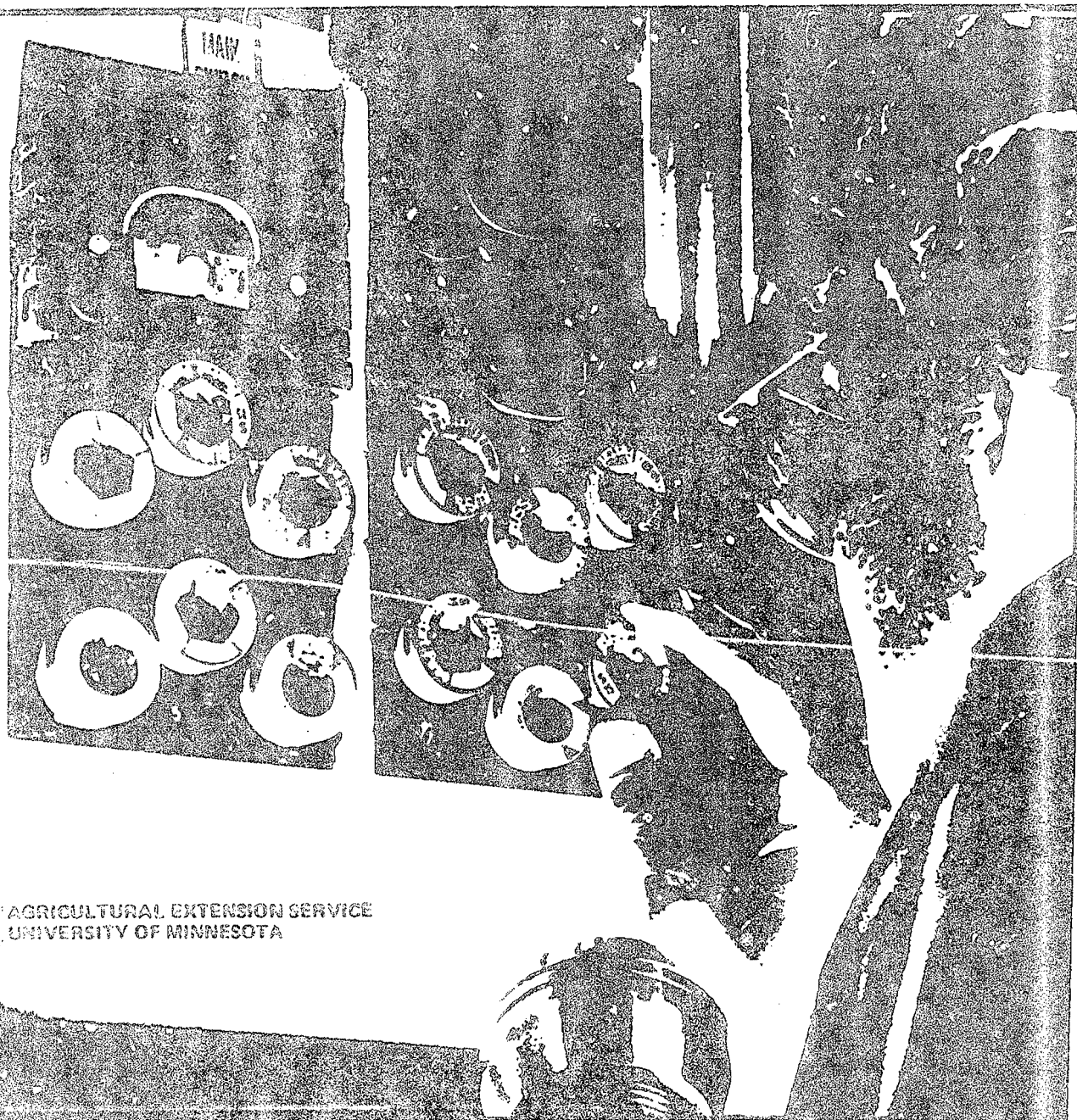


evaluating wiring in older minnesota homes



AGRICULTURAL EXTENSION SERVICE
UNIVERSITY OF MINNESOTA

evaluating wiring in older minnesota homes

Wiring is a critical variable influencing a family's comfort and safety. Deficiencies are a frequent source of inconvenience, a threat to safety, and often costly to correct. Buyers and remodelers of older homes should, therefore, become familiar with the basic elements and operation of the electrical system.

