

Electrical Safety & Sizing: Disconnects, Breakers, MCA/MOP, Lockout

YES Electric • Arc Workforce Academy HVAC Apprenticeship

Draft 1 (October 2026). This lesson is under review. Videos are made by other companies, not YES Electric; follow this lesson and your journeyman where they differ. Boxes marked "Shop photo coming" will get real photos from our shop in a later version.

Unit 3 • Electrical for HVAC I • Appendix A Competencies 1 & 6 — Unit 3 capstone Class time: ~4 hrs (1.5 video/classroom + 2.5 bench) — Unit 3 written + practical exam follows

1. What you'll be able to do

- Run **full lockout/tagout** on an HVAC circuit — disconnect, lock, tag, verify (3.2's ritual now formalized to OSHA language your OSHA-10 already introduced).
- Size and verify the electrical hookup from the nameplate: **MCA → wire gauge, MOP → breaker size** — and catch the two classic field errors (breaker too big; wire sized to the breaker instead of MCA).
- Explain **HACR breakers**, why motor loads need time-delay tolerance, and what a tripping breaker is trying to say (it's a SYMPTOM).
- Install/inspect a **disconnect** correctly: within sight, fused vs non-fused choice, line/load landed right.
- State the GFCI rules that touch our work (condensate pumps, receptacles near equipment, service receptacle requirements).

This caps Unit 3: you can measure (3.2), read (3.7), and now you can be TRUSTED around the power that the rest of the program assumes.

2. Tools & materials

- Lockout kit per student (lock, tag, hasp — theirs to keep)
- Disconnect pile: non-fused pull-out, fused 60 A, a melted one (the show-and-tell)
- Wire gauge board (14 → 6 AWG cut samples), breaker samples incl. HACR-rated
- Nameplate photo deck from 1.2/1.7 (now the electrical lines matter)

3. Watch first

Order	Video	Channel	Length	Why
1	HVAC Safety Training — Ladders, PPE, Lockout Tagout	HVAC School	33:12	The whole safety frame
2	LOTO (Lock Out Tag Out)	HVAC School	17:15	The procedure, properly
3	MCA is 27 and the Breaker is a 50A?	HVAC School	6:11	The "wait, that's legal?" lesson
4	How Many Amps Can a Wire Carry — Ampacity Basics	HVAC School	5:52	Wire sizing logic
5	HVAC Disconnects — Fuse Size, Fused vs Non-Fused	AC Service Tech	14:08	The box on the wall, mastered
6	What Is a HACR Breaker / Why Is My Breaker Tripping?	AC Service Tech	5:36	Breaker as symptom
7	How to Install an AC Disconnect	HVAC School	3:17	The install, quick
8	GFCI and AFCI Testing Explained	HVAC School	18:15	The protection devices around our gear

