

Older Homes

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.

Masterclass. Read this any time after R1.6 (grounding and bonding) and R2.1 (the service call). Read it again before your first job in a house built before 1975. R2.9 (whole-house safety inspection) sends you here for the deep version.

Before this masterclass: R1.4 (receptacles, switches, GFCI and AFCI), R1.6 (grounding and bonding), R2.1 (the service call), and R2.2 (meters). R2.7 covers heat, burning smells, and aluminum repairs on a service call. This masterclass covers the whole house.

Code edition. Code references are NEC 2026. Where a section 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 one applies before you quote a section to anyone. In older houses this matters more than usual, because the AHJ also decides how much of the old wiring has to be brought up to date when you change something.

Learning Objectives

When you finish this masterclass you will be able to:

1. Identify knob-and-tube wiring, cloth-covered NM cable, early two-wire plastic NM with no ground, armored BX cable, and aluminum branch wiring, by sight and with a meter.
2. Identify the panels with known failure histories: Federal Pacific Stab-Lok, Zinsco and Zinsco-Sylvania, Bulldog and ITE Pushmatic, split-bus panels, and fuse panels.
3. Say what the code allows you to leave in place, what you must change when you touch it, and what must be fixed now because it is unsafe.
4. Replace a two-prong receptacle the three legal ways under NEC 406.12(D) (2023: 406.4(D)), and add a real equipment ground under 250.130(C).
5. Apply the AFCI rule for replaced receptacles and for modified or extended circuits (406.12(D)(4) and 210.12(E)).
6. Repair an aluminum branch-wiring connection with one of the three methods the U.S. Consumer Product Safety Commission (CPSC) accepts as permanent, and know which "fixes" it does not accept.
7. Explain to a customer how insurance companies may treat these wiring types and panels, without guessing on the insurer's behalf.

8. Write a staged upgrade plan for a customer who cannot do everything at once: what today, what this year, and what eventually, with the reason for each.
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Background: Why Older Houses Get Their Own Masterclass

A house is wired once, with the materials and the code of its day, and then lives for 50 to 100 years. During that time the code changes every three years, people add circuits, handymen add splices, insulation gets blown into attics, and the family's electrical use goes from a few lamps and a radio to two refrigerators, a window AC in every bedroom, and a car charger.

When you walk into a house built before about 1975, you are looking at layers. A 1938 house in Norwood or Ensley may have its original knob-and-tube in the second floor ceiling, cloth-covered cable from a 1955 kitchen remodel, two-wire plastic cable from a 1968 bathroom, a fuse box that was replaced by a Federal Pacific panel in 1976, and modern NM-B from a 2005 addition. Each layer has different problems and different rules.

Three ideas run through this whole masterclass.

Old is not the same as illegal. The NEC is mostly written for new work. Wiring that was installed correctly under the code of its day is generally allowed to stay as long as it is in good condition and nobody changes it. Knob-and-tube still has its own article in NEC 2026 (Article 394). Two-prong receptacles still have a legal replacement path (406.12(D)(2)). The AHJ makes the final call on existing wiring.

Touching it changes the rules. When you replace a receptacle, extend a circuit, or change a panel, the new work has to meet today's code, and some rules reach back into the old circuit. Replace a receptacle in a bedroom and it now needs AFCI protection (406.12(D)(4)). Extend a bedroom circuit more than 6 feet and the whole circuit needs AFCI protection (210.12(E)). You have to know these before you quote a scope.

Condition beats age. A 1940s knob-and-tube run that was never disturbed, sits in open air, and tests clean is often in better shape than 1970s aluminum wiring with every receptacle backstabbed. Your job is to look, test, and write down what you see, not to condemn a house because of its age.

Picture coming: A cutaway of a two-story older house showing the layers. Labels with arrows: "1930s knob-and-tube in 2nd-floor ceiling, buried under blown-in insulation"; "1950s cloth-covered NM in kitchen"; "1960s two-wire plastic NM, no ground, in bathroom"; "1970s aluminum NM on a bedroom addition"; "Fuse box replaced by Federal Pacific panel in basement"; "2005 NM-B on rear addition." A legend at the bottom gives each wiring type a color.

Part A: Identify the Wiring

Look first, test second. Most of what you need to know you can see in an unfinished basement, a crawl space, an attic, the panel, and inside one or two boxes. Never pull wiring around to read it. Old insulation cracks when you bend it.

Safety: before you open any box in an older house. Turn off the breaker or remove the fuse, prove your meter on a known live outlet, read the device dead, and prove the meter again (live-dead-live, R2.1). In older houses the panel directory is often wrong or missing, and knob-and-tube circuits sometimes share a neutral with another circuit. A device can be dead on the hot and still have current on the neutral from another circuit. Treat every conductor as live until your meter says otherwise, and keep your hands off the neutral until you have read it to ground.

Wiring type ID table

Wiring type	Rough years in houses	What you see	Ground?	Main concerns
Knob-and-tube (K&T)	1880s to early 1930s (Kuhlman, p. 135); some houses later	Separate single wires, spaced apart, on white porcelain knobs along joists and through porcelain tubes in holes; cloth-and-rubber insulation; black cloth sleeve (loom) where wires enter boxes	No	Brittle insulation, splices outside boxes, buried in insulation, overloaded, extended by amateurs
Cloth-covered NM	Roughly 1930s to 1960s	Flat cable with a woven fabric outer jacket, often tar-coated; rubber-insulated wires inside; sometimes no ground	Often no; later ones may have a small bare ground	Rubber insulation turns hard and cracks, especially near hot light fixtures
BX (early armored cable)	Early 1900s onward	Spiral steel armor, no separate green or bare wire inside, sometimes no thin bonding strip	Armor was used as the ground path; reliability varies	Rusted or loose armor, no bonding strip, no bushings at the cut ends
Two-wire plastic NM	Roughly 1950s to mid-1960s	Gray or white plastic-jacket cable with a black and a white wire and no ground wire	No	No ground for three-prong devices; people install three-prong receptacles anyway
Aluminum NM (branch circuits)	1965 to the mid-1970s (CPSC Pub. 516)	Plastic-jacket cable printed "AL" or "ALUMINUM"; silver-colored wires; 12 AWG on 15 A circuits and 10 AWG on 20 A circuits	Usually yes	Connections overheat at devices and splices
Modern NM-B	Mid-1980s to today	Plastic jacket printed "NM-B," with a bare ground; jacket color shows size (white 14, yellow 12, orange 10) on newer cable	Yes	Normal; check workmanship

The date ranges are rough. Houses were rewired, added onto, and repaired with whatever was on the truck. Identify each run by what you see, not by the year the house was built.

A1. Knob-and-tube

What it is. Knob-and-tube runs each conductor as a separate wire. The hot and the neutral travel apart from each other through the house. Porcelain knobs nailed to joists and studs hold the wires off the wood, and porcelain tubes line the holes where wires pass through framing.

Where wires had to be fished through a finished wall and could not be held on knobs, the installer slid a continuous cloth tube called loom over each wire. Terence Croft's 1915 book *Wiring of Finished Buildings* describes it as the cheapest concealed method of the day and says that, carefully installed, it was safe and permitted by the National Electrical Code (Croft, p. 123). Croft also describes the inspector's trick for spotting bad work: grab the loom in one hand and the wire in the other. If the loom runs continuously from outlet to outlet, the wire won't slide inside it. If the installer only slipped short pieces of loom on at the outlets, the wire slides easily (Croft, p. 124).

Why it worked when new. The wires were spaced apart and surrounded by air, so they shed heat. NEC 2026 still states the original installation rules: at least 3 inches between conductors and at least 1 inch between a conductor and the surface it runs over (394.19(A)), and supports within 6 inches of each side of a splice and no more than 4½ feet apart (394.30(A)). Splices are soldered unless approved splicing devices are used (394.56).

Why it fails now. Kuhlman lists the two main disadvantages as no ground and a fire hazard when insulation is put around it (Kuhlman, p. 135). The rubber insulation under the cloth dries out and cracks with age. Homeowners and insulation contractors bury the wires in blown-in or batt insulation, which traps heat. NEC 2026 394.12(5) does not allow concealed knob-and-tube in the hollow spaces of walls, ceilings, and attics where the space is insulated by loose, rolled, or foamed-in-place insulation that envelops the conductors. Over the decades, people add splices hanging in the air, tap new outlets off the old wires with electrical tape, and put larger fuses on the circuit when it blows.

How to identify it, step by step.

1. In the basement or crawl space, look along the floor joists under the first floor. Look for pairs of single wires on white porcelain knobs, spaced several inches apart.
2. In the attic, look along the ceiling joists with a flashlight. Look for knobs and tubes, even if blown-in insulation partly covers them. Do not dig through insulation with your hands; vermiculite or old insulation may contain asbestos. Look and photograph from the access hatch, and tell your journeyman.
3. At the panel or fuse box, look for single cloth-covered wires entering through separate holes instead of cables.
4. Inside a switch or ceiling box (power off and proven dead), look for single wires with black cloth loom where they enter the box, and no ground wire.
5. At a ceiling light, look for wires that come into the box through loom with no cable clamp.