Evaluating an electrical system is not difficult. If one becomes familiar with a few basics, it can become one of the easiest steps in assessing an older home. The following information will help buyers and remodelers of older homes determine if serious defects exist. If additional help is needed, consult a licensed electrical contractor or local electrical inspector. An electrical contractor can tell a buyer or remodeler exactly what electrical problems exist and approximately how much it will cost to correct them. Please recognize that most electrical inspectors have schedules that do not allow individual consultation and teaching homeowners how to wire. A person who wants this training should contact a vocational school.

Remodelers should realize that it is desirable, as well as legally required, to obtain an electrical permit from a local inspector before beginning any rewiring or new wiring work. In Minnesota, the *National Electrical Code* establishes minimum safety standards for rewiring older homes as well as new wiring for additions. The code is based upon accepted good electrical practices. Thus, remodelers will want to follow the code. This will help them install a safe and adequate electrical system that is more likely to pass the final safety inspection. Remember, for one's own safety, any rewiring and new wiring should be started only after a permit is obtained.

The information presented in this folder is intended to help buyers and remodelers of older homes work with an electrical inspector, licensed electrical contractor, or licensed electrician. It is not a guide for untrained individuals who want to save money by doing their own work. Consult qualified individuals before doing or having any electrical work done.

THE BASICS OF ELECTRICAL WIRING

An electrical system in a home is relatively simple to understand. It operates in the following way:

- The amount of electricity that flows is measured in amps (or amperes). Because some appliances need more electricity, they are said to "draw more amps."
- The force at which electricity is delivered is measured in volts. Some appliances such as electric ranges, dryers, and large air conditioners require more force, or volts, to operate.
- The combined amount (amp) and force (volt) of electricity is measured in watts. For example:
 5 amps flowing at 115 volt = 575 watts (5×115)
 10 amps flowing at 115 volt = 1150 watts (10×115)
 5 amps flowing at 230 volt = 1150 watts (5×230)

Thus, watts measure the combined amp amount and volt force through an appliance as illustrated below (figures rounded):

Appliance	Amps	Volts	Watts
Air conditioner (window)	0 to 11	115	690 to 1,380
Air conditioner (central)	22	230	5,000
Clock	.3	115	3.5
Washer	5 to 8	115	575 to 920
Dryer (electric)	22 to 30	230	5,000 to 6,900
Dryer (gas)	5 to 8	115	575 to 920
Dishwasher	15	115	1,840
Garbage disposal	5 to 8	115	575 to 920
Iron	10	115	1,150
Electric range	35 to 70	230	8,000 to 16,000
Refrigerator	5 to 8	115	575 to 920
Toaster	10	115	1,150
Television (black-white)	3	115	345
Television (color)	5	115	575

- If too much electricity flows through a circuit, the wire gets too hot. Smaller wires cannot carry as much electricity as large wires. Thus, smaller capacity fuses or circuit breakers are placed on these circuits as safety switches. When too much electricity flows through the fuse or circuit breaker, it stops the flow of electricity to prevent a fire. For safety, fuses and circuit breakers must be replaced by a proper size fuse or circuit breaker for the size of wire in the circuit (diagram 1).

