

Panel Upgrades and Service Changes

YES Electric • NEC 2026 with NEC 2023 numbers in parentheses

Draft 1 (October 2026). This chapter is under review. Code numbers are NEC 2026. Your local inspector may use an earlier edition, so ask your journeyman which one applies. Boxes marked "Picture coming" will get drawings and photos in a later version.

Phase 1, Installation. YES Electric Residential Electrical Course.

A panel change is the largest job the residential service crew sells. This module walks the job from the first look at the house to the moment the lights come back on. Two masterclasses go deeper on the parts this module only touches. R-SERVICE covers the mast, weatherhead, drip loops, clearances, and underground laterals. R-LOAD covers the load calculation. R1.2 (How a House Is Wired) covers the parts of a load center and how power gets from the pole to the outlet. Read R1.2 first if you have not.

Code edition. This module cites NEC 2026. Where a section number moved, the NEC 2023 number is in parentheses. The local inspector (the AHJ, "authority having jurisdiction") may enforce an earlier edition, so ask your journeyman which edition applies before the job is permitted.

1. Learning Objectives

When you finish this module you will be able to:

1. Walk every step of a 200 A panel change in order: survey, load calc, utility call, permit, material list, disconnect, demo, set, land, bond, ground, label, inspect, and re-energize.
2. Set a load center plumb at the right height with the right working space, land the service conductors, and torque every terminal to the value on the label.
3. Install the main bonding jumper in a service panel, and keep neutrals and grounds apart in a subpanel.
4. Build the grounding electrode system for a house: two ground rods, the water pipe bond, and the concrete-encased electrode on new construction.
5. Size the service conductors with the dwelling rule in 310.12, size the grounding electrode conductor from Table 250.66, and size an equipment grounding conductor from Table 250.122.
6. Install the outdoor disconnect and a Type 1 or Type 2 surge protective device (SPD), both of which a service replacement triggers under NEC 2026.
7. Label the panel and leave the job ready for the inspector.

2. Background in Plain Language

2.1 Panel change vs. service change

People use these words loosely. On the job they mean different scopes.

Job	What gets replaced	Utility involved?
Panel change (same size)	The load center (the "can," the guts, the breakers). Meter base and service entrance cable stay.	Yes. The utility pulls the meter or cuts the drop so the line side of the panel is dead.
Panel upgrade (bigger size)	Load center, plus the service entrance conductors and usually the meter base, because a 100 A meter base and 100 A cable cannot carry 200 A.	Yes. The utility may also need to upsize the drop or lateral on its side.
Service change	Everything on the customer side from the point where the utility's wires end: mast or riser, service entrance conductors, meter base, disconnect, panel, grounding electrode system.	Yes. Disconnect, then reconnect after the inspection release.

In this module, "service change" means the full job. A plain panel swap uses the same steps with fewer parts.

2.2 Who owns what

The utility owns the power until it reaches the meter. On a Birmingham-area house that utility is usually Alabama Power. The line between their work and ours sits at the meter base.

Item	Who furnishes it	Who installs it
Transformer, service drop or underground lateral to the house	Alabama Power	Alabama Power
Meter	Alabama Power	Alabama Power
Meter base (socket)	Varies. Alabama Power drawings show the company furnishing the socket for some services and the customer installing it. Customer-owned sockets must be on Alabama Power's accepted list.	Customer's electrician (us)
Mast, weatherhead, riser conduit, service entrance conductors	Customer	Us
External disconnect on the load side of the meter	Customer	Us
Panel, breakers, SPD, grounding electrode system	Customer	Us
Grounding electrode conductor at the meter socket, minimum 6 AWG copper	Customer	Us

Sources for this table: Alabama Power Residential Metering Handbook drawings R-01, R-06, and R-08, and Alabama Power Customer-Owned Meter Equipment (updated August 12, 2026). URLs are in Section 11.

2.3 What NEC 2026 adds when you replace service equipment

Three rules in NEC 2026 apply the moment you replace a dwelling's service equipment. Each one changes your material list.

1. **Surge protection.** 230.67(A) requires an SPD on every service that supplies a dwelling unit. 230.67(D) says that where service equipment is replaced, all of 230.67 applies. The SPD must be Type 1 or Type 2 (230.67(C)), must be part of the service equipment or right next to it (230.67(B)), and must have a nominal discharge current rating (In) of at least 10 kA (230.67(E)). Module R1.9 covers the SPD install.
2. **Outdoor disconnect.** For one- and two-family dwellings, 230.70(A)(1) puts the service disconnect in a readily accessible outdoor location, on the house or within sight of it. If the service disconnect is indoors, an outdoor emergency disconnect per 225.41 satisfies the rule instead (2023: 230.85). 230.70(E) says replacing the service equipment on a one- or two-family dwelling brings these rules in. If you replace only the meter socket, the service

entrance conductors, or their raceways and fittings, 230.70(A)(1) and 230.70(B)(2) do not apply.

3. **Marking.** The outdoor disconnect enclosure on a one- or two-family dwelling is marked "EMERGENCY DISCONNECT" on the outside front, white letters on a red background, letters at least 13 mm (½ in.) high (230.70(B)(2)).

Alabama Power has its own rule that lands in the same place. Since January 1, 2022, it requires an external disconnect on the load side of a new residential meter base anywhere in its service territory, whether or not the town has inspections (Alabama Power Builder's Guide and its "Important Update to Residential Metering Procedure" page).

The practical result is that almost every YES service change uses one of two layouts:

- **Layout A, meter-main.** A meter base with a built-in 200 A main breaker outside. The main breaker is the service disconnect and it is outdoors, so the interior panel becomes a subpanel fed by a four-wire feeder.
- **Layout B, meter plus outdoor disconnect.** A meter base, then a separate 200 A fused or breaker disconnect outside, then the interior panel as a subpanel. Same electrical result as Layout A.

In both layouts the interior panel is no longer service equipment. Its neutral bar must float. This catches people who have only swapped panels in older houses where the inside panel held the main breaker. Section 4.8 walks through it.

2.4 Why the order of steps matters

Every step in this job either depends on the one before it or must be signed off by someone else before you can go on. You cannot set a panel until the utility kills the line side. The utility will not reconnect until the inspector releases the job. The inspector will not release it until the grounding, bonding, labels, and torque are right. A step done out of order costs a second trip, and a second trip with the power off means a customer with no lights overnight.

Picture coming: The panel-change sequence as a numbered strip of 11 icons left to right: (1) clipboard "Survey," (2) calculator "Load calc," (3) phone and permit card "Utility and permit," (4) meter with a red X "Disconnect," (5) old panel with arrows out "Demo," (6) level on a new can "Set," (7) torque wrench on lugs "Land," (8) ground rod and clamp "Bond and ground," (9) directory card "Label," (10) inspector badge "Inspect," (11) light bulb "Energize."

3. Specs You Will Use on Every Job

3.1 Service and feeder conductor size, dwelling rule (310.12)

310.12 lets you size the service conductors of a one-family dwelling at 83 percent of the service rating, for services rated 100 A through 400 A. 310.12(B) gives the same 83 percent rule to a feeder that carries the entire load of the dwelling. That is the feeder from the outdoor meter-

main to the indoor panel in Layout A and Layout B. If no adjustment or correction factors apply, you can read the size straight off Table 310.12(A) for conductors rated 75 °C or higher.