Field photo coming: Basement ceiling of a pre-1935 Birmingham house. Two parallel single cloth-covered conductors run along the side of a floor joist on white porcelain knobs about 4½ feet apart, with a porcelain tube visible where one wire passes through a joist. A tape measure held across the two wires shows about 4 inches of spacing. Shot with flash, the knob nails visible.

Field photo coming: Attic view from a hatch: knob-and-tube conductors running across ceiling joists, half buried in gray blown-in cellulose insulation, with one porcelain knob visible above the insulation. An arrow labeled "394.12(5): not allowed buried in insulation."

Is it legal to leave? Article 394 is still in NEC 2026. It permits concealed knob-and-tube only for extensions of existing installations, or elsewhere by special permission (394.10). That tells you the code still recognizes the existing wiring as a wiring method. Whether a particular run may stay depends on its condition and on the AHJ. Knob-and-tube buried in insulation, damaged, or with splices outside boxes is a defect to fix, not a method to keep.

What we do at YES. We do not extend knob-and-tube. We do not tap new circuits off it. When we find it, we document where it is and what condition it is in, and we recommend replacement in the staged plan (Part F). If it is buried in insulation, or if we see damage or open splices, it goes in the Safety-Critical band.

A2. Cloth-covered NM

What it is. Nonmetallic cable with a woven fabric outer jacket, often coated in tar or wax, holding two rubber-insulated wires, sometimes with a small bare ground in later versions. It was the next step after knob-and-tube.

How to identify it.

1. Look at cable runs in the basement and attic. A fabric weave you can see on the jacket, often dark brown or black, means cloth NM.
2. In a box (power off, proven dead), look at the individual wires. Rubber insulation under a thin cloth braid is the tell.
3. Bend nothing. Touch the insulation near the device lightly with an insulated screwdriver tip. If it flakes or crumbles, note it.

The problem. The rubber insulation hardens and cracks, worst where heat collects: inside ceiling boxes above light fixtures, especially fixtures that have been run with bulbs bigger than the fixture's rating. Kuhlman shows a box where an over-lamped light had cooked the wire insulation until it cracked when touched (Kuhlman, p. 124). When the insulation is gone at the device, any movement can short the hot to the box or to the neutral.

What to do.

1. If the insulation is intact and flexible, the cable can stay. Note it.
2. If the insulation is cracked only for the first inch or two inside the box, a journeyman may decide to cut back to good insulation if there is enough length, or to cover the damaged section with a heat-shrink sleeve listed for the purpose. Ask your journeyman before doing either. Tape wrapped over crumbling rubber is a temporary fix at best.
3. If the insulation is crumbling for more than the last few inches, or along the run, the circuit needs to be replaced. It goes in the staged plan.

4. When you replace a light fixture on cloth-covered wire, check the fixture's label for the wire temperature it requires. Many newer fixtures say "use wire rated for at least 90°C." Old rubber insulation is not rated that high. Follow the fixture's listing and instructions (110.3(B)).

A3. BX (early armored cable)

What it is. Two insulated wires wrapped in a spiral steel armor. Early BX had no separate ground wire. The armor itself was the ground path back to the panel. Later armored cable (Type AC) added a thin aluminum or copper bonding strip inside the armor to make the armor a better conductor.

How to identify it. Spiral metal jacket, no green or bare wire inside. Look at a cut end for a thin flat strip folded back over the armor. No strip means early BX.

Meter note. Kuhlman notes that non-contact voltage testers do not work on BX or MC cable, because the metal jacket shields the wires (Kuhlman, p. 11). Use your meter on the conductors.

What to check.

1. Is the armor tight in the box connector? Loose armor means a poor ground path.
2. Is there a red plastic anti-short bushing at the cut end of the armor, protecting the wires from the sharp edge?
3. Is the armor rusted, especially in damp basements and crawl spaces?
4. Measure the ground path (Part C, Step C4). Early BX armor may or may not be a good enough path to trip a breaker on a fault. Do not assume a BX box is grounded until you have measured it.

A4. Two-wire plastic NM with no ground

What it is. Plastic-jacketed cable with a black wire and a white wire, and no bare ground. It looks like modern NM except for the missing ground.

How to identify it. Read the cable jacket in the basement or attic. Count the wires in a box. No bare or green wire, and two-slot receptacles or three-slot receptacles with nothing on the green screw.

The problem. A three-prong receptacle on two-wire cable with nothing connected to the ground screw looks safe and is not. A plug-in tester will show "open ground." Worse, some people jump a short wire from the neutral screw to the ground screw. That is called a bootleg ground. A three-light plug-in tester reads "correct" on a bootleg ground, because it cannot tell the difference between a real ground and a neutral jumper. If the neutral ever opens upstream, the metal case of anything plugged in becomes live (R2.2 shows how to catch a bootleg ground with a meter). Part D covers the legal ways to deal with ungrounded receptacles.

A5. Aluminum branch wiring

What it is. NM cable with solid aluminum conductors used for ordinary 15 A and 20 A circuits. CPSC Publication 516 explains that a copper shortage in the mid-1960s pushed builders to use aluminum for general-purpose circuits, and that cable installed between 1965 and the mid-1970s may contain it (CPSC Pub. 516, p. 1). The same publication reports a CPSC-sponsored survey finding that homes built before 1972 and wired with aluminum were 55 times more likely to have one or more connections at outlets reach "Fire Hazard Conditions" than homes wired with copper.

Why it fails. Aluminum connections build up resistance over time at screws and splices, and the added resistance makes heat when current flows. CPSC describes the damage as cumulative (Pub. 516, p. 1). The failures happen at the connections, not along the middle of the wire.

How to identify it, step by step.

1. Look at cable jackets in the basement, attic, or garage. CPSC says aluminum cable is marked "Al" or "Aluminum" every few feet. Shine a flashlight at a low angle across the jacket to read embossed markings (Pub. 516, p. 2).
2. Read the whole marking. "CU-clad" or "Copper-clad" along with "AL" means copper-clad aluminum, which CPSC's repair guidance does not cover (Pub. 516, p. 2).
3. At the panel (dead front off, with your journeyman), look at the branch-circuit wires on the breakers. Silver-colored solid wire on 15 A and 20 A breakers is aluminum.
4. Note the wire size. CPSC notes aluminum branch circuits were sized 12 AWG for 15 A and 10 AWG for 20 A (Pub. 516, footnote 2). A 10 AWG wire on a 20 A breaker feeding bedroom receptacles is a strong hint.
5. Do not confuse aluminum branch wiring with aluminum service entrance cable or aluminum feeders to a range or dryer. Large aluminum conductors on services, ranges, and dryers are common, are made of a different alloy than the old branch-circuit wire, and are outside CPSC's branch-circuit repair guidance (Pub. 516, footnote 3). Those connections still need to be torqued to the label and inspected (R2.7).

Trouble signs CPSC lists: faceplates on receptacles or switches that are warm to the touch, flickering lights, circuits that don't work, and the smell of burning plastic at outlets or switches. CPSC also warns that aluminum connections often fail with no warning at all (Pub. 516, p. 2).

A6. Backstabbed devices

Many older houses have receptacles and switches with the wires pushed into holes in the back of the device instead of wrapped under the screws. These push-in connections hold the wire with a small spring contact, and Kuhlman finds failed backstab connections common enough on dead-outlet calls that a backstabbed first outlet is his lead suspect (Kuhlman, p. 82). NEC 2026 406.10(3) now makes the limit a code rule: push-in terminals may be used only on branch circuits rated 15 A or less, and only with 14 AWG solid copper conductors. Earlier editions of the NEC left that limit to the device's UL listing. Backstabbed devices in older houses were installed before this rule existed, so finding one is not a violation by itself. Two cases are defects today: a

12 AWG wire pushed into a back hole, and aluminum wire pushed into a back hole. When you replace or service a backstabbed device, move the wires to the screw terminals (R2.7). When you find one failed backstab, expect more in the same house.

Picture coming: Wiring-type ID chart, one row per type, each with a photo-realistic close-up and a date band: knob-and-tube (porcelain knob, single cloth wire, "1880s-early 1930s"); cloth NM (woven jacket, rubber wire, "1930s-1960s"); BX (spiral armor, no ground wire, "early 1900s on"); two-wire plastic NM (black and white only, "1950s-mid-1960s"); aluminum NM (silver wires, jacket printed "ALUMINUM," "1965-mid-1970s"); modern NM-B (bare ground, colored jacket, "today"). Each row has a small "Ground? Yes/No" tag.

Part B: Identify the Panel

Read the label inside the panel door or on the dead front first. Photograph it. Then look at the breakers. Never pull a breaker out of an older panel to look at it unless your journeyman is there and the panel is dead from upstream.

Safety: older panels can be live when they look off. Three of the panels in this part have field reports of breakers that stay on inside after the handle is moved to OFF: Zinsco (InspectApedia, "Zinsco Summary"), Bulldog Pushmatic (InspectApedia, "Pushmatic"), and Federal Pacific Stab-Lok (Arc Guide, Part 8). On any of these, prove a circuit dead with your meter at the point of work every single time. If the panel has no main breaker, the only way to kill the whole panel may be at the meter, which is utility work (R2.1, Part E).