Diagram 1. Capacities of wires and fuses

Wire size (copper)



No. 14-15 amps



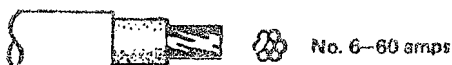
No. 12-20 amps



No. 10-30 amps



No. 8-40 amps



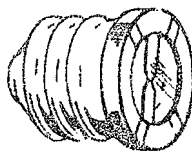
No. 6-60 amps



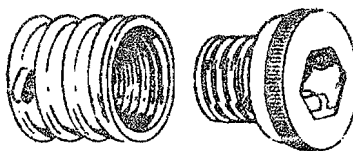
No. 4-70 amps



No. 2-100 amps



This is an old "Edison base plug fuse" which should (and legally must in many communities) be replaced with the "Type-S Adaptor" (below left) and "Type-S Fuse" (below right) in all 15, 20, and 30 amp circuits.



"Cartridge fuses" like this are found in circuits rated 60 amps or less.



"Knife blade fuses" like this are found in circuits rated over 60 amps.

Diagram 2. Minnesota FHI-VA Minimum Electrical Service

1. All single family dwellings with less than a 60 Amp. 115-230 volt 3-wire service will require a 100 Amp. 115-230 service.
2. An existing 60 Amp. 115-230 volt service may remain if:
 - a. It is in good safe condition.
 - b. It is not overloaded.
 - c. If major electrical appliances are to be added or if additional circuits or greater electrical loads are needed, Section 220-8 of the NEC "Optional Calculation for Additional Loads in Existing One-Family Dwelling Occupancies" shall be used.
3. Internal wiring and outlets shall conform to:
 - a. One 15 Amp. branch circuit with balanced load for every 575 sq. ft. of habitable floor area.
 - b. At least one duplex receptacle on a separate 20 Amp. kitchen appliance circuit.
 - c. At least one duplex receptacle on a separate 20 Amp. laundry circuit.
 - d. Minimum numbers of receptacle outlets shall be as required by the local Housing Maintenance Code. (See Electrical outlets below.)
 - e. Bathrooms shall have at least one receptacle. This receptacle may be in wall light if readily accessible.
 - f. All hazardous wiring and all disconnected wiring shall be removed. This includes wiring to and in garages and other accessory buildings.

All applicable local codes and ordinances, when more stringent, shall apply.

Adding Loads to an Existing 60 Ampere Service in a Single Family Residence

There has been much discussion and confusion relative to how much additional load is permitted to be added to an existing 60 Ampere service in an existing single family dwelling.

The National Electrical Code gives two methods of making this determination, both of which are acceptable. One is to calculate the load as per Section 220-4 "Calculation of Feeder Loads." The other method is relatively simple and is now in the 1971 National Electrical Code Section 220-8 "Optional Calculation for Additional Loads in Existing One-Family Dwelling Occupancy." Section 220-8 has merit and is valuable as a quick check method to determine if additional load can be added to an existing 60 Amp. service.

Electrical outlets. In all existing dwellings now or hereafter supplied with electrical service, every habitable room with 120 square feet of habitable floor space or less shall be provided with two separate floor or wall type electric convenience outlets, and an additional electric convenience outlet shall be required for each additional 60 sq. ft. or fraction thereof of habitable floor space, required outlets shall, insofar as possible, be spaced equal distances apart. Kitchens and rooms with kitchen areas shall have one electric convenience outlet in addition to the number herein required for other habitable rooms. One ceiling type electric light fixture or one wall type electric light fixture controlled by a remote switch may be supplied in lieu of one required electric convenience outlet in each habitable room. Every public hall, water closet compartment, bathroom laundry room and furnace room shall contain at least one supplied electric light fixture. All electric outlets and fixtures shall be installed, maintained, and energized by a source of electric power in a manner complying with the city electrical code applicable now or at the time such outlets or fixtures were or are installed. The electric service and all wiring shall be maintained in good condition and used in a safe manner. The Director of Inspections may order hazardous electrical installations removed.

There has been some confusion when a light fixture can be substituted for a required convenience outlet. A ceiling or wall type light fixture can only be substituted for an electrical convenience outlet (receptacle) when it is controlled by a remotely located wall switch. Also, note the number of outlets required above the minimum is determined by the room size.

