



RESIDENTIAL ELECTRICAL WIRING GUIDELINES

REQUIRED BRANCH CIRCUITS

- (a) Small Appliance Branch Circuits – The NEC required a minimum of two 20-ampere branch circuits to supply receptacle outlets for small appliance loads, including refrigeration equipment, in the kitchen, pantry, breakfast room, and dining room. These circuits, whether two or more are used, shall NOT supply anything other than receptacles in these areas. Lighting outlets and built-in appliances such as garbage disposals, exhaust hoods, microwaves, dishwashers, and trash compactors are NOT permitted on these circuits. Kitchen countertop receptacles must be supplied by these small appliance branch circuits.

Exception: The receptacle outlet for refrigeration equipment shall be permitted to be supplied from an individual branch circuit rated 15 amperes or greater.

- (b) Laundry Branch Circuit – One 20-ampere branch circuit must be provided for the laundry. This circuit is limited to receptacles within the laundry room. No other outlets or lighting is permitted on this circuit.
- (c) Bathroom Branch Circuit – At least one 20-ampere circuit for bathroom receptacle outlets shall be supplied. Such circuits may have no other outlets.

Exception: Where the 20-ampere circuit supplies a single bathroom, outlets for other equipment within the same bathroom shall be permitted to be supplied in accordance with 210.23(A). This circuit would NOT be used to supply a whirlpool bath or a hot tub!

- (d) Central Heat – Central heating equipment shall be supplied by an individual branch circuit.
- (e) General Lighting Branch Circuits – Shall be computed on a three watts per square foot basis. You may wire up to 600 square feet of living area on a 15-ampere branch circuit or up to 800 square feet on a 20-ampere circuit. These branch circuits may supply lighting outlets in all areas of the dwelling and receptacle outlets, other than those covered in (a) – (d) above.
- (f) Arc-Fault Circuit Interrupter Protection – All 120-volt, single phase, 15- and 20-ampere branch circuits supplying outlets installed in dwelling unit family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways or similar areas shall be protected by a listed arc-fault circuit interrupter, combination-type, installed to provide protection of the branch circuit.

PLEASE CONTACT YOUR LOCAL INSPECTOR FOR SPECIFIC QUESTIONS.

REQUIRED RECEPTACLE OUTLETS

NOTE – Changes in the 2008 National Electrical Code require, for dwelling units, all 125-volt, 15- and 20-ampere receptacles shall be listed tamper-resistant receptacles. All 15- and 20-ampere, 125- and 250-volt non-locking receptacles located in damp or wet locations shall be a listed weather-resistant type.

- (a) At least one outlet shall be installed in bathrooms within 36 inches of the outside edge of each basin. The receptacle outlet shall be located on a wall or partition that is adjacent to the basin location.
- (b) At least one outlet shall be installed in each attached garage, and in each detached garage with electric power.
- (c) At least two outlets installed outdoors, one on the front and one on the back of the dwelling, accessible at grade level. Outdoor outlets installed in wet locations shall be a listed weather-resistant type and shall have an enclosure that is weatherproof whether or not the attachment plug cap is inserted. At least one outlet shall be installed for any balcony, deck or porch of 20 square feet or larger.
- (d) At least one receptacle must be installed in each unfinished portion of the basement. This receptacle is in addition to any receptacles that may be installed for laundry or other specific purposes and GFCI protected.
- (e) In every kitchen, family room, dining room, living room, parlor, library, den, sun room, bedroom, recreation room or similar room, or area of dwelling units, receptacle outlets shall be installed so that no point along the floor line in any wall space is more than six feet horizontally, measured from an outlet in that space, including any wall space, two feet or more in width, and excluding only that space occupied by sliding panels in exterior wall. The wall space afforded by fixed room dividers, such as freestanding bar-type counters, or railings, shall be included in the six-foot measurement. No outlets may be installed over an electric baseboard heater. (Generally stated, this means the first receptacle would be placed within 6 feet of the doorway and the next one within 12 feet of the first one and so forth around the room until you reach another doorway or break in the wall, where you would then need a receptacle within 6 feet of that doorway or break. These measurements are to be made horizontally along the wall at floor line. Separate wall spaces 2 feet wide or more require a receptacle on them.)
- (f) In kitchens and dining area, a receptacle outlet shall be installed at each counter space 12” or wider. Countertop receptacles shall be installed so that no point along the wall line is more than 24”, measured horizontally from a receptacle outlet in that space. Peninsular bars and islands 12” or wider shall have at least one receptacle. (This rule is applied similarly to the 6-12-2 foot dimensions in (e) above except that in the kitchen the dimensions are 24-48-12 *inches* beginning at each end of the countertop.)
- (g) Receptacles installed in the floor must be installed in a listed floor box. These may be purchased as an assembly at most retail electrical supply stores. Receptacles installed in the floor within 18” of the wall may be used in place of wall-mounted receptacles.
- (h) A receptacle outlet is required in any dwelling unit hallway that is ten feet or more in length.