Table 310.12(A), common residential rows (verified, NEC 2026 text):

Service or feeder rating (A)	Copper (AWG/kcmil)	Aluminum or copper-clad aluminum (AWG/kcmil)
100	4	2
125	2	1/0
150	1	2/0
175	1/0	3/0
200	2/0	4/0
225	3/0	250
400	400	600

The 83 percent rule exists because a house never runs every load at once. Utilities have decades of data showing a 200 A house rarely pulls more than about 166 A for long. The rule lets you use a smaller wire for the one feeder that carries the whole house, and only that feeder.

The 83 percent rule does not apply to a subpanel that feeds part of the house. A 100 A garage subpanel fed from the main panel is sized from Table 310.16 at full ampacity, because 310.12(B) covers only a feeder supplying the entire load of the dwelling. This is the most common sizing mistake on panel jobs.

3.2 Grounding electrode conductor (GEC) size, Table 250.66

The GEC connects the service neutral to the grounding electrodes. You size it from the largest ungrounded (hot) service conductor.

Largest service conductor, copper	Largest service conductor, aluminum	GEC, copper
2 or smaller	1/0 or smaller	8
1 or 1/0	2/0 or 3/0	6
2/0 or 3/0	4/0 or 250	4

The copper GEC values for these three rows are verified in the NEC 2026 text. Larger rows did not come through in the OCR copy. This is still being checked against the printed code book.

Three exceptions cut the size down, and you will use them on most houses:

- **Rods only.** If the GEC goes only to ground rods and does not continue on to another kind of electrode, it never needs to be larger than 6 AWG copper (250.66(A)).

- **Concrete-encased electrode only.** If it goes only to a concrete-encased electrode, it never needs to be larger than 4 AWG copper (250.66(B)).
- **Ground ring only.** It never needs to be larger than the ring conductor (250.66(C)).

The reason is that a ground rod's contact with the dirt limits how much current can ever flow through it. A wire fatter than 6 AWG to a rod buys nothing.

3.3 Water pipe bonding jumper and main bonding jumper, Table 250.102(C)(1)

250.104(A)(1) says the metal water piping bonding jumper is sized from Table 250.102(C)(1), and never has to be larger than 3/0 copper. The main bonding jumper is sized from the same table (250.28(D)).

Largest service conductor, copper	Largest service conductor, aluminum	Bonding jumper, copper	Bonding jumper, aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0

3.4 Equipment grounding conductor (EGC) size, Table 250.122

The EGC is the bare or green wire that runs with the circuit. You size it from the breaker that protects the circuit, not from the wire size.

Breaker rating, not exceeding (A)	EGC, copper	EGC, aluminum
15	14	12
20	12	10
60	10	8
100	8	6
200	6	4

The 15, 20, 60, and 100 A rows are verified in the NEC 2026 text. The 200 A row dropped out of the OCR copy and is still being checked against the printed code book. The NEC 2026 table has no separate 30 A or 40 A row. A 30 A or 40 A circuit falls under "not exceeding 60 A" and gets a 10 AWG copper EGC.

3.5 Grounding electrode facts (250.52, 250.53)

Item	Rule	Section
Ground rod length	At least 8 ft (2.44 m)	250.52(A)(5)
Rod diameter, stainless, copper-coated, or zinc-coated steel	At least $\frac{5}{8}$ in. (15.87 mm) unless listed	250.52(A)(5)(2)
Length in contact with soil	At least 8 ft	250.53(A)(4)(a)
Driving	Vertically, to at least 8 ft. If you hit rock, drive at up to 45° from vertical, or bury in a trench at least 30 in. deep	250.53(A)(4)(b) and its exceptions
Top of rod	Flush with or below grade, unless the top and the clamp are protected	250.53(A)(4)(c)
Second rod	A single rod must be supplemented by another electrode unless that one rod measures 25 ohms or less	250.53(A)(2) and Exception
Spacing between rods	At least 6 ft (1.8 m). The informational note says spacing at twice the rod length works better	250.53(A)(3)
Jumper that is the only connection to a supplemental rod	Never needs to be larger than 6 AWG copper	250.53(E)
Concrete-encased electrode	At least 20 ft of $\frac{1}{2}$ in. or larger rebar, or 20 ft of bare 4 AWG copper, in at least 2 in. of concrete in a footing in contact with earth	250.52(A)(3)
Metal underground water pipe	Counts as an electrode if at least 10 ft is in direct contact with earth. It must always be supplemented by another electrode	250.52(A)(1), 250.53(D)(2)
Water pipe connection point	Within 5 ft of where the pipe enters the building, measured along the pipe	250.68(C)(1)
Water meter	Continuity cannot depend on the water meter or a filter. Bond around it	250.53(D)(1)
Gas pipe	Never a grounding electrode	250.52(B)(1)
Clamps	Listed for the rod and the wire materials. One wire per clamp unless the clamp is listed for more. Buried clamps listed for direct burial	250.70

YES drives two rods on every service, 6 ft or more apart. Measuring one rod to prove 25 ohms takes a three-point test set and more time than driving the second rod, so the second rod is cheaper.

3.6 Working space and location (110.26, 240.24, 408.43)

Rule	Value	Section
Depth of clear space in front of a 120/240 V panel	3 ft (900 mm)	Table 110.26(A)(1), 0–150 V to ground, Condition 1
Width of clear space	30 in. or the width of the equipment, whichever is greater	110.26(A)(2)
Height of clear space	6½ ft (2.0 m) or the height of the equipment, whichever is greater	110.26(A)(3)
Highest breaker handle	Center of the grip of the highest breaker, in its highest position, not more than 6 ft 7 in. (2.0 m) above the floor	240.24(A)
Not in clothes closets	No breakers near easily ignitable material such as in clothes closets	240.24(D)
Not in bathrooms	No breakers in bathrooms of dwelling units	240.24(E)
Not over stairs	No breakers over the steps of a stairway	240.24(F)
Not face up	A panelboard may not be installed face-up or face-down	408.43

If the old panel sits in a closet or a bathroom, the new one cannot go back in the same spot. Price the relocation in the survey.

3.7 Alabama Power numbers

Item	Value	Source
Meter height	Center of meter at least 4 ft and not more than 5 ft above final grade	APSC Special Electric Rule E-2, quoted in Alabama Power Customer-Owned Meter Equipment, p. 2
External disconnect	Required on the load side of a new residential meter base since January 1, 2022	Alabama Power Builder's Guide
Underground service conduit	3 in. service conduit, at least 24 in. below grade up to the meter socket, at least three conduit straps on a permanent socket	Alabama Power Builder's Guide
GEC at the meter socket	Minimum 6 AWG copper to the ground rod	Residential Metering Handbook, drawings R-01 and R-06
Intersystem bonding device	Must not drill or damage the meter socket and must not block the meter cover	Residential Metering Handbook, drawing R-01 note 7
Disconnect and reconnect requests	Business Service Center, 1-888-430-5787. Allow up to three business days. Have the 911 address and the meter or account number ready	Alabama Power Builder's Guide
Inspection release	Must match the 911 address exactly. The 911 address must be posted on the meter socket and the front window	Alabama Power Builder's Guide

4. Step-by-Step Procedures

The procedures below follow the job in time order. Each step says what to do, with sizes and quantities, and why.