Panel ID table

Panel	How to recognize it	Known concern	What we recommend
Federal Pacific Electric (FPE) Stab-Lok	"Federal Pacific" or "FPE" on the label; "Stab-Lok" printed on the breakers or dead front; breaker handles often in a row of thin red-tipped toggles	Breakers that do not reliably trip; breakers that may not fully disconnect	Document; recommend panel replacement
Zinsco, Zinsco-Sylvania, GTE-Sylvania	Brand on the label; breakers with handles in several colors; breakers that slide onto the bus instead of snapping onto a flat stab	Breaker-to-bus connection overheats and can fuse the breaker to the bus	Document; recommend panel replacement
Bulldog Pushmatic, ITE Pushmatic	Push buttons instead of toggle handles; "Pushmatic" or "Bulldog" or "ITE" on the label	Stiff, hard-to-operate breakers; on/off indicator that can stick; field reports of failure to trip	Document; recommend replacement at the next change or sooner if damaged
Split-bus ("rule of six")	No single main breaker; up to six large breakers at the top marked as service disconnects, one of which feeds the lower section of breakers	Too many handles to shut off the house in an emergency; often overcrowded; obsolete parts	Document; recommend replacement when service work is done or the panel is full
Fuse panel (plug fuses, cartridge fuses)	Screw-in round fuses with glass windows; a pull-out block or lever for the main	Overfusing (fuse bigger than the wire); tampering (pennies behind fuses); no GFCI or AFCI options	Document; correct overfusing now; recommend replacement in the staged plan

B1. Federal Pacific Stab-Lok

What the record says. In 1983 the CPSC closed a two-year investigation into FPE Stab-Lok residential breakers. CPSC testing confirmed that the breakers failed certain UL calibration tests, the tests that check whether a breaker trips within set time limits when overloaded. The investigation focused mainly on two-pole breakers made before 1979. CPSC closed the matter without deciding whether the breakers were safe, citing the cost of the further study and its budget, and it has since added a note telling electricians, inspectors, and homeowners to read the release carefully because it made no determination either way (CPSC Release 83-008, revised 2011).

What that means for you. You cannot tell by looking whether a given Stab-Lok breaker will trip. Toggling it on and off does not test its trip function. The Arc Guide adds that a tripped Stab-Lok breaker may sit in a position that looks off while the circuit stays live (Arc Guide, Part 8).

Step by step when you find one.

1. Photograph the label and the breakers with the panel door open and the dead front on.
2. Tell your journeyman before you remove the dead front. Some inspectors report that Stab-Lok breakers can come out with the cover; have your journeyman decide how to remove it.
3. Prove every circuit you work on dead with your meter at the device, never by the handle position.
4. Do not install "replacement" Stab-Lok-type breakers on your own. Any breaker change in an FPE panel is a journeyman decision.
5. Write it in the report as a panel with a documented history of breakers failing UL trip tests, and recommend replacement. Cite the CPSC release if the customer asks for a source. Do not tell the customer it was recalled. It was not.

B2. Zinsco and Zinsco-Sylvania

What the sources say. InspectApedia describes the central problem as burn-ups at the clip that connects each breaker to the bus, with field reports of breakers overheating, failing to trip, and in some cases staying on after they were switched off (InspectApedia, "Zinsco Summary"). An insurer's loss-control page from Great American Insurance Group says damaged or failing Zinsco breakers are not obvious by sight and that, due to the design flaw, all Zinsco breakers and panels should be replaced with current UL-listed equipment (Great American, "Is Your Electric Panel a Fire Risk?").

Step by step when you find one.

1. Photograph the label and the breakers.
2. Look, without touching, for discoloration, melted plastic, soot, or arcing marks around the breakers. If you see any, it is Safety-Critical.
3. Do not exercise the breakers to "test" them. InspectApedia warns that even switching them on and off can increase the risk of a future failure to trip.
4. Prove circuits dead with a meter at the point of work.
5. Recommend panel replacement. Do not recommend buying replacement Zinsco-type breakers.

B3. Bulldog and ITE Pushmatic

What the sources say. InspectApedia reports occasional field failures since 1986, breakers that become stiff and hard to operate over time, an on/off indicator flag that can stick and give a false reading, and a dangerous failure where the breaker stays on inside while appearing off. It also notes that opinions among inspectors and electricians conflict, and that no official study has documented a high failure-to-trip rate (InspectApedia, "Pushmatic"). Replacement Pushmatic breakers are sold new and used; InspectApedia warns that salvaged breakers have an unknown history and that some new ones do not fit older panels (InspectApedia, "Pushmatic Replacements").

Step by step when you find one.

1. Photograph the label and the push-button breakers.
2. Note any breaker that is stiff or whose indicator does not match what your meter reads.
3. Prove dead at the point of work.
4. Recommend replacement at the next service or panel change. Move it up to "this year" or "today" if any breaker is damaged, hot, or will not turn off.

B4. Split-bus panels

What it is. A panel with no single main breaker. The top section holds up to six large breakers marked as service disconnects. One of them feeds the lower section of the panel, where the smaller branch breakers sit. To shut off the whole house you turn off every breaker in the top section. The American Society of Home Inspectors' article on split-bus panels explains that these were common into the early 1970s, that older codes allowed them when all the power could be shut off with six disconnects or fewer, and that people often break the rule later by swapping two-pole breakers in the top section for single-pole breakers to get more circuits (ASHI Reporter, "Split Bus Electrical Panels," 2021).

Current code. NEC 2026 230.71 says each service shall have only one service disconnect unless the requirements of 230.71(B) are met. An existing split-bus panel installed under an older code may be allowed to stay. Any new service equipment follows the current rule.

Step by step when you find one.

1. Count the handles in the top section. More than six handles, or single-pole breakers in the top section, means someone added circuits there. Document it.
2. Find the breaker that feeds the lower section. Its large conductors run down behind the top breakers to the lower bus.
3. Label the top section "SERVICE DISCONNECTS — turn off all to shut off house" if it is not labeled, and show the customer.
4. Recommend replacement when the panel is full, damaged, or when any service work is planned.

B5. Fuse panels

What it is. Screw-in plug fuses for 120 V branch circuits, and a pull-out block with cartridge fuses for the main and for 240 V loads. A fuse protects the wire the same way a breaker does: a metal link inside melts when too much current flows.

The real danger is overfusing. When a 15 A fuse on a 14 AWG circuit blows often, people screw in a 20 A or 30 A fuse, or put a penny behind the fuse so it can never open. The wire is now unprotected. NEC 240.4(D) limits 14 AWG copper to 15 A protection and 12 AWG copper to 20 A.

What the code says about plug fuses.

- Plug fuses rated 15 A or less have a hexagonal window, cap, or other part, so you can tell them from larger fuses (240.50(C)).
- Edison-base plug fuses (the kind with the same threads as a light bulb) may be used only as replacements in existing installations where there is no evidence of overfusing or tampering (240.51(B)).
- Type S fuses have different bases for each size range (0–15 A, 16–20 A, 21–30 A) so a larger fuse cannot be put in a smaller fuseholder (240.53). Type S adapters screw into Edison-base fuseholders to convert them, and once installed they are designed to be nonremovable (240.54(A) and (C)).

Step by step when you find one.

Safety: The fuse box may have exposed live parts once its cover is off. Treat it as live. Insulated tools, safety glasses, one hand where possible, and your journeyman present.

1. Photograph the fuse box with every fuse visible.
2. Read the ampere rating on every fuse. Write it down next to the circuit.
3. Identify the wire size on each circuit where you can see it at the box or in the basement.
4. Any fuse larger than the wire allows (more than 15 A on 14 AWG, more than 20 A on 12 AWG) is overfusing. Any penny, foil, or bridged fuse is tampering. Both are Safety-Critical.
5. Correcting overfusing on the spot means installing the correct-size fuse. Your journeyman decides whether to install Type S adapters at the same time to prevent it from happening again (240.54). Tell the customer why the smaller fuse may now blow, and that the answer is more circuits, not a bigger fuse (R2.1, Part C, Check 4).
6. Note that a fuse panel has no GFCI or AFCI breaker options. Protection has to come from GFCI receptacles and outlet branch-circuit AFCI devices (Part E), or from a panel replacement.

Picture coming: Panel ID chart, five panels side by side, each with one bold tell called out by an arrow: FPE ("Stab-Lok" lettering on red-tipped breakers); Zinsco (multicolored breaker handles); Pushmatic (push-buttons instead of toggles); split-bus (six large breakers at top labeled "SERVICE DISCONNECTS," heavy wires running to a lower section); fuse panel (round screw-in fuses with hex windows on 15 A, a pull-out main block). Under each, one line: "Meter at the point of work. Handle position proves nothing."

Part C: Test the Old Wiring

You test older wiring to find out three things: does the circuit have a real ground path, are there loose or failing connections, and is any of it unsafe right now. R2.2 teaches the meters. This part shows how to use them in an older house.

Step C1. Map the circuits first

Older panel directories are often missing or wrong. Before you test anything, map what you can (Arc Guide, Job 10).

1. Photograph the existing directory.
2. With a helper, turn off one breaker or remove one fuse at a time and note what goes dead. Use a plug-in tester or a lamp at each receptacle.
3. Note anything that does not go dead with any single breaker. That can mean two circuits feed one box, or a shared neutral, both of which are common in knob-and-tube and early remodels.
4. Write the map on the job board.

