kind and size of fuse. In most cases, a 15-amp should be used. The right size of tamper-resistant, Type-S fuse with adapter will upgrade old systems and ensure greater safety.
- Repeat the above procedure for remaining fuses.

Follow a similar procedure if you have the circuit breaker type of service entrance panel. Since manufacturers use different designs for this equipment, check resetting instructions inside the breaker panel. If you follow procedures given, the trigger mechanism will reset properly. Some breakers must be moved to an extreme off position before they will reset.

Trouble shooting

Looking for the cause of a blown fuse or tripped breaker need not be time-consuming if you investigate it in a systematic manner. If you know the cause of trouble, correct it; then replace the fuse or reset the breaker. If you do you do not know the cause of the trouble:

- Locate main service entrance panel. It is usually near the point where wires enter the house.
- Locate fuse or breaker that controls power to the circuit that failed.
- Check lights served by other circuits to be sure main power source is on.
- Check for equipment that is hot or has a burned odor.
- Disconnect any equipment recently added to the circuit.
- After locating and correcting the source of trouble, replace the blown fuse with the proper size of Type-S, time-delay fuse (15 amp for #14 wire and 20 amp for #12 wire circuits). If you aren't sure of normal circuit wire size, use the #15 ampere Type-S time-delay fuse. If, after giving a breaker an ample cooling period, it does not hold, recheck the load on this circuit.
- If trouble continues, call your local electrician.

What about cartridge fuses?

In the average home, cartridge fuses are often used on the special 3-wire, 120/240 volt circuits for ranges, clothes dryers and for 240-volt water heaters. They are available in two types: the ordinary, single-link type and the time-delay, dual-element type. All cartridge fuses for household use should have a voltage rating of not more than 300 volts. Cartridge fuses with higher voltage ratings will not fit the normal pullout fuse holders found in homes. Where motors make up the main load on a special circuit, use the time-delay, dual-element fuse.

Circuit breakers

Circuit breakers are commonly used for protecting wiring and for safety. A simple bi-metal heating mechanism in each unit trips the breaker when the circuit is overloaded. Individual units for home circuit protection are usually rated at 15 or 20 amperes. From 30 to 50 ampere breakers are sometimes used for protection of special circuits.

It is possible to increase the number of circuits in an existing service panel by using dual circuit breakers. When adding circuits, be very careful to avoid overloading established service equipment. Hire a competent electrician or other qualified person to plan and install new circuits.

Rewiring needed?

The number and kind of major appliances and the method of heating in a home will determine the size of service entrance conductors needed. For the modern home with a fuel-fired heating system, the entrance wires and service equipment must have a rated amperage of at least 100 amperes. In addition to the range circuit, from 16 to 24 branch circuit positions should be provided.

New or remodeled homes that are heated with electricity need service conductors and service entrance equipment that have at least a 150 to 200 amperes capacity. In addition to the above 16- to 24-circuit positions, at least another 10 120-volt circuit positions (five 240-volt circuits) will be needed.

Where electric power suppliers offer a combination heating/air conditioning electric rate, place both heat and air conditioning circuits in the separate 100-amp panel. This will help maintain load balance.

Where electric home heating equipment is not separately metered, one large service entrance panel will suffice. A word of caution is in order, however. Don't preclude easy expansion of your wiring system by installing a panel that is too small or completely loaded now. Remember, the difference in cost of a 200-amp and a 150-amp service entrance panel is small, and the labor-installation cost difference is also low.

While each new home should have its own wiring plan that conforms to family living patterns, the minimum wiring system for a non-electrically heated home should accommodate those appliances and circuits shown in Table 1.

Table 1
Appliance-circuit schedule for modern home (minimum).

Appliance	Nominal load	Usual voltage	Number of circuit positions to allow
Range	12,000 watts	120/240 volts	2
Water heater	4,500 watts	240 volts	2
Clothes dryer	5,000 watts	120/240 volts	2
Clothes washer	600 watts	120 volts	1
Dishwasher	1,200 watts	120 volts	1
Appliance circuits	3,000 watts	120 volts	2
Lighting circuits[1]	3 watts per square foot[1]	120 volts	4
Food freezer	1,000 watts	120 volts	1
Fuel fired heat system	600 watts	120 volts	1
Air conditioner	2,000 watts	240 volts	2
Waste disposer	500 watts	120 volts	1

Spares (minimum)		120 volts	3

[1]Based on outside house dimensions: include finished basement rooms.

As indicated, each 240-volt major appliance requires two circuit positions; each 120-volt appliance only one. Table 2 shows the relative physical size of number 14 through number 0 copper conductors. The maximum load that each conductor should carry and the fuse or breaker size is shown at 115/230 volt levels, which are often used in the National Electrical Code. Power suppliers attempt to maintain 120/240 volts at the electric meter, however.

Table 2
Relationship between wire size, electrical load and fuse size.

Gauge size	Maximum watts at 115V	Maximum watts at 230V	Fuse or breaker amps
14	1,725	3,450	15
12	2,300	4,600	20
10	3,450	6,900	30
8	4,600	9,200	40
6	6,325	12,750	55
4	8,050	16,100	70
2	10,925	21,850	95
0	14,375	28,750	125

As indicated earlier, electricity is one of the safest sources of energy **if** your wiring system is properly designed and installed with the proper control valves. Adequate wiring comes first, then proper selection and maintenance of protective equipment. Don't accept substitutes when purchasing fuses.

Many businesses do not always carry a complete stock of time-delay fuses of either type. Thus, you must guard against the possibility of uninformed sales personnel trying to sell you a much-too-large, potentially dangerous, 25- or 30-amp ordinary fuse, when a time-delay fuse of much smaller size is what you want and need for adequate protection. Remember, too, that for many of the individual appliance circuits, especially motor-operated appliances, you will need time-delay fuses 15 amperes in size. If your local dealers cannot provide what you need for your safety and protection, consult your local electric power supplier or insurance company. They will help you find the right equipment. Many will also provide valuable tips and plans on energy-conserving home or farmstead wiring systems.

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- G1408, Electric Heat Cable for Farm and Home Use
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