4.1 Survey the house

Do the survey before anyone prices the job. Everything you miss here becomes a change order or a free trip.

1. **Photograph the outside.** Shoot the meter base, the mast or riser from the weatherhead to the meter, the service drop attachment, and the path from the meter to where the panel sits inside. Take one wide photo with the whole wall in it.
2. **Read the meter base label.** Record the brand, the amp rating, and whether it has a main breaker. A 100 A or 125 A meter base cannot stay on a 200 A upgrade.
3. **Look at the service entrance cable.** Note SE cable or conduit, the size printed on the jacket, and the condition. Old SE cable with a cracked jacket leaks water into the meter base and then into the panel. Kuhlman describes replacing many panels whose lugs

corroded from water that ran down SE cable from the weatherhead ("Electrical Panels," pp. 40–41).

4. **Open the panel cover with the journeyman present.** Record: - Brand and model, bus rating, main breaker size, and the short-circuit rating (kAIC) on the label. - Number of spaces used and open. - Any Federal Pacific Stab-Lok, Zinsco, or other brand with a known history (Arc Guide, Part 10, "Panel Inspection"). - Double-tapped breakers, more than one neutral under one terminal, aluminum branch wiring, burnt or discolored terminals. - Every 240 V load and its breaker size: range, dryer, water heater, AC or heat pump, electric furnace strips, well pump, EV charger.
5. **Check the panel location against Section 3.6.** Measure 3 ft of clear depth and 30 in. of width. Look for closets, bathrooms, stairs, water heaters, and shelving inside the space.
6. **Find the existing grounding.** Follow the GEC from the panel or meter base. Find the rod or rods, the water pipe clamp, and the gas bond if one exists. Note whether the water service is metal or plastic where it enters the house. A plastic water line means the water pipe is not an electrode, though the interior metal piping still gets bonded.
7. **Count the circuits that will need to be extended.** If the panel moves, every circuit must reach the new location. 210.12(E) says that if branch-circuit wiring in an AFCI-required area is modified, replaced, or extended, it needs AFCI protection, unless the extension is 6 ft or less and adds no outlets or devices. Each circuit that has to be lengthened more than 6 ft becomes an AFCI breaker.
8. **Check smoke and CO alarms.** Some AHJs treat a service change as a trigger for alarm upgrades. R1.8 covers this. Note what is there and how old it is.
9. **Ask the customer three questions.** Do you plan to add an EV charger, a heat pump, or a generator? Has anything in the house been tripping or flickering? Do you know of any work done without a permit?

Field photo coming: Survey photo set from one real YES job, six frames: meter base with label readable, mast and weatherhead, panel exterior, panel with dead-front off showing the breaker layout, the GEC clamp on the water pipe, and the measured working space with a tape across it.

4.2 Do the load calculation

1. Use the survey list of 240 V loads, the square footage, and the number of small-appliance and laundry circuits.
2. Run the optional dwelling calculation of 120.82 (2023: 220.82) for a new service size. For an existing house adding a load, use 120.83 or the utility-history method of 120.87 (2023: 220.83, 220.87).
3. The result must be no more than the service rating you plan to install. 230.79 requires the service disconnect rating to be at least the calculated load, and 230.79(C) sets 100 A as the minimum for any one-family dwelling.

R-LOAD teaches all three methods with worked examples. Do not size a service from the number of breakers in the old panel.

4.3 Permit and utility coordination

The order of calls matters. Ask the office which AHJ covers the address, because Birmingham, unincorporated Jefferson County, and the smaller cities each run their own permit desk.

1. **Pull the permit.** The office pulls it in the name of the qualified person on the YES account. You will need the address, the service size, and overhead or underground.
2. **Book the utility disconnect.** Call the Alabama Power Business Service Center at 1-888-430-5787. Give the 911 address and the meter or account number. Allow up to three business days. Ask whether the drop or lateral must be upsized for the new rating.
3. **Book the inspection.** Some AHJs inspect before the utility reconnects (a "service release"). Others also want a rough look before cover-up when walls are open. Ask the AHJ which inspections apply.
4. **Post the 911 address.** Alabama Power wants it on the meter socket and in the front window, and the inspection release must match it exactly.
5. **Tell the customer the outage window in writing.** Plan for 6 to 8 hours of no power on a straight 200 A swap. A relocation or a mast rebuild can run into a second day.

R-SERVICE shows the full timeline and who does what on service-change day.

4.4 Build the material list

Below is a typical list for a 200 A overhead service change in Layout A (meter-main outside, panel inside as subpanel). Your journeyman will adjust it for the house.

Qty	Item	Why
1	200 A meter-main combination, on Alabama Power's accepted list or as the utility directs	Meter base plus outdoor service disconnect in one enclosure; satisfies 230.70(A)(1) and the Alabama Power external disconnect rule
1	200 A main-lug or main-breaker load center, 40 spaces or more, with ground bar kit	Interior panel, now a subpanel. A main breaker in it is allowed and gives the customer a shutoff inside
1	Separate equipment ground bar kit for the panel brand	Subpanel needs grounds isolated from neutrals
As measured	Service entrance cable or conductors, 4/0 Al or 2/0 Cu	Line side of the meter-main, per Table 310.12(A)
As measured	SER cable, 4/0-4/0-4/0-2/0 Al, or four conductors in conduit	Four-wire feeder, meter-main to the interior panel. The 2/0 Al is the equipment ground; confirm the EGC size with your journeyman
1	Type 1 or Type 2 SPD, In of 10 kA or more, listed for the panel	230.67
2	5/8 in. × 8 ft copper-bonded ground rods	250.52(A)(5), 250.53(A)(2)
2	Listed direct-burial acorn clamps	250.70
1 roll	6 AWG bare solid copper	GEC to rods and jumper between rods, 250.66(A) and 250.53(E)
1	Listed water-pipe ground clamp sized to the pipe	250.104(A)(1), 250.70
As measured	4 AWG copper	Water pipe bonding conductor for 4/0 Al service, Table 250.102(C)(1)
1	Intersystem bonding termination (IBT)	250.94(A), cable and phone bonding
As needed	Breakers to match the new panel: AFCI, GFCI, dual-function, two-pole	Branch circuits; AFCI for any circuit extended more than 6 ft (210.12(E))
1	"EMERGENCY DISCONNECT" label, red background, white letters, ½ in. minimum	230.70(B)(2)
1	Plaque for other energy sources (if solar or a generator is present)	225.41(B)
As needed	Antioxidant compound if the lug instructions call for it on aluminum	Lug manufacturer instructions
As needed	Conduit, straps, connectors, duct seal, filler plates, NM cable for extensions, wire connectors	General

4.5 Shutdown day: before you touch anything

⚠ **DANGER.** With the main breaker off, the service lugs and the wires coming into the top of the panel are still live. Only the utility can make them dead, by pulling the meter or cutting the drop. Never work on the line side of a main breaker that is energized. NFPA 70E work on energized service equipment is outside this module. See commercial 2.1 for lockout and PPE.