Electrical Certification

Contractor's Name _____

Address _____

License Number _____

Issued by _____

This is to certify that a licensed electrician employed by this firm has inspected the electrical system of the dwelling located:

1. This inspection reveals that this system (_____ AMP Service) is consistent with the code enforcement standards applicable to this jurisdiction that all visible wiring is properly installed and is in good condition and meets the VA/FHA minimum electrical standards for Minnesota.
2. This property does not meet the VA/FHA minimum electrical standards and the following work is necessary to meet the standard.

I certify that I am authorized to sign this certification on behalf of _____

and that, by the signature hereinafter made, _____

_____, is duly bound under the terms and conditions of the certification.

In the event that the certification as to condition of the electrical system, based on examination of visible elements, on the date of the inspection hereinbefore referred to is subsequently found to have been inaccurate and that a prudent Certifier hereby agrees to make such expenditures as may be necessary to make or cause to be made, the repairs found to be necessary provided such faulty condition is determined to have been in existence on or before the date of this certification.

I further certify that I have no interest, present or prospective, in the property, buyer, seller, broker, mortgage or any other party involved in the transaction.

Warning

Section 1010 of Title 18, U.S.C., Federal Housing Administration transaction, provides: "Whoever, for the purpose of - influencing in any way the action of such Administration - makes, passes, utters, or publishes any statement, knowing the same to be false - shall be fined not more than \$5,000 or imprisoned not more than two years, or both." Other Federal Statutes provide severe penalties for any fraud as intentional misrepresentation made for the purpose of influencing the issuance of any guaranty or insurance or the making of any loan by the Administrator of Veterans' Affairs.

Date _____

Signature and Title

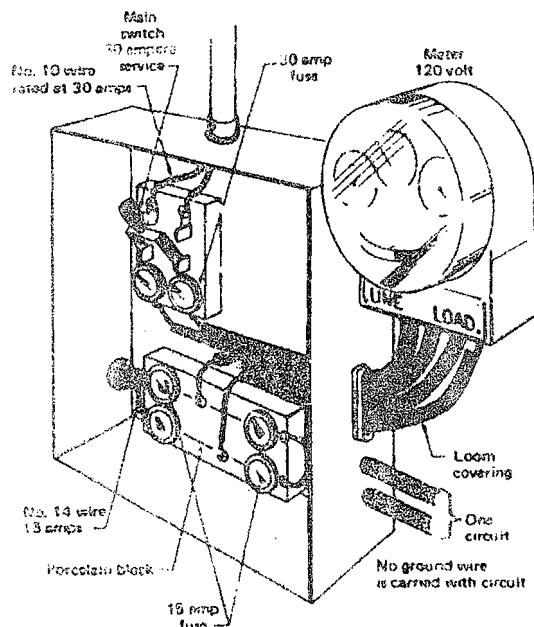
ELECTRICAL STANDARDS

The three basic codes or standards that relate to wiring and rewiring in older homes are:

- **Local Housing Codes**—Most communities have regulations requiring property owners to maintain a minimum amount of safety and health in electrical service. These regulations relate to safety and not necessarily efficient, convenient, or adequate wiring. Most electrical regulations of local housing codes are patterned after the *National Electrical Code* although they often vary to some degree between communities.
- **FHA-VA Minimum Electrical Requirements**—If a home buyer applies for an FHA, FmHA, MHFA, or VA mortgage,² the home is inspected by a licensed electrician who completes an "Electrical Certificate" (diagram 2). The home wiring must be brought up to the minimum FHA-VA electrical requirements. These requirements are usually similar to (as in St. Paul) or the same as (as in Minneapolis) local housing codes.
- **National Electrical Code for One and Two Family Dwellings (NEC)**—The electrical code establishes national standards for installing wiring when rewiring an older home or building a new home. Paperback copies of the NEC are available for \$6.50 (price as of January 1, 1978) from the State Board of Electricity, 1954 University Avenue, St. Paul, MN 55104.