Safety: Turning off circuits in an occupied house can shut off a medical device, a sump pump, a freezer, or a home office computer. Ask the customer before you start, and turn everything back on as you go.

Step C2. Receptacle readings

At each receptacle, take the three readings with your meter (R2.2): hot-to-neutral, hot-to-ground, and neutral-to-ground.

Hot-Neutral	Hot-Ground	Neutral-Ground	In an older house, this most likely means
About 120 V	About 120 V	0–2 V	Ground path present. Still check it is a real ground, not a bootleg (Step C3).
About 120 V	0 V	About 120 V or floating	No ground. Two-wire cable, or a three-prong receptacle with nothing on the ground screw.
About 120 V	About 120 V on some, low or 0 on others	varies	Partial ground. BX armor, a loose box connector, or ground present on some runs only.
About 120 V, but neutral-ground over 5 V with a load on			High-resistance neutral connection somewhere upstream (Arc Guide, Part 3). Find it.

Step C3. Catch a bootleg ground

A bootleg ground is a jumper from the neutral screw to the ground screw on a receptacle with no real ground. The three-light plug-in tester reads "correct." Your meter can catch it.

1. Turn off the breaker. Prove dead with live-dead-live.
2. Pull the receptacle out of the box and look at the ground screw. A short wire running from the silver neutral screw to the green ground screw is a bootleg ground. Remove it.

3. If you cannot see it (for example, it is spliced in the back of the box), use the meter with the circuit back on: plug a load of at least 1,000 W into the receptacle, such as a space heater on low, and read neutral-to-ground. A real, separate ground path reads a few volts with load on, because the neutral carries current and the ground does not. A bootleg ground reads 0 V or very close to it with load on, because the two are the same wire at the receptacle.
4. Document every bootleg ground you find. It is Safety-Critical.

Step C4. Measure the ground path

Do this on any receptacle or box where you plan to rely on the ground, including every BX box.

1. Turn off the circuit and prove it dead.
2. Set your meter to ohms (Ω).
3. Use a long test lead. Connect one end to the panel's ground bar (with your journeyman, dead front off, keeping clear of live parts) or to a known-good ground at a nearby modern receptacle.
4. Touch the other probe to the ground screw or the metal box at the receptacle you are testing.
5. Subtract the resistance of the long lead itself (touch the two probe ends together first and note the reading).
6. The Arc Guide gives less than 1 ohm as a good reading on a ground path back to the panel (Arc Guide, Symptom 11, Step 4). A reading of several ohms, or one that jumps around when you wiggle the cable at the box, is a poor path. Do not rely on it.

Step C5. Look and feel for heat

1. With normal loads running, put the back of your hand near (not on) every receptacle and switch cover plate in the rooms with older wiring. A plate that is warm with nothing plugged in is a warning sign.
2. Use a spot thermometer on cover plates and on panel breakers while the circuits are under load (Arc Guide, Part 10, "Thermal Inspection Without a Camera"). A breaker or plate much warmer than its neighbors gets opened (power off) and inspected.
3. In a house with aluminum wiring, check every plate this way. CPSC lists warm faceplates as a trouble sign (Pub. 516, p. 2).

Step C6. Insulation testing on knob-and-tube

An insulation resistance tester (a "megger") puts a high DC test voltage on a de-energized circuit and measures how much leaks through the insulation. Commercial Module 2.2 teaches the tool. On old wiring it can show insulation that is breaking down before it fails.

Safety: A megger's test voltage can damage anything plugged in or connected, including electronic dimmers, smoke alarms, and GFCI and AFCI devices. It can also shock you. Only run an insulation test with your journeyman, with the circuit off at the panel, every load unplugged,

every device that could be damaged disconnected, and the test voltage your journeyman chooses.

1. Your journeyman decides whether to test and at what voltage.
2. Test hot to neutral, hot to ground (if any), and neutral to ground (if any).
3. Write down each reading.
4. Compare circuits to each other. A circuit that reads far lower than the others in the same house is the one to look at first.

This masterclass does not give a pass/fail number for old wiring. Your journeyman interprets the readings.

Step C7. Look at the service and grounding

Older houses often have weak service equipment and grounding. While you are there, check the items that R1.5, R1.6, and R-SERVICE teach in depth:

1. Service entrance cable on the outside wall. Kuhlman reports that SE cable often lets water travel into the meter socket and down into the panel, corroding the connections until they must be replaced (Kuhlman, pp. 40–41). Look for cracked jacket, a missing drip loop, and rust stains below the meter.
2. The panel interior. Kuhlman shows a panel where years of water had ruined the bus, neutral bar, and every breaker, and notes that the meter outside is usually worse because that is where the water starts (Kuhlman, p. 107).
3. The water pipe bond. Older houses often have a bond to the metal water pipe. NEC 250.104(A) requires metal water piping to be bonded. Check that a jumper crosses the water meter (Kuhlman, p. 88). If the water line has been replaced with plastic, the old water pipe may no longer be a grounding electrode, and the house may be relying on whatever else is there (R1.6).
4. Clamp the grounding electrode conductor to the water pipe with your clamp meter. Kuhlman says it should read 0 or about 0.1 A, and current above that points to a neutral problem (Kuhlman, p. 45). R2.5 covers the neutral procedure.

Part D: Ungrounded Receptacles: The Three Legal Fixes and the Ground Wire Option

The most common older-house job is a customer who wants three-prong receptacles where they have two-prong ones. The code gives you a clear set of choices. Learn them exactly.

D1. What the code allows when no ground exists

NEC 2026 406.12(D)(2) (2023: 406.4(D)(2)) applies where there is no equipment grounding conductor in the receptacle box. You may do one of these three:

Option	What you install	Required marking	When to use it
(a)	A new non-grounding (two-prong) receptacle	None	Customer only needs two-prong; cheapest; still no shock protection
(b)	A GFCI receptacle	The receptacle or its cover plate marked "No Equipment Ground"	One location, customer wants three-prong and shock protection
(c)	Grounding-type (three-prong) receptacles supplied through a GFCI (GFCI receptacle upstream or GFCI breaker)	Each marked "GFCI Protected" and "No Equipment Ground," visible after installation	Several receptacles on the same circuit; one GFCI protects them all

Two more rules apply to (b) and (c). The equipment grounding terminal of the GFCI must not be connected to any outlets it feeds, and the ground terminals of the downstream receptacles must not be connected to each other (406.12(D)(2)(b) and (c)). That rule exists because a wire connecting those ground screws without a real ground behind it would look like a ground to the next electrician and would not be one.

Why GFCI works without a ground. A GFCI compares the current going out on the hot with the current coming back on the neutral. If the difference is more than about 5 mA, it trips (Kuhlman, p. 30). It does not need a ground wire to do that. If a person touches a live part, the current that goes through them to ground does not come back on the neutral, and the GFCI opens the circuit. What it cannot do is give a surge protector or an electronic device a ground reference. Informational Note No. 1 to 406.12(D)(2) warns that some equipment manufacturers require a grounded circuit, and Informational Note No. 2 points to 250.114, which lists appliances that need an equipment ground. In houses that list includes refrigerators, freezers, air conditioners, clothes washers, dryers, dishwashers, ranges, kitchen waste disposers, information technology equipment (computers), sump pumps, and aquarium equipment (250.114(3)). For those, run a real ground (D2) or a new circuit.

What is not allowed. A three-prong receptacle with nothing on the ground screw and no GFCI protection is not one of the three options. A bootleg ground is not one of the options either.

D2. Adding a real ground under 250.130(C)

When the customer needs a true ground (for a refrigerator, a computer, a sump pump), NEC 250.130(C) lets you add an equipment grounding conductor to an existing ungrounded receptacle or branch circuit. The new ground wire may connect to any one of these:

1. Any accessible point on the grounding electrode system.
2. Any accessible point on the grounding electrode conductor.
3. The equipment grounding terminal bar in the enclosure where the receptacle's branch circuit starts (the panel the circuit comes).

4. An equipment grounding conductor that is part of another branch circuit starting in the same enclosure as the receptacle's circuit.
5. For grounded systems (a normal house), the grounded service conductor inside the service equipment enclosure.

The Arc Guide tells techs not to run a ground from a "distant ground source" and calls that a code violation unless it comes from the original panel (Arc Guide, Part 8). That is too narrow. Under 250.130(C) you may connect to the grounding electrode system, the grounding electrode conductor, the panel's ground bar, or another circuit's ground from the same panel. You may not connect to a random cold water pipe in the middle of the house, a gas pipe, or a ground wire from a circuit that starts in a different panel.

Step by step: adding a ground to an existing receptacle.