1. **Confirm the utility has disconnected.** The meter is pulled and the socket is covered, or the drop is cut at the pole or the weatherhead. Look at it yourself.
2. **Test before touch.** Use the three-step method from R1.1. Test your meter on a known live source (a generator or a battery-powered proving unit), test the service lugs L1 to L2, L1 to neutral, L2 to neutral, L1 to the can, L2 to the can, then test your meter on the known source again. All six readings on the lugs must be zero.
3. **Photograph the inside of the old panel with every breaker visible.** You will use it to put each circuit back in a sensible place.
4. **Label every branch circuit cable before you pull it.** Wrap tape on each cable with the breaker number and what it feeds, using the old directory and a quick check with the customer. Mark both the hot and the neutral of each circuit so they stay paired.
5. **Mark multiwire branch circuits.** A cable with a black, a red, and one white shares the neutral between two circuits. The two hots must land on a two-pole breaker or two breakers with a listed handle tie, so both open together. R1.4 explains why.

4.6 Demo the old equipment

1. Remove the panel cover, then the breakers, then the branch conductors from the breakers and the bars.
2. Remove the service entrance conductors from the main lugs or main breaker.
3. Loosen the cable connectors and pull every cable out of the can. Keep the labels on.
4. Remove the can from the wall. If it is a flush panel in a finished wall, cut the drywall back only as far as the new can needs.
5. Remove the old meter base and SE cable if they are being replaced. The utility owns the meter and takes it with them or leaves it with you; follow their instruction.
6. Bag and tag any old breaker the customer wants to keep, then haul the rest off.

4.7 Set the new load center

1. **Mark the height.** Hold the can so the center of the grip of the highest breaker, at its highest position, will be no more than 6 ft 7 in. above the floor (240.24(A)). In practice that puts the top of a 40-space can around 6 ft.
2. **Check the space.** Clear depth 3 ft, width 30 in., height 6½ ft (Section 3.6).
3. **Knock out only what you need.** Remove knockouts for each cable or conduit you will bring in. Use the right connector for each one. Every unused opening must be closed (110.12(A)).

4. **Mount it plumb.** Use a level on the side of the can. On a surface mount, use all the pre-cut mounting holes in the back (Square D instruction bulletin S1B33894, "Surface Mounting"). On a flush mount, set the front edge flush with the finished wall and fasten to the studs through the side knockouts.
5. **Mount it upright.** Never face-up on a ceiling or face-down (408.43).

Why plumb matters. Breakers are tested and listed in an upright panel. A crooked can also leaves the dead-front out of line, so twistouts and filler plates do not seat and leave openings to live parts.

4.8 Land the conductors

Use this order: service conductors, then the feeder, then the grounding electrode conductor, then branch circuits. Every terminal gets torqued to the value printed on the label or wiring diagram inside the enclosure. 110.14(D) requires the torque value marked on the equipment or in its instructions to be met with an approved means, such as a torque tool.

Service entrance conductors into the meter-main (Layout A):

1. Pull the conductors through the connector or hub into the line side of the meter-main. Line on top, load on the bottom.
2. Strip each conductor to the length marked on the lug, plus no more than $\frac{1}{8}$ in. Bare aluminum outside the lug corrodes.
3. Clean aluminum conductors with a wire brush and apply antioxidant if the lug instructions call for it.
4. Insert each conductor fully into its lug. L1 and L2 to the line terminals, the neutral to the neutral lug.
5. Torque each lug with a torque wrench to the value on the meter-main label. Mark each lug with a paint pen line across the screw head and the lug body. The line lets the inspector and anyone after you see that it was torqued and has not moved.

Main bonding jumper in the meter-main:

1. The meter-main is now the service equipment. Its neutral bar must be bonded to the enclosure with the main bonding jumper (250.24, 250.28). Most meter-mains ship with the bond installed. Confirm it with your eyes and your meter: continuity from the neutral lug to bare metal of the can.
2. If the bond is a screw, 250.28(B) requires it to have a green finish visible after install. Torque the bonding screw to the value on its card (Square D bulletin S1B33894, "Main Circuit Breaker or Main Lug Wiring," step 3).

Feeder from the meter-main to the interior panel (four wires):

1. Run the SER cable or the four conductors in conduit from the load side of the meter-main breaker to the interior panel.
2. In the meter-main, land L1 and L2 on the load terminals of the main breaker, the neutral on the neutral bar, and the equipment grounding conductor on the equipment ground terminal.
3. In the interior panel, land L1 and L2 on the main lugs or main breaker, the neutral on the neutral bar, and the equipment ground on the ground bar.

Interior panel as a subpanel:

1. **Remove or never install the bonding screw or strap.** The neutral bar must float, insulated from the can.
2. **Install the separate equipment ground bar** bonded to the can (408.40).
3. **Never put grounds on the neutral bar** in this panel. 408.40 says equipment grounding conductors may land on a neutral bar only where the bar is identified for it and is located where the code allows neutral and ground to be connected. Behind the service disconnect, 250.24(B) and 250.142(B) forbid connecting the neutral to equipment grounding conductors or metal parts.

Why a subpanel's neutral must float. The neutral carries the return current of every 120 V load. If the neutral bar is bonded to the can in a subpanel, part of that return current takes the equipment grounding conductor and every metal box, conduit, and appliance frame in parallel with the neutral. That puts current on metal people touch, and if the feeder neutral ever opens, all of the return current goes onto the grounds. Kuhlman makes this point in "Neutrals and Grounds connected in panel, main service panel vs sub-panel," p. 43, and says he asks it of every electrician he interviews.

Picture coming: Service panel vs subpanel side by side, labeled. Left: service panel with three service conductors entering, the green bonding screw installed through the neutral bar into the can, neutrals and grounds on the same bar, GEC from the neutral bar to the rods. Right: subpanel with four feeder conductors entering (L1, L2, white neutral, green or bare ground), the bonding screw removed and shown in a "do not install" circle, neutrals on an insulated neutral bar, grounds on a separate ground bar screwed to the can.

Grounding electrode conductor:

1. In Layout A or B, the GEC connects at the service equipment (the meter-main or the outdoor disconnect), at the neutral or the bonded equipment ground terminal there (250.24(A)(1), 250.24(A)(4)). It does not connect at the interior subpanel.
2. Run the GEC in one piece, without splices, except with irreversible compression connectors or exothermic welds (250.64(C)).

3. Secure it to the wall. 6 AWG or larger copper not exposed to physical damage may run along the surface without a raceway. Where exposed to damage, put it in RMC, IMC, Schedule 80 PVC, RTRC-XW, EMT, or cable armor (250.64(B)).
4. If the GEC is in a ferrous metal raceway (steel conduit), bond the raceway to the GEC at both ends (250.64(E)). A steel sleeve around a GEC that is not bonded at both ends acts like a choke during a lightning surge.

