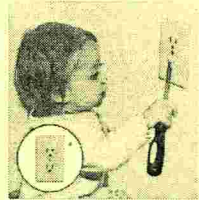


PLAN YOUR WIRING PROJECT

This brochure is intended to be a general overview of residential electrical requirements. No claim is made that this information is complete or beyond question. Additional information and knowledge is needed to properly install electrical wiring that is essentially free from fire and electric shock hazard.

For assistance, please reference authoritative publications based on the 2008 National Electrical Code © (the NEC).

GENERAL CIRCUIT REQUIREMENTS



03 NEC 406.11 All 1 25-volt, 15- and 20- amp receptacles installed in dwelling units shall be listed tamper-resistant. This includes receptacles installed outdoors, in basements and in garages.

04 NEC 210.12 All branch circuits supplying 125-volt, 15 and 20 ampere outlets 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.

05 NEC 210.11 and 422.12 In addition to the branch circuits installed to supply general illumination and receptacle outlets in dwelling units, the following minimum requirements apply:

- Two 20-amp circuits for the kitchen receptacles
- One 20-amp circuit for the laundry receptacles
- One 20-amp circuit for the bathroom receptacles
- One separate, individual branch circuit for central heating equipment

06 NEC 210.52 Receptacles installed in the kitchen to serve countertop surfaces shall be supplied by not less than two separate small appliance branch circuits.

07 NEC 300.3 All conductors of the same circuit, including grounding and bonding conductors, shall be contained in the same raceway, cable, or trench.

08 NEC 408.4 Every circuit and circuit modification shall be legibly identified as to its clear, evident and specific purpose or use in sufficient detail on a directory located on the face or inside of the electrical panel doors.

09 NEC 240.4 Conductors shall be protected in accordance with their ampacity per Table 310.16 and 240.4(D)

10 NEC 406.3 Receptacle outlets shall be of the grounding type, be grounded, and have proper polarity.

Fuse or Circuit Breaker Size	Minimum Wire Size	
	Copper	Aluminum
15 amp	14	N/A
20 amp	12	N/A
30 amp	10	8
40 amp	8	6
50 amp	6	4

Note: Conductors that supply motors, air-conditioning units, and other equipment may have overcurrent protection that exceeds the limitations in the above chart.

An equipotential bonding grid to mitigate step and touch voltage potential shall be installed at outdoor swimming pools, spas and hot tubs as well as livestock areas, and at outdoor electrical equipment in and adjacent to natural and artificially made bodies of water.

11 NEC 210.52 Generally, receptacle outlets in habitable rooms shall be installed so that no point measured horizontally along the floor line in any wall space is more than 6-feet from a receptacle outlet. A receptacle shall be installed in each wall space 2-feet or more in width.

12 NEC 210.52 At kitchen countertops, receptacle outlets shall be installed so that no point along the wall line is more than 24 inch measured horizontally from a receptacle outlet in that space. Countertop spaces separated by range tops, sinks or refrigerators are separate spaces.

13 NEC 210.52 A receptacle outlet shall be installed at each counter space 12 inch or wider, and at each island counter or peninsular space 24 inch by 12 inch or greater. Receptacles shall be located not more than 20 inch above the countertop, or where mounted below a countertop less than 6 inches beyond the support base, not more than 12 inch below the countertop.

14 NEC 210.52 & 406.8 At least one receptacle, accessible at grade level and no more than 6.5' above grade, shall be installed at the front and back of a dwelling and shall have covers that are weatherproof whether or not an attachment plug is inserted.

15 NEC 406.8 All 15- and 20- amp, 125- and 250-volt receptacles installed outdoors shall be listed as weather-resistant.

GROUND-FAULT CIRCUIT-INTERRUPTER PROTECTION



16 NEC 210.8 Ground-fault circuit-interrupter (GFCI) protection shall be provided for all 125-volt, 15 and 20 amp receptacle outlets installed outdoors, in boathouses, garages, unfinished accessory buildings, crawl spaces at or below grade

level, unfinished basements, bathrooms, at kitchen countertops and within 6' of the outside edge of the sink in laundry rooms, utility rooms, and at wet-bars.