A home must always meet any local housing code. It must meet the FHA-VA requirements only if FHA, FmHA, MHFA, or VA financing is involved. It must

Diagram 3. 115 volt—30 amp service



NOTE: Both conductors are fused. When new service is installed only hot or phase wire is fused or protected.

meet the NEC if wiring is installed or existing wiring is changed. The local inspector is directly responsible for enforcing these standards.

ADEQUACY OF WIRING CAPACITY

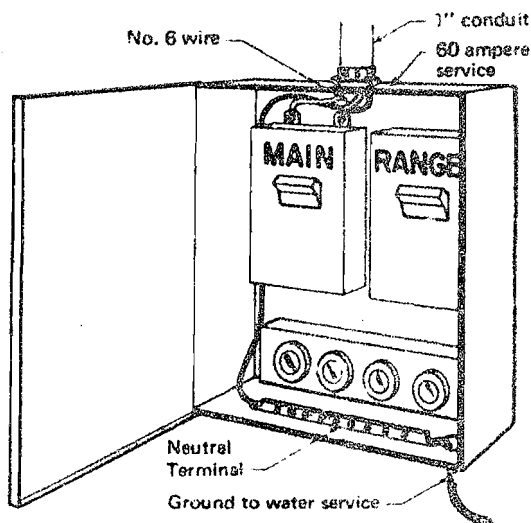
The capacity of the wiring system in older homes should be of special concern. Many older homes, while adequately wired when built, do not provide the amount of electricity needed for common appliances or additional expansion.

Amp Capacity

To be adequate, the wiring system must be able to deliver the amps required by the home's appliances. Buyers of older houses will find wiring systems of the following capacities:

- **30 Amp (diagram 3)**. This capacity service was installed before 1920 to replace gas lights with electric lights. It can handle only a limited amount of lighting and a few minor appliances. It is not adequate for most families. Furthermore, additional circuits cannot safely or legally be added. FHA-VA minimum electrical requirements do not allow 30 amp service to remain if the buyer obtains an FHA, FmHA, MHFA, or VA mortgage.
- **60 Amp (diagram 4)**. This service may be adequate if only one major appliance such as a range, dryer, or air conditioner is used. This size service is the minimum allowed under FHA-VA requirements for FHA, FmHA, MHFA, or VA financing or under the NEC if new circuits are to be added. Under the NEC, for example, if you have an electrical range, you cannot add a circuit for an air conditioner without increasing the service to 100 amps.

Diagram 4. 115/230 volt—60 amp service



²FHA, FmHA, MHFA, and VA are abbreviations for Federal Housing Administration, Farmers Home Administration, Minnesota Housing Finance Agency and Veterans Administration.

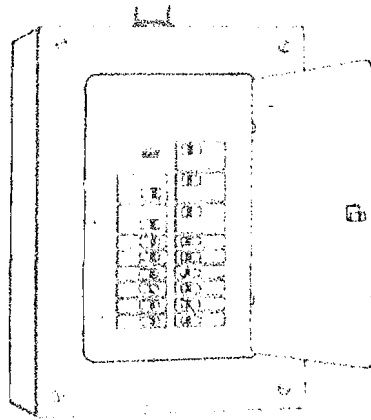


Diagram 5. 115/230 volt - 100 amp service

100 Amp (diagram 5). This size is the minimum required for new houses and the minimum accepted when rewiring older houses. It will be adequate for most loads including electric dryers, ranges, water heaters, and air conditioners. Unusual loads such as electric heating will require a larger service such as 150 or 200 amp.

If questions arise about the adequacy of a 60 or 100 amp service, you may wish to check with a licensed electrical contractor or electrical inspector. You can also refer to section 220 of the NEC to help check the service capacity considering your likely electrical demand.