4. The idea

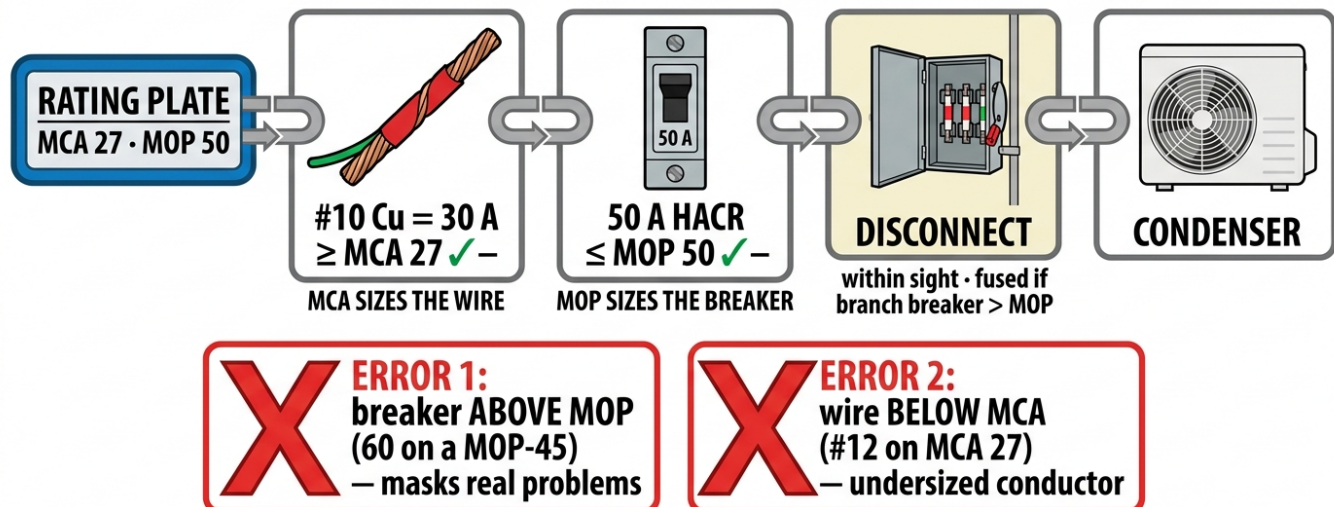
Lockout/tagout — the formal version of "verify dead"

1. **Identify all sources** (the 3.1 lesson: line AND control may arrive from different boxes; capacitors store energy regardless).
2. **Open the disconnect / breaker.**
3. **Lock it** (your lock, your key, on a hasp if multiple workers). **Tag it** (name, date, work).
4. **Verify dead** — live-dead-live (3.2), BOTH legs (3.6's trap).
5. **Discharge stored energy** — capacitors (3.5's ritual).
6. You, and only you, remove your lock when done.

On residential service calls, the pull-out disconnect in your pocket is the informal equivalent — but anywhere a second person could re-energize (occupied homes count: helpful homeowners flip breakers), the lock goes on. **Graded on every practical from now to graduation.**

THE HOOKUP CHAIN — NAMEPLATE TO PANEL

motor inrush is why the breaker may legally exceed the wire ampacity — the unit overloads protect the motor; the breaker handles shorts



MCA and MOP — the nameplate's two commandments

- **MCA (Minimum Circuit Ampacity)** sizes the **WIRE**: conductor ampacity $\geq$ MCA. (MCA already includes the 125% continuous-load math — done for you by the manufacturer.)
- **MOP/MaxFuse (Maximum Overcurrent Protection)** sizes the **BREAKER/FUSE**: protection $\leq$ MOP.

The counterintuitive legal case (the Short #219 lesson): **MCA 27 / MOP 50 → #10 wire (30 A) on a 50 A breaker is correct.** The breaker is allowed above the wire's ampacity here because motor inrush needs headroom AND the equipment's own overloads protect the motor; the breaker's job on this circuit is short-circuit/ground-fault, not overload. Quick-reference ampacities to memorize (copper, typical 60/75°C residential context): **#14=15, #12=20, #10=30, #8=40/50, #6=55/65.**

The two field errors you'll hunt on real jobs: 1. **Breaker > MOP** ("it kept tripping so someone put a 60 in") — illegal, fire-adjacent, and it MASKED a real problem. 2. **Wire sized to the breaker instead of MCA-minimum** isn't an error — but wire sized BELOW MCA is (the #12 someone ran to a MCA-27 condenser).

Breakers: HACR, and the breaker-as-symptom rule

Modern breakers are HACR-rated (time-delay curve tolerant of motor inrush — LRA slams 5–7× RLA for a moment; the curve rides through it). A breaker that trips is **reporting**, not failing:

- Trips at START every time → inrush problem (failing compressor/start gear, weak cap — 3.5/6.7) or genuinely wrong breaker.

- Trips after MINUTES → running overcurrent (failing motor, condenser airflow, charge) or loose/hot connection AT the breaker.
- Trips INSTANTLY on energize → dead short (6.5's hunt). **Upsizing the breaker is never the repair.** Find the report's subject.