17 NEC 680.71 A hydro-massage bathtub (with a recirculating piping system, designed to discharge water upon each use) shall be supplied by an individual branch circuit and shall have ground-fault circuit-interrupter protection.

18 NEC 680.71 All 125-volt receptacles not exceeding 30 amperes installed within 6 feet of the inside walls of a hydromassage bathtub shall be GFCI protected.

19 NEC 680.73 Hydromassage bathtub equipment shall be accessible without damaging the building structure or finish.

20 NEC 680.22 All 15- and 20-amp, single-phase, 125-volt or 240-volt outlets supplying pool pump motors shall have GFCI protection.

WIRING METHODS

21 NEC 314.23 All electrical boxes shall be rigidly secured to the building structure.

22 NEC 314.27 Boxes used as the sole support for a ceiling-suspended paddle fan shall be listed and not be used as sole support for fans weighing more than 70 lbs.

23 NEC 334.30 Type NM (nonmetallic) cable shall be secured at intervals not exceeding 4.5 feet and within 12 inch of each box.

24 NEC 314.17 The outer jacket of NM cable shall be secured to the box and extend into the box a minimum of ¼ inch.

25 NEC 300.14 The minimum length of conductors, including grounding conductors, at all boxes shall be 6 inches and shall be long enough to extend at least 3 inches outside the box.

26 NEC 300.4 Cables and raceways shall be protected from damage and where installed through bored holes in joists, rafters, or wood framing members, the holes shall be bored so that the edge of the hole is not less than 1¼ inch from the nearest edge of the wood member, or shall be protected by a steel plate at least 1/16 inch thick and of appropriate length and width.

NOTE: Check with local building codes to determine where holes or notches may be made in joists.

27 NEC 300.22 Type NM cable shall not be installed in spaces specifically fabricated for environmental air, but may pass perpendicular through joist or stud spaces used as such.

28 NEC 110.14 Only one conductor shall be installed under a terminal screw. In boxes with more than one grounding wire, the grounding wires shall be spliced with a "wire tail" or "pigtail" which is then attached to the grounding terminal screw of the device.

29 NEC 200.7(C) Where permanently re-identified at each location where it is visible and accessible, the conductor



with white colored insulation in type NM cable may be used as an ungrounded conductor.

30 NEC 250.134 & 314.4 All electrical equipment, metal boxes, cover plates, and plaster rings shall be connected to an equipment grounding conductor.

31 NEC 110.12 & 110.3(B) Unused openings in boxes shall be effectively closed. If cable openings are made in non-metallic boxes and subsequently not used, the box shall be replaced.

32 NEC 408.41 Each grounded conductor shall terminate within a panelboard in an individual terminal that is not used for any other conductor.

33 NEC 314.25 In completed installations, each box shall have a lamp-holder, canopy or device with an appropriate cover plate.

34 NEC 314.19 Junction boxes shall be installed so that the wiring contained in them can be rendered accessible without removing any part of the building.

35 NEC 314.16 The volume of electrical boxes shall be sufficient for the number of conductors, devices, and cable clamps contained within the box. Nonmetallic boxes are marked with their cubic inch capacity. Use the following table to calculate the minimum box size:

Conductor Size	14 AWG	12 AWG
Each separate insulated wire	2 in ³	2.25 in ³
All ground wires (combined)	2 in ³	2.25 in ³
For each device (switch/receptacle)	4 in ³	4.4 in ³
All internal cable clamps (combined)	2 in ³	2.25 in ³

Sample Box Fill Calculation: Box with Four 14/2 w/ground type NMB cables:

8 insulated wires	16 cubic inches
All ground wires	2 cubic inches
1 switch	4 cubic inches
1 receptacle	4 cubic inches
All cable clamps (combined)	2 cubic inches
Minimum Box Volume	28 cubic inches

36 NEC 410.16 Luminaires (lighting fixtures) installed in clothes closets shall have the following minimum clearances from the defined storage area:

- 12 inches for totally enclosed surface incandescent or LED luminaires
- 6 inches for recessed totally enclosed incandescent, fluorescent or LED luminaires
- 6 inches for surface mounted or recessed fluorescent luminaires

Surface mounted fluorescent or LED luminaires listed for installation in storage space shall be permitted.