- (i) At least one 15 or 20 ampere, 125 volt GFCI protected receptacle must be installed at an indoor spa or hot tub location, not closer than six feet from the inside wall of the unit and not more than ten feet away from it. Light fixtures, outlets and ceiling fans over spas and hot tubs shall be a minimum of 7'6" above the maximum water level. Outdoor spas or hot tubs have the same requirements as a swimming pool. Check with your local inspector for those requirements.

REQUIRED LIGHTING OUTLETS

- (a) At least one wall switch-controlled lighting outlet shall be installed in every habitable room: in bathrooms, hallways, stairways, attached garages, detached garages with electric power, and at outdoor entrances or exits with grade level access. The lighting outlet for interior stairways shall have a wall switch at each floor level, and landing level that includes an entryway, to control the lighting outlet(s) where the difference between floor levels is six steps or more.
- (b) At least one wall switch controlled lighting outlet shall be installed in an attic, underfloor space, utility room, and basement, where these spaces are used for storage or contain equipment requiring servicing. The switch shall be located at the point of entry to these areas, and the lighting outlet located at or near the equipment requiring servicing.

SMOKE DETECTORS REQUIRED

Smoke alarms shall be installed in the following locations:

- (a) In each sleeping room.
- (b) Outside each sleeping area in the immediate vicinity of the bedrooms.
- (c) On each additional story of the dwelling, including basements but not including crawlspaces and uninhabitable attics. In dwellings or dwelling units with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.
- (d) A 3 wire is required to make the interconnection.

When more than one smoke alarm is required to be installed within an individual dwelling unit the alarm devices shall be interconnected in such a manner that the actuation of one alarm will activate all of the alarms in the individual unit.

CARBON MONOXIDE DETECTORS

The State of Colorado now requires carbon monoxide detectors be installed outside of all sleeping rooms and within 15 feet of each door to these rooms. These can be combination smoke and carbon monoxide detectors, or just carbon monoxide detectors that are either battery operated, plugged in to a non-switched receptacle, or part of a house security system.

Carbon monoxide detectors are required to be installed in every single family dwelling that includes a fuel-fired appliance or an attached garage, and where interior alterations, repairs, fuel-fired appliance replacements, or additions, any of which require a building permit, occurs or where one or more rooms lawfully used for sleeping purposes are added.

GROUND FAULT PROTECTION

A ground fault circuit interrupter must protect ALL receptacles listed below:

- (a) Bathroom receptacles.
- (b) Garages, and also accessory buildings that have a floor located at or below grade level not intended as habitable rooms and limited to storage area, work area, and areas of similar use.
- (c) Outdoors with the following exception:
Receptacles that are not readily accessible and are supplied by a dedicated branch circuit for electric snow-melting or deicing equipment shall be permitted to be installed in accordance with 426.28. Please call your local inspector for more information.
- (d) Crawl spaces – at or below grade level.
- (e) All receptacles in an unfinished basement with the following exception:
A receptacle supplying only a permanently installed fire alarm or burglar alarm system shall not be required to have ground-fault circuit-interrupter protection.
- (f) Kitchens – where the receptacles are installed to serve the countertop surfaces.
- (g) Laundry, utility, and wet bar sinks – where the receptacles are installed within 6 feet of the outside edge of the sink.
- (h) Boathouses.
- (i) Hydro massage bathtubs.
- (j) Spas and hot tubs and associated electrical components.

