Wiring Guidelines-Single Family Dwellings

Building Guides

Building Inspection
385 Kimbark St
303-651-8332

DO NOT HESITATE TO ASK YOUR INSPECTOR QUESTIONS

This guideline has been prepared to assist the lay person in complying with the requirements of all Longmont adopted Electrical Codes, and assure the installation of a safe and reliable electrical system. This guideline is not inclusive for every installation and is not an instruction manual.

Along with meeting NEC requirements, the permit and inspection process defined by ordinance must be followed. If for some reason, the job does not meet the requirements of the NEC and an extra visit is necessary, a re-inspection fee may be required before the inspector can return.

Check our web site (http://www.ci.longmont.co.us/bldginsp/adopted/index.htm) for the currently adopted codes and the City's local adopted amendments. In addition, check with Longmont Power and Communications (303-651-8386) for their requirements.

1. ELECTRIC SERVICE

The service equipment must be large enough to supply the connected load, which is calculated using *Article 220* of the NEC. The most common sizes of residential service equipment are 100, 125, 150, and 200 amperes. The minimum wire size for service entrance conductors are listed below:

Conductor Types and Sizes for 120/240-Volt, 3-Wire, Single-Phase Dwelling Services

RH, RHH, RHW, RHW-2, THHN, THHW, THW, THWN, XHHW, USE*

*Type "USE" (Underground Service Entrance) conductors are not permitted to enter a building unless they are rated with the additional markings RHH and RHW.

COPPER	ALUMINUM AND COPPER CLAD ALUMINUM	SERVICE RATING IN AMPS.
AWG	AWG	
4	2	100
3	1	110
2	1/0	100 (minimum for new home)

COPPER	ALUMINUM AND COPPER CLAD ALUMINUM	SERVICE RATING IN AMPS.
1	2/0	150
1/0	3/0	175
2/0	4/0	200

The service equipment must be grounded in accordance with Article 250 of the NEC, which, in general, says the neutral must be bonded to the grounding electrode system at the main service enclosure.

The main service disconnect shall be mounted either outside or inside the dwelling. The main is allowed inside only when the panel and meter enclosure are mounted directly back to back. All service equipment and electrical panels shall have a clear area 6'6" high, 30" wide and 36" deep in front. This clear area must extend from floor to 6'6" high with no intrusions from other equipment, cabinets, counters, appliances, etc. *Panels are NOT permitted in clothes closets or bathrooms.*

In the main service equipment, the neutral and equipment grounding conductors are bonded together; in sub-panels, the neutral is isolated from the grounding conductor. A concrete encased electrode is required on all new buildings. The electric meter enclosure should be mounted at 5' 6" above finish grade, at the center of the meter opening. Overhead drops should have a clearance of 10' above finish grade to the bottom of the drip loop.

2. BRANCH CIRCUIT WIRING

Type NM (Romex) sized #12/2 w/ground and #14/2 w/ground are used for lighting and general purpose receptacle circuits. #10/2 w/ground is commonly used for electric water heaters, #10/3 w/ground for electric dryers, and #8/3 w/ground & #6/3 w/ground for ranges and wall mounted ovens.

The cables must be protected by over-current devices (circuit breakers), which do not exceed their rated ampacity. The rated ampacities for cable types are listed below:

COPPER NM CABLE	TYPE S.E., AND S.E.R. ALUMINUM CABLE
15 amperes for #14	40 amperes for #8
20 amperes for #12	50 amperes for #6
30 amperes for #10	
40 amperes for #8	
50 amperes for #6	

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

Type NM cable must be stapled within 12" of metal boxes, 8" of plastic boxes and every 4½ feet thereafter. Proper connectors must be used where NM cable enters metal cabinets, boxes or panel boards.

When Type NM cable is installed parallel to framing members, or in bored holes, it shall be located at least 1¼" 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. *Article 300-4(d).*

Cable or raceway-type wiring methods installed in a groove, to be covered by paneling, carpeting, or similar finish, shall be protected by a $^{1}/_{16}$-inch steel plate, sleeve, or equivalent, or must be recessed in the groove 1 ¼-inch for the full length of the groove in which the cable or raceway is installed.

Ceiling mounted paddle fans shall be supported by outlet boxes identified for such use. NEC 314.27d

3. REQUIRED BRANCH CIRCUITS

a. *Small Appliance Branch Circuits* - The NEC requires a minimum of two 20 ampere branch circuits to feed receptacle outlets for small appliance loads, including refrigeration equipment in the kitchen, pantry, breakfast room, and dining room. Lighting outlets and built-in appliances such as garbage disposals, hood fans, dishwashers, and trash compactors are not permitted on these circuits. Kitchen counter top receptacles must be supplied by at least two small appliance branch circuits.

b. *Laundry Branch Circuit* - One 20 amp branch circuit must be provided for the laundry. This circuit is limited to receptacles within the laundry room. No other outlets are permitted on this circuit.

c. *Bathroom Receptacles* - At least one 20 amp circuit for bathroom receptacle outlets shall be supplied.

d. *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 210-23a.

e. *Central Heat* - Central heating equipment shall be supplied by an individual branch circuit.

f. *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.