37 NEC 410.2 Closet storage space is the volume bounded by the sides and back closet walls and planes extending from the closet floor vertically to a height of 6 feet or the highest clothes-hanging rod and parallel to the walls at a horizontal distance of 24 inches from the sides and back of the closet walls respectively, and continuing vertically to the closet ceiling parallel to the walls at a horizontal distance of 12 inch or the shelf width, whichever is greater.

38 NEC 410.16 Incandescent luminaires with open or partially enclosed lamps and pendant fixtures or lamp-holders are not permitted in clothes closets.

39 NEC 410-66 Recessed lighting fixtures installed in insulated ceilings or installed within 1/2inch of combustible material shall be approved for insulation contact and labeled Type IC.

The Minnesota Energy Code requires that all penetrations through an air barrier be sealed. Sealing applies to all penetrations including the service entrance, conduit, cables, panels, recessed luminaires and electrical boxes.

EQUIPMENT LISTING AND LABELING

40 Minnesota Rules 3800.3620 All electrical equipment, including luminaires, devices and appliances used as part of or in connection with an electrical installation shall be listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) as having been tested and found suitable for a specific purpose.



41 NEC 110.3 All electrical equipment shall be installed and used in accordance with the listing requirements and manufacturer's instructions.

ELECTRICAL SERVICES



42 NEC 310-15 CONDUCTOR SIZES FOR 120/240 VOLT 3-WIRE, SINGLE-PHASE, DWELLING SERVICES AND FEEDERS

Copper	Aluminum	Service Rating
4 AWG	2 AWG	100 amps
1 AWG	2/0	150 amps
2/0	4/0	200 amps
400 kcmil	600 kcmil	400 amps

43 NEC 110.14 Listed anti-oxidant compound shall be used on all aluminum conductor terminations, unless product information specifically states that it is not required.

44 NEC 300.7 Portions of raceways or sleeves subject to different temperatures (i.e. passing from the interior to the exterior of a building) shall be sealed with an approved material to prevent condensation from entering equipment.

45 NEC 230.54 Service entrance raceways shall be rain-tight and arranged to drain.

46 NEC 300.9 The interior of raceways installed in wet locations above grade shall be considered wet locations.

47 NEC 300.4 Where raceways containing ungrounded conductors No. 4 or larger enter a cabinet, box, or enclosure, the conductors shall be protected by a bushing providing a smoothly rounded insulating surface.

48 NEC 230.70 The service disconnecting means shall be installed at a readily accessible location either outside a building or structure or inside nearest the point of entrance of the service-entrance conductors.

49 NEC 230.70 Electrical panels shall be readily accessible and shall not be located in bathrooms.

50 NEC 240.24 Overcurrent devices shall not be located in the vicinity of easily ignitable materials such as clothes closets.

51 NEC 408.36 Plug-in type overcurrent devices that are back-fed shall be secured by an additional approved device.

52 NEC 110.26 Sufficient working space shall be provided around electrical equipment. The depth of that space in the direction of access to live parts shall be a minimum of 3 feet. The minimum width of that space in front of electrical equipment shall be the width of the equipment or 30 inches whichever is greater. This workspace shall be clear and extend from the floor to a height of 6.5'. This space shall not be used for storage.

53 NEC 110.26 Illumination shall be provided for all working spaces about service equipment and panelboards.

GROUNDING AND BONDING

54 NEC 250.32 Buildings supplied by a branch circuit or feeder shall have an equipment grounding conductor run with the supply conductors and connected to the grounding electrode system at the separate building.

55 NEC 250.50 All grounding electrodes that are present at each building or structure served shall be bonded together to form the grounding electrode system.

56 NEC 250.50 Electrodes include a metal underground water pipe in direct contact with earth for 10 feet or more, a metal frame of a building or structure, a concrete encased electrode or a ground ring

57 NEC 250.53 A metal underground water pipe shall be supplemented by an additional electrode, such as a rod, pipe or plate electrode.