1. Confirm with your journeyman that 250.130(C) applies and which connection point you will use. Most often it is the ground bar in the panel the circuit comes, or the ground wire of a modern circuit from the same panel that passes near the box.
2. Turn off the circuit. Prove it dead.
3. Size the new ground wire. It must be at least the size 250.122 requires for the circuit's overcurrent device: 14 AWG copper for a 15 A circuit, 12 AWG copper for a 20 A circuit (Table 250.122).
4. Route the ground wire from the receptacle box to the connection point. Protect it the same as any wire in that location (R1.3). A green insulated or bare copper conductor is used.
5. At the connection point, land it on the ground bar or splice it to the other circuit's ground with a listed connector.
6. At the box, connect it to the receptacle's green screw with a pigtail, and to the box with a ground screw if the box is metal.
7. Install a grounding-type receptacle. Because you are replacing a receptacle, 406.12(D)(3) through (5) also apply: GFCI where the location now requires it, AFCI where the location now requires it (D3 below), and tamper-resistant where required.
8. Turn the circuit on. Take the three readings, then do the ground path resistance test (Step C4).

D3. AFCI when you replace receptacles

NEC 406.12(D)(4) (2023: 406.4(D)(4)) says that if you replace a receptacle on a 120 V, 15 A or 20 A circuit in any area listed in 210.12(B), (C), or (D), the replacement must be one of these:

1. A listed outlet branch-circuit type AFCI receptacle.
2. A receptacle protected by a listed outlet branch-circuit type AFCI receptacle upstream.
3. A receptacle protected by a listed combination type AFCI circuit breaker.

The areas in a dwelling (210.12(B)) are kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, laundry areas, and similar areas. Bathrooms, garages, outdoors, and unfinished basements are not on that list.

In a fuse panel, or in an old panel with no AFCI breaker made for it, options 1 and 2 are your only choices. An outlet branch-circuit AFCI receptacle at the first receptacle of the circuit protects that receptacle and everything downstream of it.

Common combination. In a bedroom with two-wire cable, the customer wants three-prong receptacles. The bedroom requires AFCI on replacement, and the ungrounded receptacles need GFCI protection to be three-prong. A dual-function (AFCI and GFCI) breaker can do both where the panel accepts one. In a panel that does not, a dual-function receptacle at the first outlet can do both, if one is listed for the purpose; confirm the product's listing and instructions (110.3(B)). Mark every downstream receptacle "GFCI Protected" and "No Equipment Ground."

D4. AFCI when you modify or extend a circuit

NEC 210.12(E) says that if branch-circuit wiring in any of those 210.12(B) areas is modified, replaced, or extended, the circuit must be protected by either an AFCI method in 210.12(A), or a listed outlet branch-circuit type AFCI at the first receptacle outlet or switch of the existing branch circuit. The exception: no AFCI is required where the extension is not more than 6 feet and adds no outlets or devices other than splicing devices. Conductors inside an enclosure, cabinet, or junction box do not count toward the 6 feet.

What this means in an older house. Moving a bedroom receptacle 8 feet along the wall triggers AFCI for the whole circuit. Replacing a panel and extending bedroom circuits to reach the new panel's location by more than 6 feet triggers AFCI on those circuits. Count this in every scope (R3.1, R3.2).

D5. Tamper-resistant and weather-resistant on replacements

When you replace a receptacle where the code would require a tamper-resistant receptacle in new work, the replacement must be tamper-resistant (406.12(D)(5)). Two exceptions apply: replacing a non-grounding receptacle with another non-grounding receptacle, and terminating aluminum conductors directly on CO/ALR receptacles installed as replacements. Outdoors and in other locations that require weather-resistant receptacles, the replacement must be weather-resistant (406.12(D)(6)).

Picture coming: Two-prong replacement decision chart. Start box: "Two-prong receptacle to replace." First diamond: "Is there a real ground in the box (measured, not assumed)?" YES → "Grounding-type receptacle, connected to ground (406.12(D)(1))." NO → second diamond: "Does the customer need a true ground (fridge, computer, sump pump)?" YES → "Add ground under 250.130(C) or run a new circuit." NO → three boxes: "(a) Two-prong for two-prong," "(b) GFCI receptacle marked 'No Equipment Ground,'" "(c) Three-prong downstream of a GFCI, each marked 'GFCI Protected' and 'No Equipment Ground.'" A banner across the bottom: "In bedrooms, living areas, kitchens, halls, closets, laundry: AFCI too (406.12(D)(4))."

Part E: Aluminum Branch Wiring Repairs

This part is for the planning and the scope. R2.7 covers the hands-on repair on a service call. The repair itself is journeyman work until you are signed off on it.

E1. The three permanent repairs CPSC accepts

CPSC Publication 516 says that, as of its 2011 date, CPSC approves only three methods as a permanent repair (Pub. 516, p. 2):

#	Method	What it is	Notes from CPSC
1	Complete replacement with copper	New copper branch circuits; the old aluminum can be abandoned in the walls	The best method; often impractical or expensive
2	COPALUM crimp	A short copper pigtail crimped to the aluminum wire with a COPALUM sleeve, using a dedicated power tool and die	Considered safe and permanent; the tool is available only to electricians trained by the manufacturer
3	AlumiConn connector	A short copper pigtail joined to the aluminum with a set-screw AlumiConn connector	The next best alternative where COPALUM is not available; requires careful, professional workmanship

CPSC says the repair should include every connection or splice involving aluminum wire in the home: outlets, dimmers, switches, fixtures, appliances, and junction boxes (Pub. 516, p. 3). Fixing one receptacle is a repair to one receptacle, not to the house.

E2. What CPSC does not accept as permanent

Method	CPSC position
Other crimp connectors, including pliers-type crimps sold at retail	CPSC staff strongly recommends against them (Pub. 516).
Pigtailing with twist-on wire connectors, including connectors sold for aluminum-to-copper	Not an acceptable permanent repair; CPSC lab and life tests found substantial numbers overheated severely (Pub. 516).
Replacing devices with CO/ALR switches and receptacles	Not an acceptable permanent repair (Pub. 516).

CPSC allows AL/CU twist-on pigtails or CO/ALR devices only as an emergency, temporary repair for a failed termination, followed as soon as possible by a complete repair with a recommended method (Pub. 516).

Correction to the Arc Guide. The Arc Guide tells techs to use CO/ALR devices with anti-oxidant compound and "purple wire nuts" on aluminum (Arc Guide, Part 2, Aluminum wiring; Part 5 table). CPSC does not accept either as a permanent repair. Use the Arc Guide's own Part 10

repair hierarchy, which follows CPSC, and treat CO/ALR devices and twist-on connectors as temporary only.

E3. What the NEC says

- 110.14 requires terminals and splicing connectors to be identified for the material of the conductor, and does not allow aluminum and copper to be mixed in a terminal or connector where they touch unless the device is identified for that purpose and condition of use. Terminals used for aluminum must be so identified (110.14(A)).
- 406.10 lets wiring devices marked CO/ALR directly terminate aluminum conductors, following the manufacturer's instructions. Devices not marked CO/ALR are not permitted to directly terminate aluminum.
- 110.3(B) requires listed equipment to be installed according to its listing and instructions. The AlumiConn's torque values and the COPALUM tool procedure come from the manufacturers, and following them is a code requirement as well as the condition CPSC sets.

E4. Step by step: planning an aluminum remediation

1. Confirm the wire is aluminum and not copper-clad (Part A5).
2. Map every circuit with aluminum wire (Step C1).
3. Count every termination and splice on those circuits: receptacles, switches, dimmers, light fixtures, appliances hardwired to the branch circuits, junction boxes, and the breaker terminals at the panel. CPSC wants all of them repaired (Pub. 516, p. 3).
4. Note the boxes that are too small to hold the pigtails and connectors. AlumiConn and COPALUM connectors take more room than the original wires. Box fill rules are in 314.16; your journeyman decides on box extensions or replacements.
5. Hand the count to the office for options: full copper rewire, COPALUM where a trained installer is available, or AlumiConn. No prices on the job board (R3.1).
6. Until the repair is done, if you find a failed aluminum termination on a service call, the temporary repair is a journeyman decision, documented as temporary, with a recommendation for the full repair.

Safety: warm plate on an aluminum circuit. Turn the circuit off, tag it, and tell the customer not to use it until it is opened and repaired. A warm faceplate is one of CPSC's listed trouble signs, and the connection behind it is already overheating.

Picture coming: Aluminum repair side by side. Left: a receptacle box with aluminum branch wires, each joined to a short copper pigtail by a COPALUM crimp sleeve with its insulating cover; the copper pigtails go to a standard receptacle. Middle: the same box using purple AlumiConn set-screw connectors and copper pigtails, a torque screwdriver beside it showing "torque per manufacturer." Right: a red X over a twist-on connector joining aluminum and copper, and a red X over a CO/ALR receptacle with aluminum on its screws, captioned "Temporary only (CPSC Pub. 516)."

Part F: What to Leave, What to Fix, and the Staged Upgrade Plan

F1. Three bands

R2.9 uses three severity bands for every finding. Use the same bands here.