Branch circuits:

1. Land each circuit's hot on its breaker, torqued to the value printed on the breaker.
2. Land each neutral in its own terminal on the neutral bar. 408.41 allows only one grounded conductor per terminal. Two neutrals under one screw means that when someone loosens it to work one circuit, the other circuit's neutral opens with the power on.
3. Land grounds on the ground bar. Check the label for how many grounds a terminal may take; many bars allow two or three of the same size.
4. AFCI and dual-function breakers with a white pigtail: the circuit neutral goes to the breaker's neutral terminal and the pigtail goes to the neutral bar (Arc Guide, Job 5).
5. Install the breakers by hooking the terminal end on the mounting rail and rotating the breaker in until the jaw seats on the bus (Square D bulletin S1B33894, "Standard and Tandem Branch Circuit Breakers").
6. Tandem breakers go only in a panel marked for them, and only in the positions the label shows (S1B33894, same section). 408.54 requires the panel to physically limit the number of breakers to its rating.
7. Use only breakers listed for the panel. Square D's bulletin requires Square D breakers in Square D load centers. QO and Homeline breakers do not interchange (Arc Guide, Part 8).

⚠ **Torque.** In-pound and foot-pound wrenches are not the same. 250 in-lb is about 21 ft-lb. Read the unit on the label twice before you set the wrench. The Arc Guide (Part 10, "The 78% Torque Problem") reports an IAEI field study where 78 percent of experienced electricians under-torqued connections, and a fatal mobile-home fire traced to 250 in-lb service lugs tightened to about 12 ft-lb.

4.9 Bond the service raceways and enclosures

1. 250.92(A) requires bonding of every raceway, cable armor, and enclosure that contains service conductors, including the meter base.
2. Standard locknuts alone do not count as the bond on the service side (250.92(B)). Use threaded hubs made up wrenchtight, threadless fittings made up tight, bonding locknuts, or bonding bushings with a jumper.
3. Where a knockout is oversized, concentric, or eccentric and the ring is not fully removed, put a bonding jumper around it (250.92(B)).

4. Install the IBT outside the enclosures at the service. It needs room for at least three intersystem bonding conductors and must not block the meter cover or the disconnect door (250.94(A)). Alabama Power does not allow you to drill the meter socket to mount it (Residential Metering Handbook, R-01, note 7).

4.10 Build the grounding electrode system

Bond together every electrode present at the house (250.50). On an existing house that is usually the metal water pipe (if the underground water line is metal) plus rods. On new construction add the concrete-encased electrode.

Drive the rods:

1. Call 811 for a utility locate before you drive anything. In Alabama the free locate service is Alabama 811.
2. Pick the first rod spot within a few feet of the meter base, at least 12 in. from the foundation so the rod clears the footing.
3. Drive a $\frac{5}{8}$ in. $\times$ 8 ft rod vertically with a rotary hammer and a ground-rod driver bit, or a fence-post driver. Drive it until the top is flush with or below grade (250.53(A)(4)(c)).
4. If you hit rock, drive it at an angle no more than 45° from vertical. If rock stops you at that angle too, lay it in a trench at least 30 in. deep (250.53(A)(4), Exceptions 1 and 2).
5. Measure at least 6 ft from the first rod and drive the second rod the same way. 16 ft (twice the rod length) works better if the yard allows (250.53(A)(3) informational note).
6. Clamp a continuous 6 AWG bare copper conductor to the first rod with a listed direct-burial acorn clamp, run it to the second rod and clamp it, without cutting it at the first clamp. The 6 AWG jumper size comes from 250.53(E) and 250.66(A).
7. Run the GEC from the service equipment to the nearest rod, or run the continuous 6 AWG from the service equipment through both rods.
8. Bury the conductor between rods and protect it where it rises out of the ground.

⚠ Wear safety glasses and hearing protection while driving rods. Hold the driver with both hands. A rod that hits a buried line can energize the driver.

Bond the water pipe:

1. Find where the water line enters the house. Measure along the pipe; your clamp must be within 5 ft of the entry point if the water pipe serves as an electrode or if you use the interior pipe to extend the electrode connection (250.68(C)(1)).
2. Clean the pipe to bright metal and install a listed clamp sized to the pipe.
3. Run the bonding conductor sized from Table 250.102(C)(1): 4 AWG copper for a 200 A service with 4/0 Al or 2/0 Cu (250.104(A)(1)). If the water pipe is also an electrode, size the GEC to it from Table 250.66, which gives the same 4 AWG copper for these service conductors.

4. Put a bonding jumper around the water meter and any filter or softener so the bond does not depend on them (250.53(D)(1), 250.68(B)).
5. Make the clamp accessible. 250.68(A) requires mechanical connections to electrodes to be accessible, except buried or concrete-encased connections.

Concrete-encased electrode (new construction):

1. Before the footing pour, the foundation crew or YES ties in at least 20 ft of ½ in. rebar, or lays 20 ft of bare 4 AWG copper, in the bottom of the footing with at least 2 in. of concrete around it (250.52(A)(3)).
2. Bring a rebar stub or the copper up to an accessible spot near the service. A rebar stub must not be in contact with earth without corrosion protection (250.68(C)(3)).
3. Connect the GEC with a listed clamp. A GEC that goes only to the concrete-encased electrode never needs to be larger than 4 AWG copper (250.66(B)).

Gas piping:

1. 250.104(B) requires bonding of any metal piping, including gas piping, that is likely to become energized. The EGC of the circuit likely to energize it counts, sized from Table 250.122. CSST gas piping has its own manufacturer bonding requirement. R1.6 covers gas and CSST bonding.

Picture coming: Residential grounding electrode system on one exterior-and-basement cutaway: meter-main on the wall with the GEC leaving its neutral terminal; two ⅝ in. × 8 ft rods at least 6 ft apart with acorn clamps and one continuous 6 AWG conductor; water line entering through the foundation with a clamp within 5 ft of entry and a jumper around the water meter; a gas line with a bonding jumper; a footing cutaway showing 20 ft of rebar with a stub rising to a clamp. Each item labeled with its section number.

4.11 Install the SPD

1. Mount the SPD on or next to the service equipment (230.67(B)), using the shortest possible leads.
2. On a panel-mount SPD, land it on a two-pole breaker as close to the main as the panel allows, or follow the SPD's own instructions.
3. Confirm the SPD is Type 1 or Type 2 and its In rating is 10 kA or more (230.67(C), (E)).

R1.9 has the full step-by-step SPD install.

4.12 Label everything

1. **Circuit directory (408.4(A)).** Every circuit gets a legible, permanent description that is specific to its use. "Kitchen counter left of sink" passes. "Kitchen" does not when there are four kitchen circuits. Spare breakers get marked "spare." The directory goes on the face of, inside, or next to the panel door.