REQUIRED DISCONNECTING MEANS

Disconnects are required in-sight of the following equipment:

- (a) Electric water heaters.
- (b) Well pump controllers.
- (c) Central heating equipment (furnaces, boilers).
- (d) Spas and hot tubs.
- (e) Hydro massage bathtubs.
- (f) Appliances.

GROUNDING REQUIREMENTS

The service equipment must be grounded in accordance with Article 250 of the NEC, which, in general, says that the neutral must be bonded to the service enclosure and the grounding electrode system as defined in NEC Article 250.50

250.50 Grounding Electrode System. All grounding electrodes as described in 250.52(A)(1) through (7) that are present at each building or structure served shall be bonded together to form the grounding electrode system. The grounding electrodes permitted in 250.52 are (1) Metal Underground Water Pipe (2) Metal Frame of the Building or Structure (3) Concrete Encased Electrode (4) Ground Ring (5) Rod and Pipe Electrodes (6) Other Listed Electrode (7) Plate Electrodes.

NOTE: THE NEC NOW REQUIRED A CONCRETE –ENCASED ELECTRODE TO BE INSTALLED ON ALL NEW INSTALLATION. THIS MUST BE INSTALLED THEN THE FOOTINGS ARE INSTALLED.

250-52(A) (3) Concrete-Encased Electrode. An electrode encased by at least 2 inches of concrete, located horizontally near the bottom or vertically, and within that portion of a concrete foundation or footing that is in direct contact with the earth, consisting of at least 20 feet of one or more bare or zinc galvanized or other electrically conductive coated steel reinforcing bars or rods of not less than ½ inch in diameter, or consisting of at least 20 feet of bare copper conductor not smaller than 4 AWG. Reinforcing bars shall be permitted to be bonded together by the usual steel tie wires or other effective means. Where multiple concrete-encased electrodes are present at a building or structure, it shall be permissible to connect to only one.

In the main service equipment, the neutral and equipment grounding conductors are bonded (connected) together; in sub-panels, the neutral is isolated from the equipment ground.

Each branch circuit or feeder to a building or structure must include an equipment grounding conductor. In rural area, please check with your local inspector for specific requirements

regarding underground service conductors from the meter pole or pedestal to the main service. Other specific provisions of Article 250.32 may also apply.

BRANCH CIRCUIT WIRING

Type NM cable (Romex) is the wiring method most commonly used in residential dwellings. NM cable must have a 90* conductor insulation rating, which is designated on the cable sheath by a "B". Type NM-B #12 and #14 are used for lighting and general purpose receptacle circuits, while #10/2 w/ground is commonly used for electric water heaters, #10/3 w/ ground for electric dryers, and #8/3 w/ ground for ranges and wall mounted ovens. Type SER cable with an insulated neutral is permitted for electric ranges, wall ovens and dryers.

These cables must be protected by overcurrent devices (circuit breakers) which do not exceed the 60 degree rated ampacity. The rated ampacities for common cable types are listed below:

COPPER NM CABLE

15 amperes for #14
20 amperes for #12
30 amperes for #10
40 amperes for #8
50 amperes for #6

TYPE SE AND SER ALUMINUM CABLE

30 amperes for #8
40 amperes for #6

It is important to note that if you begin a circuit with #12, you must use this same wire size throughout, you CANNOT mix different wire sizes on the same branch circuit.

Type NM cable must be stapled within 12" of any box with cable clamps, 8" of plastic boxed without clamps, and every 4 ½ feet thereafter. Listed connectors must be used where NM cables enter cabinets, metal boxes or panelboards. The ampacity of conductors in NM cables shall be derated in accordance with Table 310.15(B)(2)(a) where *more than* 2 cables are placed in a single hole that is fire or draft-stopped **or** are installed, without maintaining spacing, in contact with thermal insulation.