58 NEC 250.64 The grounding electrode conductor shall be continuous, securely fastened and protected from physical damage.

59 NEC 250.66 The size of the grounding electrode conductor shall be determined by the size of the service-entrance conductors, per the chart:

Equivalent Size of Service Entrance Conductor		Size of the Grounding Electrode Conductor	
Copper	Aluminum	Copper	Aluminum
4 AWG	2	8*	6
1 AWG	2/0	6	4
2/0 or 3/0	4/0 or 250	4	2

*The conductor that is the sole connection to a rod, pipe or plate electrode is not required to be larger than #6 AWG copper, however smaller conductors require physical protection.

60 NEC 250.28 A main bonding jumper or the green bonding screw provided by the panel manufacturer shall be installed in the service panel.

61 NEC 250.104 The interior metal water piping and other metal piping that may become energized shall be bonded to the service equipment with a bonding jumper sized the same as the grounding electrode conductor.

UNDERGROUND WIRING

62 NEC 300.5 Direct buried cable or conduit or other raceways shall meet the following minimum cover requirements:

Direct Burial Cable	Rigid or Intermediate Metal Conduit	Non Metallic Raceway (PVC)
24 inches	6 inches	18 inches

Residential branch circuits rated 20 amps or less at 120 volts or less and with GFCI protection at their source are allowed a minimum cover of 12"

NOTE: This table does not apply to underground wiring at outdoor pools, spas, or hot tubs - see NEC Article 680

63 NEC 300.5 Underground service laterals shall have their location identified by a warning ribbon placed in the trench at least 12" above the underground installation.

64 NEC 300.5 Where subject to movement, direct buried cables or raceways shall be arranged to prevent damage to the enclosed conductors or connected equipment.

65 NEC 110.14 Wire splicing means for direct burial conductors shall be listed for such use.

66 NEC 300.5 Conductors emerging from underground shall be installed in rigid metal conduit, intermediate metal conduit, or Schedule 80 rigid nonmetallic conduit from 18" below grade or the minimum cover distance to the point of termination above ground.



Residential Electrical Inspection Checklist



Based on the 2008 National Electrical Code

Generally, Minnesota law requires all electrical work to be performed by licensed, bonded and insured electrical contractors and their employees.

Homeowners, within strict limitations, are exempt from electrical licensing. An owner is a natural person who physically performs electrical work on premises the person owns and actually occupies as a residence or owns and will occupy as a residence upon completion of construction.
MN Stat §326B.31, Subd. 22

A separate request for electrical inspection form with the required fees must be submitted to the Department at or before commencement of any electrical installation that is required by law to be inspected.

All wiring shall be inspected before it is concealed and the installer shall notify the inspector when the wiring is complete, before the wiring is utilized and the associated space occupied.

When an owner files a Request for Electrical Inspection form and inspection fees with the Department of Labor & Industry or other electrical inspection authority, that person is signing an affidavit that they own and occupy the residence and that they personally and physically will perform all of the electrical work, including the laying out of such work.

It is illegal for an owner to install electrical wiring in mobile home or recreational vehicle parks, or on property that is rented, leased, or occupied by others.

A ROUGH-IN INSPECTION must be made before insulation, sheet-rock, paneling, or other materials cover any wiring. Underground wiring must be inspected before the trench is back-filled. Except for the final connection to switches, receptacles, and lighting fixtures, all ground wires and other wires in boxes must be spliced and pigtailed for the rough-in inspection.

STATE ELECTRICAL INSPECTORS ARE AVAILABLE BY TELEPHONE WEEKDAYS BETWEEN 7:00 AM AND 8:30 AM ONLY

01 Where wiring is concealed before inspection, the person responsible for concealing the wiring shall be responsible for all costs resulting from uncovering and replacing the covering material. MN Rules 3800.3770

02 The installer shall schedule a final inspection when the electrical work is completed prior to the wiring being utilized and the space occupied. MN Rules 3800.3780

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