Disconnects

- **Within sight** of the unit, required — it protects the next tech (you).
- **Non-fused pull-out** (most residential): just a switch. **Fused**: adds local protection — required when the branch breaker exceeds the unit's MOP (e.g., panel has a 60 but MOP is 45 → fused disconnect with 45s brings the circuit into spec; the legit fix for half the "breaker too big" finds).
- Line on top lugs, load to the unit, ground bonded; weatherproof, cover closed (sun-rotted disconnects with exposed lugs are an Alabama yard staple — note them on every service).

GFCI touches

The service receptacle required near equipment (within 25 ft) is GFCI in damp locations; condensate pumps + GFCI nuisance trips are a real combo (test, don't assume); test-button monthly is the customer line. AFCI belongs to living-area circuits — you'll meet it when air handlers share bedroom circuits in retrofits (rare, flag-and-refer).

5. Bench procedure

1. **Full LOTO drill**: every student, complete 6-step sequence on the shop condenser, witnessed, graded. (This is now the opening move of every practical exam in the program.)
2. **Nameplate-to-hookup audit**: 6 plate photos + the actual installed wire/breaker specs (instructor provides "as-found" data, some wrong): pass/fail each install, name the error, state the fix. Include one MCA-27/MOP-50 case and one fused-disconnect fix case.
3. **Wire gauge hands-on**: match cut samples to ampacities by eye + gauge tool; feel why #10 vs #12 matters at 27 A.
4. **Disconnect autopsy + install**: wire a fused disconnect on the practice wall: line/load correct, fuses sized to a given MOP, weather head intact. The melted one gets passed around with its story (loose lug → I^2R → 2.4 called it).
5. **Breaker-as-symptom round**: three trip-pattern scenarios; students give the suspect list, NOT a bigger breaker.

Checkout (Unit 3 practical, cumulative): LOTO → meter ritual → one diagram trace → one component verdict (cap or contactor, instructor's choice) → one nameplate hookup audit. Pass = Unit 3 complete; Comps 1 (electrical-safety portion), 6, 19 signed.

6. Field gotchas

- **The helpful homeowner** who "flipped it back on for you" is the reason locks exist. Pocket the pull-out OR lock the panel — every time you leave line of sight.
- **A 60 A breaker on a MOP-45 unit** found in the wild: document, inform, correct (fused disconnect or breaker swap) — this is exactly the kind of thing our license signs for.
- **Aluminum branch wiring** on older homes: different ampacity table, antioxidant + proper lugs, torque matters double. Flag for the licensed electrician when it's beyond our scope — know where our scope ENDS.
- **Double-lugged breakers, backstabbed receptacles feeding air handlers, extension-cord "disconnects"** — the parade of finds. Photograph, document, quote the fix.
- **Torque screwdrivers are real tools:** lug torque specs exist and loose lugs are the #1 heat source (the melted disconnect's autopsy). Snug-plus-grunt is not a spec.

7. Competency link

- **Comp 1** (safety protocols — electrical portion) and **Comp 6 — Unit 3 COMPLETE**, Comp 19 complete.
- LOTO opens every practical hereafter; MCA/MOP returns at every install capstone (7, 8, 9) and the strip-heat circuits of 8.3.

8. Check yourself

1. The six LOTO steps, in order, including the two stored/secondary energy considerations.
2. MCA sizes the ; **MOP sizes the** . Who did the 125% math?
3. MCA 27 / MOP 50: legal wire + breaker combo, and WHY the big breaker is OK here.
4. **10 copper carries ___ A; #12 ___ A; #8 ___ A.**
5. Found: 60 A breaker, unit MOP 45, wire #8. Two legal fixes?
6. Breaker trips after 10 minutes of running — three suspects, in order.
7. Why must the disconnect be within sight, and when must it be FUSED?
8. What's HACR about a breaker?
9. The melted disconnect: likely root cause and which formula from 2.4 explains it?
10. Homeowner says "I'll just flip the breaker when you yell." Your move?