Number of Circuits

One generally can tell the number of circuits in a house by counting the number of fuses or circuit breakers. In some cases, however, "dummy" fuses or circuit breakers are installed to either fool the untrained eye or facilitate future expansion. To determine the actual number of circuits, a licensed electrical contractor should inspect. This individual also can tell you the capacity of each circuit, which may also be deceiving to the untrained because unsafe overfusing (replacement of burnt-out fuses with larger fuses) often occurs in older homes. The licensed electrical contractor can also tell you what must be done to correct an inadequate number of circuits or overfusing and how much it will cost.

The NEC states that a single 15 amp circuit shall not be used to service more than 575 square feet of floor area. Ten lights and convenience outlets on a single 15 amp circuit is a reasonable maximum number.

When rewiring, two separate 20 amp circuits are required for servicing the kitchen (1 circuit) and the laundry (1 circuit). Separate circuits are necessary because of the larger appliances connected to the kitchen and laundry convenience outlets (lights must be on other circuits). The NEC requires a separate circuit if window air conditioners draw more than 50 percent of the capacity of the general circuit.

WIRING TYPES AND METHODS

One of the most common and most dangerous problems³ in home wiring is the improper connection, especially between wires and switches, receptacles, and connectors. When connections are loose, fuses and circuit breakers cannot detect the problem. Heat builds up to the point that a fire may result. Improper connections often are indicated first by hot outlet or switch plates, the smell of smoldering insulation, or flickering lights and fluctuating appliance operation. If you suspect improper connections, contact a licensed electrical contractor immediately.

Most wiring devices such as receptacles (outlets) have been designed for use with copper wire⁴ or conductors. Until recently all wiring was installed with copper wire. In the past few years, however, aluminum wire has been used. Either copper or aluminum wire may be used for wiring or rewiring with switches, receptacles, and connectors tested and listed by a recognized testing laboratory (e.g., Underwriters Laboratory) and designed and listed specifically for use with that type of wiring. It is extremely dangerous and

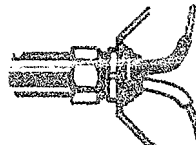
Diagram 6. Common wiring methods found in older homes



Romex (1972 to present)
—also known as nonmetallic-sheathed cable (with a grounding wire).



Greenfield (1947 to present)
—also known as Flexible Metal Conduit.
—used to carry conductors.



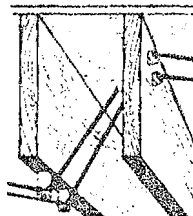
EMT Conduit (1932 to present)
—Electric Metallic Tubing (EMT).
—used as a raceway to carry conductors.



BX Cable (1930 to present)
—also known as Armored Cable (type A.C.).
—used primarily for concealed wiring in ceilings and walls.



Nonmetallic Cable (1943 to 1947)
—nonmetallic cable without a grounding wire.
—used in St. Paul and other cities, but not in Minneapolis, during the 1943 to 1947 period of metal shortage.



Knob and Tube (1900 to 1930)
—used primarily before 1930, although also used for concealed wiring in Minneapolis and other cities during the 1943 to 1947 metal shortage.
—existing knob and tube wiring may continue to be used if it is not exposed and within 8 feet of the floor.
—no new knob and tube may be installed.
—see diagram 7.

³For instance, during the summer of 1976, improper connections resulted in three fatalities and more than \$6,000,000 in fire damage in St. Paul alone.

⁴Termed conductor in the NEC.

illegal to connect with aluminum wire to devices designed for use with copper wire.

REWIRING CONSIDERATIONS--A CHECKLIST

All hazardous and illegal wiring (usually improperly installed by a do-it-yourselfer) should, and legally must, be removed. Common unsafe and illegal deficiencies include the items listed in the following checklist.

