

Swaging & Flaring (Including the Mini-Split Flare, Done Right)

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 4 • Copper, Brazing & System Integrity • Appendix A Competency 5 — (swage/flare portion) **Class time:** ~5 hrs (1 video + 4 bench — reps, reps, reps)

1. What you'll be able to do

- **Swage** copper so tube joins tube without a coupling — correct depth ($\approx$ tube OD), no splits, no ovality — with manual punch, lever/spin, and hydraulic tools.
- **Make a flare that doesn't leak:** cut → deburr → ream → tube height set → eccentric cone → oil → form → inspect — the full ritual, repeatable.
- **Assemble a flare joint to torque spec** with a torque wrench and Nylog — and recite the spec table for 1/4 / 3/8 / 1/2 / 5/8.
- Inspect and condemn bad flares on sight: too small, too tall, cracked, scored, off-center, chip-dented.
- Explain why **the flare is the #1 mini-split leak point** and exactly which steps prevent which failure (the 10-reasons video, internalized).

Unit 9 will hang entire installs on your flares. The reps happen HERE, on the bench, where a bad one costs a foot of copper instead of a system charge.

2. Tools & materials

- Flaring kits: clutch-type eccentric (program standard), bar-type (to feel the difference), cordless power flare (demo)
- Swage set: punch, lever/spin, hydraulic; spin bits in the drill
- **Torque wrenches** with crowfoot set; Nylog Blue; flare nuts assortment (incl. the heavier OEM nuts vs thin aftermarket — feel both)
- Flare gauge/inspection loupe; scrap soft copper in all sizes; two mini-split service valves on the practice board

3. Watch first

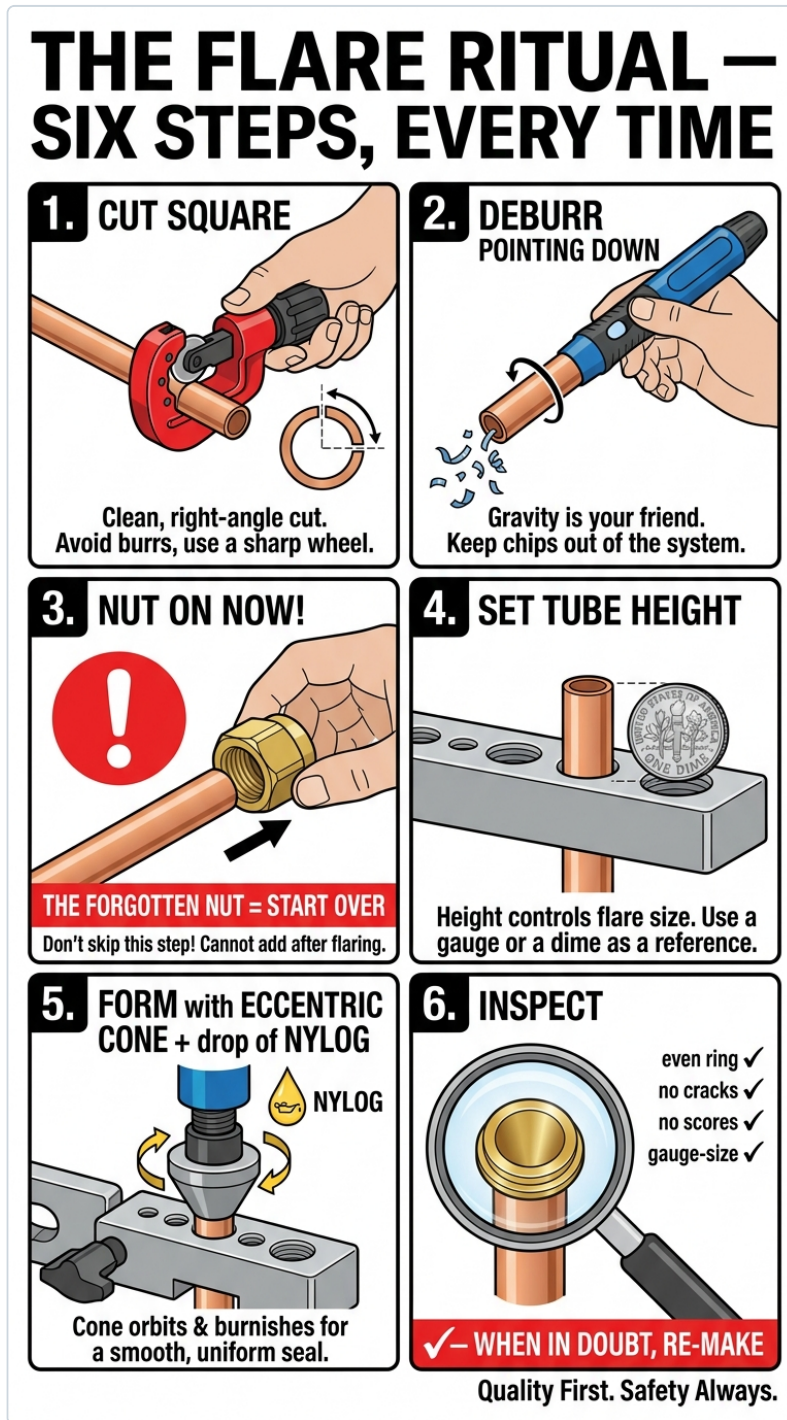
Order	Video	Channel	Length	Why
1	Swaging Copper — All 5 Tool Types	AC Service Tech	10:31	The swage landscape
2	How to Make a Flare That Won't Leak	HVAC School	36:05	THE flare class — watch fully before bench
3	Why Eccentric Flaring Tools Make the Best Flares	AC Service Tech	5:36	Tool choice justified
4	10 Reasons a Mini-Split Flare Leaks	AC Service Tech	18:15	The failure catalogue — our inspection list
5	Flare in 30 Seconds	AC Service Tech	1:00	Where you'll be by Friday
6	Dry vs Wet (Oiled) Flares — Tested	AC Service Tech	11:28	Why the drop of Nylog