2. **Service disconnect marking.** Mark the meter-main breaker or outdoor disconnect "SERVICE DISCONNECT" (230.70(B)(1)). Square D load centers ship with "Service Disconnect" and "Main" labels (S1B33894, "Installing the Cover/Trim," step 4).
3. **Emergency disconnect marking.** On the outside front of the outdoor disconnect: "EMERGENCY DISCONNECT," white on red, ½ in. letters minimum (230.70(B)(2)).
4. **Other energy sources.** If the house has solar, a battery, or a generator whose disconnect is not next to the emergency disconnect, post a plaque or directory showing where each one is (225.41(B) and 230.70(D)).
5. **Torque marks.** Every lug and breaker terminal you torqued gets a paint-pen line.
6. **Fill unused spaces** in the dead-front with filler plates (S1B33894, step 7; 110.12(A)).
7. **Cover screws.** Square D specifies 20 lb-in for trim screws (S1B33894, step 5).

Field photo coming: A finished YES panel with the dead-front on, typed directory, torque marks visible through the open door on the main lugs, SPD mounted at the top, and filler plates in every open space. Place it next to the "before" photo of the same panel from the survey.

4.13 Inspection and re-energizing

1. **Walk the job with your journeyman before the inspector comes.** Use the checklist in Section 10.
 2. **Inspector visit.** Leave the dead-front off if the AHJ wants to see terminations. Have the permit card posted.
 3. **Release.** The inspector sends the release to Alabama Power. It must match the 911 address exactly.
 4. **Before the utility reconnects,** turn off the main and every branch breaker (S1B33894, "Energizing the Load Center," step 1). Alabama Power also requires breakers off for its meter check-out (Builder's Guide).
 5. **After the meter is set,** measure at the meter-main load terminals: L1 to L2 about 240 V, L1 to N and L2 to N about 120 V each, N to ground about 0 V.
 6. **Turn on the main, then each branch breaker one at a time.** Listen and watch for a trip.
 7. **Test each circuit.** A plug-in tester on receptacles, a light at each fixture, GFCI and AFCI test buttons, and every 240 V appliance runs.
 8. **Close up.** Dead-front on, door closed, customer walk-through of the outdoor disconnect, the SPD status light, and the directory.
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5. Worked Examples

Example 1: 200 A service conductors with the 83 percent rule

Given. A one-family house getting a 200 A service. Conductors in free air or a single SE cable, no correction or adjustment factors.

1. 310.12(A) allows the service conductors an ampacity not less than 83 percent of the service rating.
2. $200\text{ A} \times 0.83 = 166\text{ A}$.
3. Table 310.16, 75 °C column: 2/0 copper = 175 A, which is at least 166 A. 4/0 aluminum = 180 A, which is at least 166 A.
4. Table 310.12(A) gives the same answer directly: 200 A row, 2/0 Cu or 4/0 Al.

Answer. 2/0 copper or 4/0 aluminum. YES uses 4/0 aluminum SE or SER on most 200 A services because of cost.

Example 2: 150 A service

1. $150\text{ A} \times 0.83 = 124.5\text{ A}$.
2. Table 310.16, 75 °C: 1 AWG copper = 130 A. 2/0 aluminum = 135 A.
3. Table 310.12(A), 150 A row: 1 Cu, 2/0 Al. Same answer.

Example 3: 100 A garage subpanel (no 83 percent)

Given. A 100 A subpanel in an attached garage, fed from the 200 A interior panel.

1. This feeder does not carry the entire load of the dwelling, so 310.12(B) does not apply.
2. Size at full ampacity from Table 310.16 at the termination temperature. Most residential panel lugs are rated 75 °C; check the label.
3. 100 A at 75 °C: 3 AWG copper (100 A in Table 310.16) or 1 AWG aluminum (100 A). Table 310.16 values for 3 AWG and 1 AWG at 75 °C did not come through clean in the OCR copy; confirm them in the printed book (still being checked against the printed code book). 1/0 aluminum at 75 °C is 120 A and is verified.
4. EGC for a 100 A breaker, Table 250.122: 8 AWG copper or 6 AWG aluminum.

Answer. Four-wire feeder, 1/0 Al SER (with a 6 AWG Al or larger ground) is the safe pick if the 1 AWG Al value cannot be confirmed. Neutral bar floats, separate ground bar, no bonding screw.

Example 4: GEC and bonding jumpers for a 200 A service with 4/0 Al

Connection	Rule	Size
GEC, service to the two ground rods only	250.66(A) caps it at 6 AWG Cu	6 AWG Cu
Jumper between the two rods	250.53(E)	6 AWG Cu
GEC to the metal underground water pipe electrode	Table 250.66, 4/0 Al row	4 AWG Cu
Water pipe bonding jumper (if the water pipe is not an electrode, only bonded)	250.104(A)(1), Table 250.102(C)(1), 4/0 Al row	4 AWG Cu
GEC to a concrete-encased electrode only	250.66(B) caps it at 4 AWG Cu	4 AWG Cu
Main bonding jumper, if it is a wire	250.28(D), Table 250.102(C)(1)	4 AWG Cu

If one GEC runs to the water pipe first and then on to the rods, it must be sized for the largest electrode it reaches (250.64(F)), so it is 4 AWG copper the whole way.

Example 5: Working-space check

Given. The customer wants the new panel on the same basement wall. A chest freezer sits 28 in. in front of the old panel. The ceiling joists are 7 ft above the slab.

1. Depth required, 120/240 V, Condition 1: 3 ft. The freezer is at 28 in., which is less than 36 in. Fail.
2. Height required: 6½ ft. 7 ft ceiling, which is more than 6½ ft. Pass.
3. Width required: 30 in. Measure 15 in. each side of the panel centerline to make sure nothing intrudes.

Answer. The freezer moves at least 36 in. out, permanently, or the panel moves. Put it on the work order so the customer knows before the job day.

Example 6: Does a panel relocation trigger AFCI?

Given. The panel moves 9 ft along a basement wall. Bedroom circuit cables must be spliced in a junction box and extended to reach.

1. 210.12(E): if branch-circuit wiring for an AFCI-required area is extended, the circuit needs AFCI protection.
2. Exception: not required if the extension is 6 ft or less and adds no outlets or devices other than splices. Wire inside boxes and the panel does not count toward the 6 ft.
3. The extension here is 9 ft. AFCI required.

Answer. Each extended bedroom, living area, kitchen, laundry, and similar circuit (the 210.12(B) areas) gets a combination AFCI or dual-function breaker. Add them to the material list during the survey.

6. Safety Summary

The warnings above sit at the step where they apply. These four apply to the whole job.