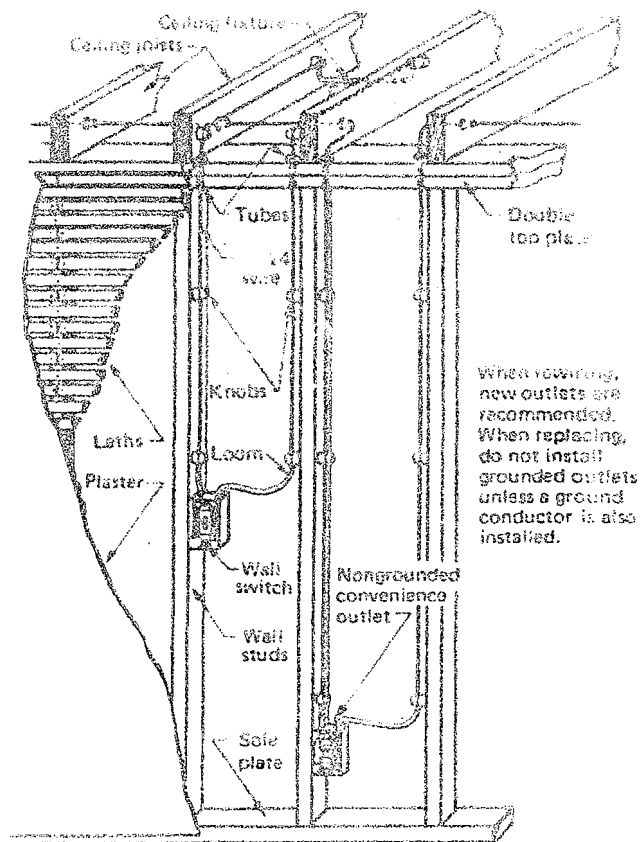
Existing condition
O.K. Def.

Common unsafe and illegal wiring in older homes

- _____ appliances fed from overhead lights
- _____ open, unprotected splices
- _____ loose or broken boxes, switches, and receptacles
- _____ exposed knob or tube wiring within 8 feet of a floor (often found in garages and basements)
- _____ octopus outlets serving several appliances (additional outlet needed)
- _____ areas where electrical equipment is used frequently such as basement shops without convenience outlets (additional outlets needed)
- _____ overhead wiring within 10 feet (horizontal) of a swimming pool must be moved (see article 680 of the NEC for additional information).
- _____ if a garage is already wired, it should have at least one light and one convenience outlet both of which are grounded.
- _____ when rewiring, although not required, it is desirable to provide for lighting and convenience outlets to the garage, entrances, patios, etc.
- _____ when rewiring, new convenience outlets installed in the bathroom or outside must include ground fault circuit interrupter protection.
- _____ every room, other than store rooms and unfinished attics and basements, should and legally must have:

- _____ at least two wall or floor convenience outlets for the first 120 square feet of floor area.
- _____ an additional wall or floor convenience outlet for each additional 80 square feet of floor area or fraction of 80 square feet. For example, a 10 by 22 foot (220 square foot) living room would require at least four convenience outlets (two convenience outlets for the first 120 feet, one convenience outlet for the next 80 feet, and one convenience outlet for the next fraction of 80 feet).
- _____ kitchens require at least one additional outlet, beyond the 120/80 square foot requirements, which shall be on a 20 amp circuit. Metal light fixtures within 8 feet above the kitchen sink or 5 feet to the side of the kitchen sink must be grounded.
- _____ dining rooms, when new circuits are added, must have a convenience outlet serviced by a 20 amp circuit.
- _____ bathrooms must have at least one light fixture and one convenience outlet which may be in the light fixture if it is easily reached. Metal fixtures in the bathroom must be grounded. (If new convenience outlets are installed, they must be protected by a ground fault circuit interrupter.)

Diagram 7. Existing knob and tube wiring



_____ laundry areas must have at least one convenience outlet serviced by a separate 20 amp circuit.

_____ if ceiling light fixtures (controlled by a separate switch) are provided, the required number of wall or convenience outlets may be decreased by one. For example, the 220 square foot living room requires as a minimum either four convenience outlets or three convenience outlets and one ceiling light fixture controlled by a separate switch.

_____ at least one light fixture shall be provided in the hall, stairway, laundry room, and furnace room.

_____ in unfinished basements, attics, and other non-habitable rooms, one light fixture is required.

_____ finally, overfused and overloaded circuits must be corrected. The correct size fuse depends on the size of wire used (diagram 1).