4. The idea

Swaging — tube becomes its own coupling

Expand one tube end so the next tube slides in (insertion depth $\approx$ one tube OD) → one braze joint instead of two + no coupling on the truck. Tools, ranked for our work: **manual punch** (cheap, fine for occasional), **spin bits** (fast, drill-driven, watch heat), **lever/hydraulic expanders** (clean, repeatable, big OD). Rules: anneal hard temper before swaging (or don't swage it), support the tube straight, depth to the tool's mark, inspect for splits — a split swage is scrap, not "probably fine under braze."

The flare ritual (this exact order, every time)



1. **Cut square** (4.1 skill), light cutter passes.
2. **Debur/ream pointing DOWN** — a chip pressed into the flare face is a leak channel with a warranty.
3. **SLIP THE NUT ON NOW.** (The forgotten-nut flare is a trade rite of passage; once is plenty — and budget says zero.)

4. **Tube height in the block:** per your tool's spec (classic bar tools: tube proud of the block by ~the thickness of a dime; clutch eccentrics: flush per tool). Height controls flare DIAMETER — the #1 size error.
5. **Form:** eccentric cone orbits as it presses (burnishes, even wall), clutch clicks at finish. One drop of **Nylog on the CONE and the flare FACE** (never in the threads' first turns? — on the face/back of flare is our standard; it lubricates forming and seating).
6. **Inspect:** even witness ring, no cracks at the rim, no scoring, correct OD against the gauge, face mirror-smooth. **When in doubt, cut it off and make another** — copper is cheap.