1. **The line side is live until the utility says it is not.** Test it yourself, every time, with the three-step method.
 2. **Never pull a meter yourself.** Only the utility pulls the meter. A pulled meter can arc and burn your hands and face.
 3. **Aluminum service conductors are stiff and spring back.** Wear gloves and safety glasses when bending 4/0 into a lug.
 4. **Ladders near the drop.** On an overhead service, keep the ladder and every tool at least 10 ft from any energized overhead line unless the utility has de-energized it. R1.1 covers ladder setup. R-SERVICE covers working near the drop.
-

7. Common Mistakes

Mistake	What goes wrong	Fix
Bonding screw left in the interior panel after adding an outdoor meter-main	Neutral current flows on grounds and metal in parallel	Remove the screw or strap, add a ground bar, move all grounds off the neutral bar
Applying the 83 percent rule to a subpanel feeder that serves only part of the house	Undersized feeder, heat at the lugs	310.12(B) is only for the feeder that carries the entire dwelling load. Size other feeders at 100 percent
Hand-tightening lugs	Loose lug, heat, failure	Torque wrench to the label value, paint-pen mark
Over-torquing aluminum	Crushed strands, a lug that loosens later	Stop at the label value, hold, release
Two neutrals under one terminal	Opening one circuit opens the other with power on	One neutral per terminal (408.41)
One ground rod, never tested	Fails 250.53(A)(2)	Drive the second rod at least 6 ft away
Two 4 ft rods instead of one 8 ft rod	Fails 250.53(A)(4)(a): each rod needs 8 ft in contact with soil	8 ft rods only. The Arc Guide "Grounding and Bonding" common-mistakes list says two 4 ft rods 6 ft apart is acceptable. That is wrong under the NEC
Water pipe clamp 12 ft from entry, past the water heater	Interior pipe more than 5 ft from entry cannot extend the electrode connection (250.68(C)(1))	Move the clamp within 5 ft of entry
No jumper around the water meter	Plumber removes the meter and the bond opens	Jumper around the meter (250.53(D)(1))
Standard locknuts on the service raceway	Not an accepted service bond (250.92(B))	Bonding locknut, bonding bushing, or threaded hub
Mixing breaker brands	Breaker jaw does not fit the bus; heat and arcing	Only breakers listed for the panel
Forgetting the SPD or outdoor disconnect on a "simple panel swap"	Failed inspection	230.67(D) and 230.70(E) apply whenever service equipment is replaced
Reading the Arc Guide wire table as service sizes	That table lists 60 °C ampacities and says 4/0 for 200 A without saying copper or aluminum	Use Table 310.12(A)

8. Field Exercise (from the course outline, written out in full)

Where: the YES training wall with a mock meter base, plus a patch of open ground for the rods.

Who: you, with a journeyman signing off. **Time:** about one full day.

Part 1: 200 A panel set.

1. Mount a 200 A main-breaker load center plumb on the training wall. Measure and write down the height from the floor to the center of the main breaker handle in its up position. It must be 6 ft 7 in. or less.
2. Mark and measure the working space in front of it with tape on the floor: 30 in. wide, 36 in. deep. Write down any obstruction.
3. Bring 4/0 Al SE cable from the mock meter base into the panel through a listed connector.
4. Land L1, L2, and the neutral on the main lugs. Torque each to the value on the panel label. Paint-pen mark each lug. Have your journeyman check one lug with his wrench without moving it.
5. Install the main bonding jumper (the green screw or strap). Torque it to the value on its card. Use your meter to show continuity from the neutral bar to the can.
6. Land a 6 AWG copper GEC on the neutral bar and run it to the rods (Part 2).
7. Land three 120 V branch circuits: a 15 A on 14-2, a 20 A on 12-2, and a 20 A AFCI or dual-function breaker on 12-2 with its pigtail to the neutral bar. Land one 240 V circuit: a 30 A two-pole breaker on 10-2 (black and white re-marked with red or black tape). Torque every terminal.
8. Write a directory that meets 408.4(A). Be specific to each circuit's use.

Part 2: Grounding electrode system.

1. Call in a locate before driving (the shop yard is pre-cleared; on a real job this is your step).
2. Drive two $\frac{5}{8}$ in. $\times$ 8 ft rods, at least 6 ft apart, tops flush with grade.
3. Connect them with one continuous 6 AWG bare copper conductor and listed direct-burial acorn clamps. Do not cut the conductor at the first rod.
4. On the training wall's water pipe stub, install a listed water-pipe clamp within 5 ft of the mock entry point and run 4 AWG copper back to the panel. Install a jumper around the mock water meter.

Part 3: Convert to a subpanel.

1. Turn the wall into Layout A: add a mock meter-main outside, and treat the training panel as the interior subpanel.
2. Remove the bonding screw. Show with your meter that the neutral bar no longer has continuity to the can.
3. Install a separate ground bar bonded to the can.
4. Move every equipment grounding conductor off the neutral bar to the ground bar.

5. Run a four-wire feeder (SER or four conductors) from the meter-main to the subpanel. Land the EGC on the ground bar.
6. Move the GEC to the meter-main.

Sign-off questions (answer out loud to the journeyman):

- Why does the neutral bar float in the subpanel but not in the meter-main?
 - Why is the rod GEC only 6 AWG when the water pipe bond is 4 AWG?
 - What three things does NEC 2026 add to a service replacement that a 2017-era panel swap did not have?
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9. NEC 2026 Cross-References

Read each section in the code book. Know the reason behind the rule.

Section	Topic
110.12(A)	Unused openings closed
110.14(D)	Terminal torque per equipment marking, with an approved means
110.26	Working space about equipment
120.82, 120.83, 120.87 (2023: 220.82, 220.83, 220.87)	Optional dwelling calc, existing dwelling, existing loads. See R-LOAD
210.12(E)	AFCI when branch wiring is modified, replaced, or extended; 6 ft exception
225.41 (2023: 230.85)	Outdoor emergency disconnect, one- and two-family dwellings
230.24	Overhead clearances. See R-SERVICE
230.42	Service entrance conductor size and ampacity
230.67	SPD required at dwelling services; (D) applies on replacement
230.70	Service disconnect: (A)(1) outdoor location for one- and two-family, (B)(2) EMERGENCY DISCONNECT marking, (E) replacement
230.71	Number of service disconnects
230.79	Disconnect rating; (C) 100 A minimum for a one-family dwelling
240.4	Conductor overcurrent protection
240.24	Location of breakers: height, closets, bathrooms, stairs
250.24	Grounding the service; (B) no neutral-to-ground on the load side
250.28	Main bonding jumper; green screw
250.32	Feeder to a detached building
250.50, 250.52, 250.53	Electrode system, electrodes, installation and second rod
250.64	GEC installation, protection, no splices
250.66	GEC size
250.68	Electrode connections: accessible, 5 ft water pipe rule
250.70	Clamps and connection methods
250.92	Service raceway bonding
250.94	Intersystem bonding termination
250.104	Bonding water and gas piping
250.118, 250.122	What counts as an EGC, and EGC size
250.142(B)	Neutral not used to ground equipment on the load side
310.12	Dwelling service and feeder conductors, the 83 percent rule
408.4(A)	Circuit directory

Section	Topic
408.36	Panelboard overcurrent protection
408.40	Panelboard grounding; ground bar
408.41	One neutral per terminal
408.43	No face-up or face-down panels
408.54	Panel limits number of breakers

10. End-of-Chapter Checklist

Use this before every inspection. Your journeyman initials each line.