Band	Meaning	Examples in older houses
Safety-Critical	Fix now or shut it off. A fire or shock hazard exists today.	Overfusing or tampered fuses; burned or melted devices, splices, or panel parts; knob-and-tube buried in insulation; open splices hanging outside boxes; bootleg grounds; warm faceplates on aluminum circuits; a breaker larger than its wire; Zinsco or Pushmatic breakers with heat damage
Code Update	Not an emergency, but below today's code or a known weak spot. Fix when practical.	No GFCI in bathrooms, kitchen counters, garage, outdoors, or laundry; ungrounded three-prong receptacles with no GFCI; missing water pipe bond jumper; no smoke or CO alarms where required (R1.8); FPE or Zinsco panel with no visible damage; split-bus panel with added circuits in the top section; aluminum branch wiring not yet remediated
Monitor	Acceptable as-is; check again later.	Undisturbed knob-and-tube in open air with intact insulation; cloth NM with flexible insulation; Pushmatic panel with breakers that operate freely and no heat signs

Where a finding sits depends on what you see. An FPE panel with scorch marks is Safety-Critical. The same panel clean is a Code Update. Undisturbed knob-and-tube in a basement ceiling with no insulation over it can be Monitor. The same wiring under blown-in insulation is Safety-Critical.

F2. What is legal to leave and what must change when touched

Item	May stay if in good condition and untouched?	What triggers a change
Knob-and-tube	Generally yes; the AHJ decides. Article 394 is still in NEC 2026.	Insulation over it (394.12(5)), damage, or any extension. We do not extend it.
Two-wire NM, no ground	Yes	Replacing a receptacle: must use a 406.12(D) (2) option, plus AFCI, TR, WR where required. Need for a true ground: 250.130(C).
Aluminum branch wiring	Yes as a wiring method	Any failed termination; CPSC recommends full remediation (Pub. 516).
Two-prong receptacle	Yes	Replacing it: see Part D.
FPE, Zinsco, Pushmatic panels	No code section forces removal of an existing panel just for its brand	Damage, overheating, a breaker that will not operate, a service change, or a panel that cannot accept the breakers the new work needs.
Split-bus panel	Yes, if installed under the code of its day	New service equipment must meet 230.71.
Edison-base plug fuses	Only as replacements where there is no evidence of overfusing or tampering (240.51(B))	Any overfusing or tampering.

F3. Insurance

Insurers set their own rules, and they change. Here is what our sources say, and nothing more:

- Great American Insurance Group's loss-control page recommends replacing all Zinsco breakers and panels with current UL-listed equipment.
- No source we fetched gives a verified insurer rule for FPE, Pushmatic, knob-and-tube, cloth NM, or aluminum wiring.

When a customer asks, say: "Some insurance companies treat these panels and older wiring differently. I don't speak for your insurer. Call your agent, tell them exactly what you have, and ask whether it affects your policy." Write in the report that you told them to ask their insurer. Never tell a customer their insurance will be cancelled or denied.

F4. Building the staged upgrade plan

Most customers in older houses cannot afford to fix everything at once. A staged plan lets them do the most important work first and gives the office clean scopes to price.

Step by step.

1. Finish the inspection (R2.9) and the tests in Part C.

2. Sort every finding into the three bands (F1).
3. Put the findings into three stages: - **Today:** every Safety-Critical item. If the customer will not approve a Safety-Critical repair today, make it safe (turn off and tag the circuit, install the correct fuse, cap the open splice in a box) and write down that they declined the repair. - **This year:** the Code Update items that reduce the most risk for the least disruption. GFCI protection in wet areas, smoke and CO alarms, correcting ungrounded three-prong receptacles, the water pipe bond, a whole-house SPD if the service is being worked on (R1.9), and replacing an FPE, Zinsco, or overfused fuse panel. - **Eventually:** the large rewiring projects. Replacing knob-and-tube that is in good open-air condition, replacing cloth NM, full aluminum remediation if a temporary method was used, and service upgrades for future loads (R-LOAD).
4. For each line, write one sentence giving the reason. "GFCI on bathroom and kitchen counter receptacles: no shock protection near water today."
5. Order the "this year" list so that work that requires opening walls is grouped with other work in the same room.
6. Note which items depend on others. A panel replacement often comes before AFCI breakers, because the old panel has none available. A service upgrade may trigger grounding electrode and bonding work (R1.6). Replacing the service equipment on a one- or two-family house also brings in NEC 2026 230.70(E): the service disconnect must be in a readily accessible outdoor location on or within sight of the house (230.70(A)(1)), unless an outdoor emergency disconnect is installed under 225.41 (2023: 230.85). Replacing only the meter socket or the service entrance conductors does not trigger it. Count the outdoor disconnect in the scope of any stage that changes the panel (R1.5, R-SERVICE).
7. For each stage, write the count the office needs: devices, circuits, feet of cable, panel size, permit needed (R3.1, R3.2). No prices.
8. Hand the plan to the office and explain it to the customer in plain words (R2.1, Part G). Techs never collect payment.

Picture coming: Staged upgrade plan as a horizontal timeline in three columns. "TODAY" (red): "Correct 30 A fuse on 14 AWG circuit 4," "Remove bootleg grounds in 2 bedrooms," "Pull insulation back / de-energize K&T circuit in attic, tag off." "THIS YEAR" (amber): "GFCI in 2 baths, kitchen, laundry, outdoors," "Smoke and CO alarms per R1.8," "Replace fuse panel with 200 A panel, AFCI/GFCI breakers," "Water pipe bond jumper." "EVENTUALLY" (gray): "Rewire 2nd-floor K&T circuits," "Replace cloth NM in kitchen." Each card carries a one-line reason under it.

Worked Examples

Example 1: 1938 bungalow, fuse box, knob-and-tube upstairs

Call. The customer bought a 1938 house and wants three-prong receptacles in the bedrooms so they can plug in a computer.

Findings.

1. Fuse box in the basement, six plug-fuse circuits and a pull-out main. Circuit 3 has a 30 A plug fuse. You trace circuit 3 to cloth-insulated single conductors on knobs in the basement ceiling feeding the two bedrooms. The wire is about 14 AWG.
2. In the attic, the bedroom ceiling knob-and-tube is under about 6 inches of blown-in insulation.
3. Bedroom receptacles are two-prong. Readings at the first bedroom receptacle: hot-to-neutral 121 V, no ground slot.
4. Water pipe enters the basement as galvanized steel, with an old clamp and a 10 AWG bare copper wire to the fuse box. No jumper across the water meter.

Bands and plan.

Finding	Band	Stage	Reason
30 A fuse on about 14 AWG wire	Safety-Critical	Today	240.4(D) limits 14 AWG copper to 15 A; the wire is unprotected.
K&T buried in attic insulation	Safety-Critical	Today	Not allowed (394.12(5)); traps heat in wiring that needs open air.
No water meter jumper	Code Update	This year	Bonding path breaks if the meter is removed (Kuhlman, p. 88; 250.104(A)).
Fuse panel, no GFCI or AFCI options	Code Update	This year	Panel replacement makes protection possible for all circuits.
Two-prong bedroom receptacles; customer needs a ground for a computer	Code Update	This year	250.114 lists information technology equipment as needing a ground; a GFCI alone gives no ground.
Remaining K&T in walls	Monitor until rewire	Eventually	Replace with grounded NM-B circuits as part of the bedroom work.

Today. With the customer's OK, your journeyman replaces the 30 A fuse with a 15 A fuse and installs a 15 A Type S adapter. Because the knob-and-tube circuit is buried in insulation, your journeyman de-energizes circuit 3 and tags it off, or arranges with the customer to have the insulation pulled back from the wiring by others. You explain why the bedroom will be without power until the circuit is replaced.

The receptacle request. The computer needs a true ground, so a GFCI receptacle alone does not meet the need. The right scope is a new grounded NM-B circuit to the bedrooms with AFCI protection. In a fuse box, that means either a panel replacement first, or an outlet branch-circuit AFCI receptacle at the first outlet of the new circuit. The office prices both options.

Example 2: 1971 ranch, aluminum wiring, FPE panel

Call. "Bedroom outlet is warm and smells funny."

Findings.

1. Panel: Federal Pacific, Stab-Lok breakers.
2. Basement cable jackets printed "ALUMINUM," 12 AWG on 15 A breakers. Not copper-clad.
3. The bedroom receptacle plate is warm with a lamp plugged in. With the breaker off and the circuit proven dead at the receptacle with your meter, you find the aluminum wires backstabbed into a standard receptacle. One hole is darkened. Aluminum in a push-in terminal was never a proper connection, and NEC 2026 406.10(3) now limits push-in terminals to 14 AWG solid copper on 15 A circuits.
4. Spot thermometer on the panel under load: all breakers within a few degrees of each other.

Today. Your journeyman makes the failed connection safe. The temporary repair (if the customer needs the circuit before the full repair) is documented as temporary under CPSC Pub. 516. The circuit is tested after the repair.

Plan.

Finding	Band	Stage
Overheated aluminum termination, bedroom	Safety-Critical	Today
Aluminum branch wiring throughout, not remediated	Code Update	This year: COPALUM or AlumiConn on every termination, or copper rewire, priced by the office
FPE Stab-Lok panel, no visible damage	Code Update	This year, coordinated with the aluminum work so the breaker terminals are done once
Bedroom receptacles replaced during repair	Applies now	Each replacement in a bedroom needs AFCI protection (406.12(D)(4)); outlet branch-circuit AFCI receptacle at the first outlet, or panel replacement with combination AFCI breakers

Customer talk. "The outlet was warm because the aluminum wire connection behind it was overheating. That's a known problem with aluminum wiring from this era. The government safety agency recommends fixing every aluminum connection in the house with one of three methods, and we've written all three up for the office to price. Your panel is a brand that failed trip testing in a federal investigation. It isn't damaged today, and we'd plan to replace it at the same time as the wiring work so we only open things up once."