Assembly — torque is a number, not a feeling

Seat the flare on the valve cone, thread by HAND fully (cross-thread = both parts scrap), then **torque wrench to spec:**

Tube OD	Torque (typical — verify per manufacturer)
1/4"	13-16 ft·lb
3/8"	26-30 ft·lb
1/2"	36-44 ft·lb
5/8"	45-48 ft·lb

Under-torqued seeps; **over-torqued work-hardens, splits the flare, or cracks the valve cone** — gorilla-tight is the more common field sin and the more expensive one. Hold the valve body with a backup wrench ALWAYS (untorqued backs twist the valve out of the unit — a warranty-ending move).

Why flares leak (the 10-reasons list as our inspection card)

Chips under the face · flare too small (height low) · too big (height high, nut can't seat) · cracked rim (over-formed, old work-hardened tube, over-torqued) · scored face (dirty cone) · off-square cut · ovalized tube (cutter abuse) · no backup wrench (twisted line) · re-used old flare after opening (re-make, don't re-pinch) · vibration with no support (the long-game leak — strap your linesets).

5. Bench procedure

1. **Swage ladder:** one good swage per tool type in 3/8 and 5/8; dry-fit a mating tube to each (smooth full-depth slide). Split one ON PURPOSE (over-expand) — see what scrap looks like.
2. **Flare reps, volume phase:** TEN flares per student in 1/4 and 3/8, every one through the full ritual with narration on the first three. Instructor destroys the bad ones with the loupe and says why.
3. **The failure museum:** make one of each deliberately — height-low (small), height-high (oversize), no-deburr (chip face), over-torqued on the rig (crack it) — label and keep; this is your visual calibration set forever.

4. **Torque lab:** assemble flares to the practice valves: hand-seat → torque wrench → feel 16 vs 30 ft·lb. One assembly with backup wrench omitted on the sacrificial valve — watch the body try to follow.
5. **Pressure proof:** Friday's best two flares per student get nitrogen at 300+ PSI and bubble solution on the practice manifold — public pass/fail. (Full pressure-test protocol is 4.5; this is the motivational preview.)
6. **Speed pass (end of week):** ritual-complete flare in under 3 minutes. Speed comes LAST, after the ritual is reflex.

Checkout: two consecutive flares (1/4 + 3/8) that pass loupe + gauge + nitrogen bubble test, assembled to torque with backup wrench, narrated. Comp 5 (swage/flare) at guided level.

6. Field gotchas

- **The nut. Slip the nut on first.** (Yes, again. It's the one everyone forgets exactly once per size.)
- **Aftermarket thin flare nuts crack** — reuse the OEM nut or buy forged; mini-split kits ship with good ones, keep them.
- **Cold weather flares:** soft copper stiffens; warm the tube end in your hand/pocket before forming on winter installs or it cracks.
- **Re-tightening a seeping flare** is one quarter-turn gamble MAX with a torque wrench — past that, cut and re-make. Crushing harder never made copper seal better.
- **Flares on R-410A/A2L pressures are unforgiving** of "pretty good" — 400–600 PSI lives behind that 30-cent cone of copper. The bubble test is your signature on it.
- **Vibration kills perfect flares:** support the lineset near the connections (Unit 9's bracket rules); a flare that lived through commissioning can still die at month six from an unstrapped line dancing.

7. Competency link

- **Comp 5** (swage/flare) at bench level — pressure-proof formally in 4.5; field volume in Unit 9 installs (Comp 48).
- Torque-wrench discipline carries to service valves, Schraders (5.x), and every A2L-era connection.

8. Check yourself

1. The flare ritual, all six steps, in order.
2. What does tube height in the block control, and the two failure flavors?
3. Where does the Nylog go and what did the wet-vs-dry video show?
4. Torque for 3/8: ___ ft·lb. What does over-torque do (three things)?
5. Why a backup wrench, always?

6. Swage insertion depth rule? What condemns a swage instantly?
 7. Five of the ten flare-leak reasons, from memory.
 8. When is re-tightening a seeping flare acceptable, and what's the limit?
 9. Why do we pressure-prove flares with nitrogen instead of trusting the loupe?
 10. A flare made in January cracks at the rim while forming. Likely cause and the prevention?
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