These are minimum safety and convenience standards required by local housing codes (such as Minneapolis and St. Paul) and the NEC for rewiring. Requirements for better wiring are greater than these standards.

REWIRING AND WIRING PROCEDURES AND PERMIT REQUIREMENTS

The following items represent the steps needed to insure that a wiring and rewiring job is safe, adequate,

and legal. By following these steps, you will avoid exposing one's family to hazards and being "ripped-off" by incompetent fly-by-night operators.

First, Determine What Should Be Done and Consider Your Immediate Needs

Carefully evaluate electrical needs, and list the new lights, switches, and receptacles desired. Take the time to list new wiring and specific locations of the new outlets in each room. Include the basement, garage, and attic in the list.

Don't Forget to Consider Your Anticipated Needs

Evaluate possible future electrical needs such as electric heat, central air conditioning, electric range, electric dryer, or electric water heater. These needs should be considered before consulting a contractor so the size of the electric service can be established. Normally a 100 amp., 115/230 volt service is adequate, but future needs may dictate a larger service. The difference in cost between a 100, 150, or 200 amp. 115/230 volt service is not very great.

Are You Allowed to Do Your Own Rewiring or Wiring?

The answer is yes for remodelers who own and occupy the single-family home to be rewired. Some local inspection departments, including Minneapolis and St. Paul, require that the remodeler sign an affidavit (before the permit is issued for do-it-yourself work) stating that:

- he or she lives at and owns the single-family home for which a permit is requested.
- he or she will personally purchase all materials and personally perform all labor in connection with the permit.

If You Legally Can Do The Work, Should You?

The answer is maybe. If a remodeler knows what he or she is doing, knows the code requirements, has the time and patience, has the tools, and respects the power of electricity, the answer is probably yes. Otherwise, a licensed electrical contractor is the best way to go. Remember, most electrical inspectors have schedules which do not permit individual consultation and teaching homeowners how to wire.

What If You Decide to Hire an Electrical Contractor?

The most important consideration becomes how to select a competent, licensed, and bonded contractor. To select an electrical contractor:

- first, check with the local electrical inspector or contact the State Electrical Board (1954 University Avenue, St. Paul, MN 55104) to insure that the contractor is licensed.
- ask material suppliers, neighbors, and friends for their recommendations.
- check with your Better Business Bureau about the contractor's record.
- shop around; charges for the same work may vary substantially.
- request written bids from several contractors. When comparing bids, make sure the contractors were bidding on the same amount of work. Also realize that a low bid may be undesirable if the resulting job is full of problems and delays. Consider the contractor's track record as well as his or her bid.
- it is desirable to have a written contract which specifies the total and itemized costs, that the contractor will obtain all necessary electrical permits in his or her own name, that the home's wiring will meet or exceed all applicable codes when completed, and that final payment will be made after the final inspection by the electrical inspector and after the contractor has furnished lien waivers from all material suppliers and subcontractors (as required by Minnesota law).

Remember, A Permit Is Both Desirable and Legally Required Before Work Begins!

Even competent do-it-yourselfers and licensed electrical contractors occasionally make mistakes. By obtaining a permit, the consumer is assured that the inspector will do everything he or she can to give help and protection. When the job is completed, the inspector will make a final check to make sure everything is safe.

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In cooperation with:

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- Kenneth L. Gebert, supervisor of electrical inspection, Minneapolis Department of Inspections, Minneapolis, Minnesota.

Sources:

- *Basic Housing Inspection*. U.S. Department of Health, Education, and Welfare, Washington, D.C. 1976.
- *National Electrical Code for One and Two Family Dwellings*. National Fire Protection Association, Boston, Massachusetts, 1978. (Available from State Board of Electricity, 1954 University Avenue, St. Paul, Minnesota 55104. \$6.50 for paperback edition as of January 1, 1978. Note: Code is revised every 3 years.)