4. REQUIRED RECEPTACLE OUTLETS

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 that is adjacent to the basin location.

b. At least one outlet shall be installed in every attached garage, and one outlet in every detached garage with electric power.

c. At least two outlets shall be installed outdoors, one on the front and one on the back of the dwelling, accessible at grade level.

d. At least one receptacle must be installed in the unfinished portion of the basement. This receptacle is in addition to any receptacles that may be installed for laundry or other specific purposes.

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 walls. The wall space afforded by fixed room dividers, such as freestanding bar-type counters or railings, shall be included in the six foot measurement. A receptacle outlet is required in any dwelling unit hallway that is ten feet or more in length. No outlets may be installed over an electric baseboard heater.

f. In kitchens and dining areas, a receptacle outlet shall be installed at each counter space wider than 12". 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.

g. Receptacles installed in the floor must use a box-receptacle combination designed specifically for that purpose. Receptacles installed in the floor within 18" of the wall may be used in place of wall mounted receptacles.

h. 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 five 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. Outdoors spa or hot tubs have the same requirements as a swimming pool. Check with your inspector for those requirements.

i. Dwelling Unit Bedrooms. All branch circuits that supply 125 volt, single phase, 15- and 20-ampere outlets installed in dwelling unit bedrooms shall be protected by an arc-fault circuit interrupter(s).

NOTE:

Arc-Fault Circuit-Interrupter Protection: an arc-fault circuit interrupter is a device intended to provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.

5. 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. The lighting outlet for interior stairways shall have a wall switch at each floor level 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, under-floor 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.

Identification of switch leg:

Circuits of 50 Volts or More. The use of insulation that is white or natural gray or that has three continuous white stripes for other than a grounded conductor for circuits of 50 volts or more shall be permitted if part of a cable assembly and where the insulation is permanently re-identified to indicate its use as an ungrounded conductor, by painting or other effective means at its termination, and at each location where the conductor is visible and accessible.

6. GROUND FAULT PROTECTION

All receptacles listed below must be protected by a ground fault circuit interrupter:

a. Bathrooms receptacles.
b. All outdoor receptacles.
c. Garage receptacles except those not readily accessible such as ceiling mounted receptacles or single receptacles in dedicated spaces for appliances.
d. Kitchen receptacles that serve counter top surfaces.
e. Counter top receptacles within 6 feet of a wet bar sink.
f. All receptacles in an unfinished basement or crawl space at or below grade, with these exceptions:
g. Single receptacle within a dedicated location and identified for specific use by a cord and plug connected appliance.
h. Single receptacle serving a permanently installed sump pump.
i. Hydro-massage bath tubs.
j. Spas and Hot tubs, water features and associated electrical components.

7. REQUIRED DISCONNECTING MEANS

Disconnects are required insight of the following equipment:

a. Central heating equipment (furnaces, boilers).
b. Spas, hot tubs and water features.
c. Hydro-massage bath tubs.
d. Air conditioners

8. 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 have two #12/2, 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 requires 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 x 7 = 15.75.

VOLUME REQUIRED PER CONDUCTOR:

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

9. EQUIPMENT GROUNDING CONDUCTOR MAKE-UP

All equipment grounding conductors must be connected together with solder-less pressure connectors such as green wire-nuts or crimp sleeves, leaving sufficient extra conductor for attachment to the metal box and/or device. When crimp type connectors are used, they must be crimped using the tool recommended by the manufacturer.

Please note that all metal junction and outlet boxes must be grounded by attaching the equipment grounding conductor out of the NM cable to the metal box using an approved screw or grounding clip. When circuit conductors are made up, six inches of free conductor measured from the back of the box, must be left for use in make-up and for the attachment of devices.

10. 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 v)

- 15A - 2,880 watts maximum
- 20A - 3,840 watts maximum
- 30A - 5,760 watts maximum

For example, if you are installing baseboard heaters which are rated at approximately 250 watts a linear foot, you could potentially install 15 feet maximum length on a 20 amp, 230 volt circuit at continuous duty.

11. ROUGH-IN INSPECTION

At the time you call for rough-in inspection, you should have all wire pulled, secured properly, and all splices made up and ready to accept devices and fixtures. Please DO NOT install any devices or cover any wiring with insulation or wall coverings, i.e., drywall or paneling. Requirements of # 9 above must be completed prior to the rough inspection.

The building code requires interconnected hard wired battery backup smoke detectors, one on each level, one in the hallway or area serving a sleeping room and one in each sleeping room. Additionally in areas where the ceiling height changes 24” or more on the same level another smoke detector must be installed in the upper ceiling level. Check the manufacture’s installation instructions for smoke detectors placement. For all remodel projects, check with the electrical inspector for smoke detector requirements.

12. FINAL INSPECTION

The electrical installation should be complete at the time of request. All devices and fixtures installed, service equipment complete, and the panel labeled properly. All wiring shall be free from short circuits, ground faults and open circuits.

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