When Type NM cable is installed parallel to framing members, or in bored holes, it shall be located at least 1 ½" from the nearest edge of the framing member, where nails or screws may penetrate the cables. If this distance cannot be maintained, the cable shall be protected by a steel plate or sleeve at least 1/16" thick. Section 300.4 (A), NEC.

Cable or raceway-type wiring methods installed in a groove, to be covered by wallboard, siding, paneling, carpeting, or similar finish, shall be protected by 1/16" thick steel plate, sleeve, or equivalent, or must be recessed in the groove 1 ½" for the full length of the groove in which the cable or raceway is installed. *Exception: Raceways as covered in Articles 342, 344, 352, and 358.* Section 300.4(E), NEC.

Ceiling mounted paddle fan outlet boxed or outlet box systems used as the sole support shall be listed, shall be marked by their manufacturer as suitable for this purpose, and shall not support fans weighing more than 70 lbs. For boxes used to support fans weighing more than 35 lbs., the required marking shall include the maximum weight to be supported. Section 314.27(D), NEC.

(For cord-and-plug connected appliances, an accessible plug and receptacle may serve as the disconnecting means.)

CONDUCTOR FILL

Outlet and junction boxes shall be of sufficient size to provide free space for all conductors and devices enclosed in the box. All outlet boxes have a specific volume, measured in cubic inches. For example, if you had two #12, with ground NM-B cables entering a box with one duplex receptacle, you would need a box with a minimum volume of 15.75 cubic inches. Each #12 that enters the box needs 2.25 cubic inches with the exception of the grounding conductor which require one 2.25 cubic inch for all of the grounds. Also, each strap containing one or more devices is counted as the equivalent of two conductors; therefore, $2.25 \times 7 = 15.75$.

VOLUME REQUIRED PER CONDUCTOR

#14 – 2 cubic inches	#8 – 3 cubic inches
#12 – 2.25 cubic inches	#6 = 5 cubic inches
#10 – 2.5 cubic inches	

EQUIPMENT GROUNDING CONDUCTOR MAKE-UP

All equipment grounding conductors must be connected together with solderless pressure connectors such as wire nuts or crimp sleeve, leaving sufficient extra conductor for attachment to the metal box and/or device. When crimp type connectors are use, they must be crimped using the tool recommended by the manufacturer. Please not that ALL metal junction and outlet boxes must be grounded by attaching the equipment grounding conductor to the metal box using an approved screw or grounding clip. When circuit conductors are made up 9or spliced), a minimum of **six** inches of free conductor must be left for use in make-up and for the attachment of devices.

ELECTRIC HEAT CIRCUITRY

Electric heat may be installed on 15, 20, or 30 amp branch circuits. Listed below is the maximum wattage that may be installed on each size branch circuit. (All circuits are figured at 240 volts)

15A – 2,880 watts maximum
20A – 3,840 watts maximum
30A – 5,780 watts maximum

For example, if you are installing baseboard heaters which are rated 250 watts a linear foot, you could install 15 feet on a 20 amp, 240 volt circuit. $250W \times 15 = 3.750$ watts.

ROUGH-IN INSPECTION

At the time you call for your rough-in inspection, you should have all wire pulled, stapled properly, and all splices made up and ready to accept devices and fixtures. Please **DO NOT** install any devices or fixtures or cover any wiring with insulation or wall covers, i.e., drywall, or paneling. All wire splices and equipment grounding conductor make-up shall be completed prior to the rough inspection.

FINAL INSPECTION

The electrical installation should be complete at the time of require. All devices and fixtures installed, service equipment complete, and labeled properly. All wiring shall be free from short circuits, ground faults and open circuits and have correct polarity. All light fixtures, switches, and receptacles are required to be grounded.

PLEASE DO NOT HESITATE TO ASK YOUR LOCAL INSPECTOR QUESTIONS.

The content of this application must not be changed. If the content is changed, the applicant may be referred to the Colorado State Attorney General's Office for violation of the Colorado law.

***** THE ELECTRICAL INSPECTOR IS NOT AUTHORIZED TO CORRECT, DESIGN, LAYOUT OR INSTALL THE ELECTRICAL SYSTEM. *****

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