- ☐ Load calc done and filed; service rating at least the calculated load and at least 100 A.
- ☐ Permit posted; 911 address on the meter socket and in the front window.
- ☐ Meter center 4 to 5 ft above final grade.
- ☐ Outdoor disconnect installed and marked EMERGENCY DISCONNECT (white on red, ½ in. letters), or the service disconnect itself is outdoors.
- ☐ Service disconnect marked SERVICE DISCONNECT.
- ☐ SPD installed, Type 1 or 2, In of 10 kA or more, status light showing normal.
- ☐ Service conductors sized per Table 310.12(A); subpanel feeders sized at 100 percent.
- ☐ Every lug and terminal torqued to the label value and paint-pen marked.
- ☐ Main bonding jumper installed in the service equipment only.
- ☐ Interior subpanel: bonding screw out, neutral bar floating, separate ground bar, no grounds on the neutral bar.
- ☐ One neutral per terminal.
- ☐ GEC unspliced, secured, protected where exposed, sized per 250.66; ferrous raceway bonded at both ends.
- ☐ Two 8 ft rods, at least 6 ft apart, tops at or below grade, listed direct-burial clamps.
- ☐ Water pipe bonded within 5 ft of entry, jumper around the water meter, clamp accessible.
- ☐ Gas piping bonded per 250.104(B) (see R1.6).
- ☐ IBT installed outside the enclosures with room for three conductors; meter socket not drilled.
- ☐ Service raceways bonded with listed bonding means, not standard locknuts alone.
- ☐ Working space 36 in. deep, 30 in. wide, 6½ ft high; highest handle at or below 6 ft 7 in.
- ☐ Panel not in a closet, bathroom, or over stairs.
- ☐ Only breakers listed for the panel; tandems only where the label allows.
- ☐ AFCI on every circuit extended more than 6 ft in an AFCI area.
- ☐ Directory complete and specific; spares marked.
- ☐ Filler plates in every open space; all unused knockouts closed.
- ☐ All breakers off before the utility reconnects; voltages checked after.

11. Sources

- NEC 2026 (NFPA 70), sections as cited.
 - Kuhlman, Residential Electrical Troubleshooting (2019): "Electrical Panels" and "Main Service Panel vs Sub-panel," pp. 40–42 (SE cable and water entry, pp. 40–41); "Neutrals and Grounds connected in panel, main service panel vs sub-panel," p. 43; "Neutral wire in electrical service," p. 45. where PDF page equals book page. Paraphrased.
 - Arc Workforce, Residential Electrical Field Guide: Part 2 ("Panels," "Wiring," "Grounding and Bonding"), Part 3 ("Torque Specifications"), Job 4, Job 5, Job 10, Part 8 (Square D, Eaton, Siemens), Part 10 ("The 78% Torque Problem," "Panel Inspection," "Grounding — The 3 Most Common Serious Mistakes"). Its code citations are NEC 2020 and were not reused.
 - Schneider Electric, Instruction Bulletin QO and Homeline Load Centers, Class 1100, S1B33894 Rev. 03, 04/2021: https://media.distributordatasolutions.com/schneider_synd/2022q1/documents/b107c99b527191b8bff14a0e22478c8ad10458eb.pdf
 - Alabama Power, Builder's Guide to Working with Alabama Power and "Important Update to Residential Metering Procedure": <https://www.alabamapower.com/content/dam/alabama-power/pdfs-docs/business/builders-guide-web.pdf>
 - Alabama Power, Customer-Owned Meter Equipment (last updated August 12, 2026): <https://www.alabamapower.com/content/dam/alabama-power/pdfs-docs/business/customer-owned-meter-equipment.pdf>
 - Alabama Power, Residential Metering Handbook drawings R-01, R-06, R-08 (revised May 2023).
 - [erico-practical-guide-to-electrical-grounding.pdf](#), Chapter 1, "Building and Service Entrance Grounding" (pp. 1–19), for further reading on electrodes.
 - [navedtra-14027-intermediate.pdf](#), Chapter 3, panelboard installation, for further reading.
 - Commercial modules 1.4 (panelboards and bonding) and 1.7 (grounding and bonding) for depth.
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Videos to watch

These videos are made by other electricians and companies, not YES Electric. Watch each one after you read the section it goes with. Where a video does something differently from this module, the caution line says so. Follow this module and your journeyman, not the video. Click a title to open it on YouTube.

Section	Video
§4.5 to §4.8 Shutdown day, demo, set the new load center, land the conductors	Electrical Panel Upgrade EASY 200 AMP Main Panel Replacement FULL TUTORIAL By MASTER ELECTRICIAN Landers Electric • 10:54 A licensed contractor does a full overhead 200 A panel change: permit, ground rods, utility disconnect, meter check for no voltage, labeling every circuit and neutral before removal, new riser and weatherhead, landing and torquing the service conductors, then the branch circuits. Caution: California job on stucco with a California utility; Alabama Power's process is in R1.5 §3.7 and §4.3. He says it is 'always good' to drive ground rods at an angle; 250.53(A) (4) allows up to 45° only when rock is hit. YES drives rods vertical, two per service, 6 ft or more apart.
§4.6 Demo the old equipment; §4.7 Set the new load center (meter, riser, panel)	How to Replace an Electrical Service Panel, Meter, and Riser (PART 1) Electrician U • 12:21 Tears out an old Zinsco panel, meter can, and riser as one assembly, then sets a 200 A main-breaker plug-on-neutral panel, a new meter can, a rigid riser, and pulls service-entrance conductors weatherhead to meter to main. Caution: His own house in Texas. He uses 2/0 copper with the 83 percent rule; YES uses 4/0 aluminum SE/SER on most 200 A services (R1.5 Example 4). Overhead service with the drop cut by the utility first.
§4.8 Land the conductors; §4.9 Bond the service (main bonding jumper)	How to Replace an Electrical Service Panel (PART 2) Electrician U • 11:07 Finishes the panel: neutrals and grounds landed, the green main bonding screw driven through the neutral bar into the can, and why that screw is used only at the service and never in a subpanel; handle ties on shared-neutral circuits. Caution: He installs standard 2-pole breakers on the 12-3 shared-neutral home runs and says AFCI breakers will come later. Under R1.5 §2.3 and Example 6, decide AFCI/GFCI requirements before you close the panel. He adds an extra bar with a bonding jumper, which is his preference, not a requirement.
§3.1 Service and feeder conductor size, dwelling rule (310.12, the 83 percent rule)	.83 Rule when to apply Electrical Code Coach • 5:52 Whiteboard walk-through: do the load calc, pick the next standard service size, then multiply the service rating (not the calculated load) by 0.83 to size the conductors, which is why 4/0 aluminum serves 200 A. Caution: Uses the 2020/2023 wording; same rule as R1.5 §3.1. The 83 percent factor does not apply to a garage subpanel feeder (R1.5 Example 3).

§3.6 Working space and location (110.26, 240.24, 408.43)	Height of Panels and Working Space Around Panels 2023 NEC 404.8(A) and 110.26 Sparky Channel • 7:39 Measures a real panel against the code: top breaker handle no higher than 6 ft 7 in., 30 in. wide working space, 90° door opening, 36 in. depth, and 6½ ft headroom. Caution: Cites NEC 2023 section numbers; check them against the 2026 numbers in R1.5 §3.6.
§4.10 Build the grounding electrode system	Ground Rod Installation Methods Electrical Code Coach • 8:16 Two rods at least 6 ft apart, two ways to connect them to the service with the GEC, and what the code allows when a rod hits rock (45° angle, then a 30 in. trench). Caution: Drawn on slides, no field footage. The angle and trench methods are only for rock; YES default is two vertical rods (R1.5 §3.5).