Example 3: 1962 house, split-bus panel, two-wire NM

Call. The customer is adding a window AC in a bedroom and wants a three-prong outlet for it.

Findings.

1. Split-bus panel. The top section has eight handles: four two-pole breakers and four single-pole breakers that someone added.

2. Bedroom wiring is two-wire plastic NM, no ground. A three-prong receptacle is already installed with nothing on the ground screw.
3. The window AC nameplate says 8.5 A.

Plan. The three-prong receptacle with no ground and no GFCI is not a legal option; it goes in the Code Update band. An air conditioner is on the 250.114 list of appliances that need an equipment ground, so a GFCI receptacle marked "No Equipment Ground" does not meet the manufacturer's need. The scope is either a ground added under 250.130(C) from the panel's ground bar, or a new grounded circuit. Either way, the bedroom receptacle replacement needs AFCI protection (406.12(D)(4)). The split-bus top section has more than six handles; document it, label the service disconnects, and recommend panel replacement when the service is worked on. The office prices the options.

Common Mistakes

1. **Calling everything old "illegal."** Knob-and-tube, two-wire NM, and two-prong receptacles each have a legal place in an existing house. Say what condition they are in, not what year they are.
2. **Installing three-prong receptacles on two-wire cable with nothing on the ground screw.** This is not one of the three 406.12(D)(2) options.
3. **Bootleg grounds.** A neutral jumped to the ground screw makes a plug-in tester read "correct" and can put voltage on an appliance case. Remove every one you find.
4. **Forgetting the labels.** GFCI-protected ungrounded receptacles must be marked "No Equipment Ground," and downstream receptacles "GFCI Protected" as well.
5. **Using a GFCI where the appliance needs a real ground.** Refrigerators, washers, AC units, computers, and sump pumps are on the 250.114 list. Add a ground under 250.130(C) or run a new circuit.
6. **Following the Arc Guide's "no distant ground" rule.** 250.130(C) gives five legal connection points. A random water pipe is not one of them; the panel's ground bar and another circuit's ground from the same panel are.
7. **Forgetting AFCI on replacements and extensions.** A bedroom receptacle replacement needs AFCI (406.12(D)(4)). An extension over 6 feet in an AFCI area needs AFCI for the circuit (210.12(E)).
8. **Treating CO/ALR devices or purple twist-on connectors as the fix for aluminum.** CPSC calls them temporary.
9. **Repairing one aluminum connection and calling the house fixed.** CPSC wants every aluminum termination and splice repaired.
10. **Trusting the handle position on FPE, Zinsco, or Pushmatic breakers.** Prove dead with a meter at the point of work.
11. **"Testing" Zinsco breakers by switching them.** It tests nothing and may make them worse.

12. **Putting the correct fuse in and leaving.** Explain to the customer why it may now blow, or they will put the big fuse back. Ask your journeyman about Type S adapters.
 13. **Telling customers what their insurer will do.** Send them to their agent.
 14. **Digging in old attic insulation.** It may contain asbestos. Look from the hatch and tell your journeyman.
 15. **Extending knob-and-tube.** We don't.
 16. **Calling every backstab a code violation.** Backstabs in older houses predate the 2026 push-in rule (406.10(3)). A 12 AWG or aluminum wire in a push-in hole is a defect; a 14 AWG copper backstab is a weak connection to move to the screws when you service the device.
 17. **Leaving the outdoor disconnect out of a panel-replacement scope.** 230.70(E) applies when the service equipment is replaced.
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Field Exercise: Two Houses and a Staged Plan

Setup. Your journeyman arranges visits to two occupied houses with the owners' permission: one built before 1950, and one built between 1965 and 1975. Bring your meter, clamp meter, plug-in tester, spot thermometer, flashlight, camera, and the R2.9 inspection checklist. Allow about three hours per house.

At each house, do the following.

1. Run the intake from R2.1. Ask the owner what work has been done on the house and when, and whether any circuits trip, flicker, or feel warm.
2. Photograph the panel label, the panel with the dead front on, and (with your journeyman removing it) the panel interior.
3. Name the panel type out loud using the Part B table. State its known concern and the source for it.
4. Walk the basement or crawl space and the attic access. Photograph every wiring type you can see without disturbing anything. Name each one using the Part A table, and say how you know (knobs, cloth jacket, "AL" print, missing ground, armor).
5. Map at least three circuits with your journeyman (Step C1).
6. At six receptacles in different rooms, take the three readings (Step C2). At any three-prong receptacle, check for a bootleg ground (Step C3).
7. At one BX or metal box, measure the ground path (Step C4).
8. With loads running, check every faceplate and the panel breakers for heat (Step C5).
9. Check the water pipe bond and the jumper across the water meter, and clamp the grounding electrode conductor (Step C7).

Write the staged upgrade plan for each house.

1. List every finding with its photo.
2. Put each finding in a band: Safety-Critical, Code Update, or Monitor.

3. Sort the findings into Today, This Year, and Eventually.
4. Write one sentence of reason for each line, with the code section or source where one applies.
5. Write the count the office would need for each stage: devices, circuits, cable footage estimates, panel size, permits. No prices.
6. Write a one-paragraph summary in plain words that the homeowner can read.

Present it. Explain each plan out loud to your journeyman as if they were the homeowner. Include one insurance question from the "homeowner" and answer it the way Part F3 says.

Pass standard. You pass when your journeyman signs off that you correctly named every wiring type and panel in both houses, proved dead with live-dead-live before every box you opened, found any bootleg ground present, put every finding in a defensible band, cited 406.12(D), 250.130(C), 210.12(E), and CPSC Pub. 516 correctly where they applied, left out prices, and wrote a plan the office could price without calling you.

NEC 2026 Cross-References

Section	What it says	Why it matters in older houses
Art. 394 (394.10, 394.12, 394.19, 394.30, 394.56)	Concealed knob-and-tube: permitted only for extensions of existing installations or by special permission; not in insulated hollow spaces; 3 in. between conductors and 1 in. from surfaces; supports within 6 in. of splices and every 4½ ft; soldered splices or approved devices	K&T is still a recognized method for existing wiring; insulation over it is not allowed
300.17 (2023: 300.15)	Boxes required at outlets and switch points for concealed knob-and-tube	Taps hanging in the air are defects
300.18 (2023: 300.16)	Fittings for transitions from cable or raceway to open wiring or knob-and-tube	How a new cable may join old wiring where a transition is allowed
406.12(D)(1)–(6) (2023: 406.4(D))	Receptacle replacements: grounding where a ground exists; three options where none exists, with markings; GFCI, AFCI, TR, and WR when replacing	The core rule for two-prong replacement
250.130(C)	Five permitted connection points for adding an equipment grounding conductor to an existing receptacle or circuit extension	Adding a real ground
250.114	Cord-and-plug equipment that must be grounded, including refrigerators, freezers, AC units, washers, dryers, dishwashers, ranges, disposers, IT equipment, sump pumps, aquarium equipment	When a GFCI "No Equipment Ground" receptacle is not enough
250.122	Minimum equipment grounding conductor size (14 AWG Cu for 15 A, 12 AWG Cu for 20 A)	Sizing an added ground
210.12(B), 210.12(E)	AFCI areas in dwellings; AFCI when circuits in those areas are modified, replaced, or extended, with the 6 ft exception	AFCI in every remodel and extension scope
406.26 (2023: 406.12)	Tamper-resistant receptacles	Required on many replacements via 406.12(D)(5)
110.14, 110.14(A)	Connections identified for the conductor material; no mixing aluminum and copper in one connector unless identified; terminals for aluminum identified	Aluminum repairs
406.10	Wiring devices marked CO/ALR may directly terminate aluminum per instructions; unmarked devices may not	What a CO/ALR device is for (and CPSC's limits on it)
406.10(3)	Push-in (backstab) terminals only on branch circuits of 15 A or less, with 14 AWG solid copper only; new as a code rule in 2026 (earlier editions left it to the UL listing)	Backstabs in older houses predate the rule; 12 AWG or aluminum in a push-in hole is a defect
110.3(B)	Install listed equipment per its listing and instructions	

Section	What it says	Why it matters in older houses
		AlumiConn torque, COPALUM tool, fixture wire temperature
240.4(D)	Small conductor overcurrent limits	Overfusing
240.50(C), 240.51(B), 240.53, 240.54	Plug fuses: hex identification at 15 A and below; Edison-base fuses only as replacements with no overfusing or tampering; Type S classes; Type S adapters nonremovable	Fuse panels
230.71	One service disconnect unless 230.71(B) is met	Split-bus panels and new service equipment
230.70(E), 230.70(A)(1), 225.41	Replacing one- or two-family service equipment brings in the outdoor service disconnect location rule of 230.70(A)(1), unless an outdoor emergency disconnect is installed under 225.41 (2023: 230.85); replacing only the meter socket, service conductors, or related raceway does not trigger it	Any staged plan that includes a panel or service replacement
250.104(A)	Bonding of metal water piping	Water pipe bond and meter jumper
314.16	Box fill	Pigtails and repair connectors in small old boxes

End-of-Chapter Checklist

Identify - [] Named every wiring type I could see (K&T, cloth NM, BX, two-wire NM, aluminum, NM-B) and said how I knew. - [] Read the full cable marking on any aluminum cable and checked for "copper-clad." - [] Named the panel type from its label and breakers, and stated its known concern with a source. - [] Did not dig in attic insulation.

Test - [] Proved dead with live-dead-live before opening every box, and never trusted a handle position on FPE, Zinsco, or Pushmatic. - [] Mapped circuits before testing. - [] Took the three receptacle readings at each receptacle tested. - [] Checked every three-prong receptacle on old wiring for a bootleg ground. - [] Measured the ground path before relying on BX armor or any old ground. - [] Checked plates and breakers for heat under load. - [] Ran insulation tests only with my journeyman, loads and sensitive devices disconnected. - [] Checked the water pipe bond, meter jumper, and current on the grounding electrode conductor.

Fix and code - [] Used only a 406.12(D)(2) option on ungrounded receptacles, with the required markings. - [] Added grounds only to a 250.130(C) connection point, sized per 250.122. - [] Applied AFCI on replacements (406.12(D)(4)) and on extensions over 6 ft (210.12(E)). - [] Used

TR and WR receptacles on replacements where required. - [] Treated CO/ALR devices and twist-on aluminum pigtails as temporary only. - [] Corrected overfusing and documented tampering. - [] Did not extend knob-and-tube. - [] Moved backstabbed wires to screw terminals on every device I serviced, and flagged any 12 AWG or aluminum push-in connection. - [] Counted the outdoor service disconnect or 225.41 emergency disconnect in any stage that replaces service equipment (230.70(E)).

Plan and hand off - [] Put every finding in Safety-Critical, Code Update, or Monitor. - [] Built a Today / This Year / Eventually plan with a reason for each line. - [] Wrote counts for the office with no prices. - [] Told the customer to ask their own insurer and wrote that down. - [] Explained the plan in plain words and sent pricing and payment to the office.

Sources

- Jesse Kuhlman, Residential Electrical Troubleshooting (2019). Pages cited: 11 (non-contact testers and BX/MC), 30 (GFCI 5 mA), 40–41 (SE cable water damage), 45 (current on the water pipe GEC), 88 (water meter jumper), 107 (water-damaged panel), 124 (over-lamped box with cracked insulation), 135 (knob-and-tube dates and disadvantages). Paraphrased; no photos copied.
- Arc Workforce, Residential Electrical Field Guide. Part 2 (aluminum wiring), Part 3 (voltage targets), Part 5 (older-home violations table), Part 8 (Older Home Quirks), Part 10 (aluminum repair hierarchy, thermal inspection), Symptom 11 (ground path under 1 ohm), Job 10 (panel labeling). Corrections to Parts 2, 5, and 8 are noted in the text.
- Terence W. Croft, Wiring of Finished Buildings (1915), pp. 123–125 (knob-and-tube in finished buildings, continuous loom, the inspector's loom test) and p. 225 (example installation with loom in partitions and knobs in the attic). Printed page numbers; the PDF page is 12 higher.
- U.S. Consumer Product Safety Commission, Publication 516, Repairing Aluminum Wiring (June 2011). <https://www.cpsc.gov/s3fs-public/516REPAIRINGALUMINUMWIRING.pdf>
- U.S. Consumer Product Safety Commission, Release 83-008, "Commission Closes Investigation of FPE Circuit Breakers and Provides Safety Information for Consumers" (March 3, 1983; revised February 18, 2011). <https://www.cpsc.gov/Newsroom/News-Releases/1983/Commission-Closes-Investigation-Of-FPE-Circuit-Breakers-And-Provides-Safety-Information-For-Consumers>
- InspectApedia, "Zinsco & Zinsco-Sylvania Electrical Panel Hazard Summary." https://inspectapedia.com/electric/Zinsco_Summary.htm
- InspectApedia, "Pushmatic Bulldog & ITE Pushmatic Circuit Breakers & Electrical Panel Hazards." <https://inspectapedia.com/electric/Pushmatic.php>
- InspectApedia, "Replacement Circuit Breakers for Bulldog Pushmatic." https://inspectapedia.com/electric/Pushmatic_Replacements.php
- InspectApedia, "Cutler Hammer Electrical Panel Inspection" (split-bus and the rule of six). https://inspectapedia.com/electric/Cutler_Hammer_Panel_Fire.php

- American Society of Home Inspectors, ASHI Reporter, "Split Bus Electrical Panels" (December 2021). <https://www.homeinspector.org/reporter-articles/split-bus-electrical-panels/>
 - Great American Insurance Group, Loss Control, "Is Your Electric Panel a Fire Risk?" <https://www.greatamericaninsurancegroup.com/content-hub/loss-control/details/is-your-electric-panel-a-fire-risk>
 - NFPA 70, National Electrical Code, 2026 edition, sections listed above.
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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
Part A, A1 (knob-and-tube: why it fails now, insulation, no ground, brittle insulation, taps with modern cable, insurance)	Knob and Tube Wiring: Top 5 Issues Jesse Kuhlman Kuhlman Electric • 9:23 Jesse Kuhlman, whose book the module cites, explains the five problems he sees: insulation packed around wires meant to run in open air, insurers refusing or surcharging, no ground (with a real case of a fridge frame made live by a grounded cable tapped off knob-and-tube), insulation cooked brittle at light fixtures, and age. Caution: Massachusetts-specific: the Mass Save insulation sign-off form does not apply in Alabama. Talk-to-camera, little field footage of identification; use Part A1's steps for that.
Part B, B1 (Federal Pacific Stab-Lok: why the panel and breakers are a known failure)	FEDERAL PACIFIC ELECTRICAL PANELS - why their panels are dangerous Electrician U • 23:27 Dustin Stelzer explains the Stab-Lok history (listing problems, CPSC testing, the 2002 New Jersey court finding) and the UL 489 hold at 100 percent, trip at 135 and 200 percent tests that many Stab-Lok breakers failed, including two-pole breakers where one pole does not trip. Caution: Mostly history; it does not show how to identify the panel in the field (use Part B's ID table). Some strong language. He says 'New York Consumer Fraud Act' where the case was under New Jersey's. Transcript checked for about the first half.
Part B, B2 (Zinsco and Zinsco-Sylvania: breakers that do not trip and bus damage)	ZINSCO ELECTRICAL PANELS - why their panels are dangerous Electrician U • 13:23 Explains how Zinsco panels and the R38 thin two-pole breaker became common, the Sylvania and Challenger name changes that help you identify them, and the failures: breakers that do not trip, one pole of a two-pole tripping alone, and overheated aluminum bus. Caution: Mentions that new replacement breakers are still made; the module's staged plan recommends panel replacement. Do not use his separate video on changing Zinsco breakers live; the module does not allow live work by helpers. Transcript checked for about the first half.
Part C, C3 (catch a bootleg ground) and Part D, D1 (the legal options instead)	People Are Adding Deadly Hacks to Outlets LRN2DIY • 8:54 Shows a three-prong receptacle that passes three different plug-in testers because a jumper ties neutral to ground, opens the box to show the jumper, shows the worse case with reversed polarity that energizes appliance frames, and lists the legal fixes (two-prong replacement, GFCI marked No Equipment Ground, or new wiring). Caution: DIY channel, not an electrician; it has affiliate links. The transcript pulled was an auto-translated Portuguese track, so it was checked for content, not exact wording. It does not show the meter tests in module Step C3; teach those alongside.

Part D, D1 option (c): one GFCI at the first receptacle protecting grounding-type receptacles downstream, with the required labels	2 Prong Receptacle Circuit Replaced by GFCI and Grounded Receptacles per 2020 NEC Sparky Channel • 21:01 Maps every receptacle on the circuit with a breaker finder, uses voltage-drop readings and a live check to find the first receptacle, puts the GFCI there with line and load correct, pigtails the downstream devices, leaves the ground screws unconnected, tests that the GFCI kills all downstream, and applies the No Equipment Ground and GFCI Protected stickers. Caution: Cites 2020 NEC 406.4(D); NEC 2026 renumbered it 406.12(D). This circuit feeds bedrooms, so 406.12(D)(4) also requires AFCI protection on the replacements (module D3); the video does not add it. He energizes the circuit briefly with conductors exposed to find the line wire, which is a journeyman step.
Part E, E1 method 3 (AlumiConn connector with copper pigtail, torqued per the manufacturer)	Aluminum Wiring Repair - How to Install AlumiConns to Fix Aluminum Wire Hazards Permanently Aluminum Wiring Repair • 9:27 A master electrician strips the aluminum without nicking it, inserts aluminum and copper into separate AlumiConn ports, torques each set screw with a torque screwdriver to the maker's value, tug-tests, and folds the larger connections into the box. Caution: Filmed in Calgary, Canada; the device, 120 V wiring, and AlumiConn instructions are the same in the US. Use the torque values printed on the AlumiConn package, not the number spoken in the video. Box fill with these connectors is a journeyman call (module E4 step 4).