

Copper Tubing: Types, Cutting, Deburring, Bending

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 — "Cut, swage, flare, and braze copper tubing to specification" (cut/bend portion) **Class time:** ~4 hrs (0.5 video + 3.5 bench — hands from here on)

1. What you'll be able to do

- Identify refrigeration copper by **type and temper**: ACR soft (coils) vs hard-drawn (sticks), and why plumbing copper (M/L/K, water-rated) is NOT linesets.
- Read tubing sizes the refrigeration way (**OD**, not plumbing's nominal ID): 1/4, 3/8, 1/2, 5/8, 3/4, 7/8 OD.
- **Cut square** with a tubing cutter (no saws on linesets) and **deburr both directions** without letting a single chip inside the tube.
- **Bend soft copper** by hand, spring, and lever bender to $\pm 5^\circ$ without kinks — and know when a fitting beats a bend.
- Keep tubing **clean, dry, capped** — the system-hygiene religion this whole unit installs.

Everything in Unit 4 protects one thing: the inside of the refrigerant circuit. Chips, moisture, and oxide scale are the three contaminations; this lesson kills the first one.

2. Tools & materials

- Soft ACR coils (1/4, 3/8, 5/8), hard-drawn sticks (3/8, 7/8)
- Tubing cutters (standard + close-quarters mini), deburring tools (multiple styles — the comparison from the video), files
- Bending springs, lever benders (1/4–5/8), sand for the demo
- Plugs/caps assortment; nitrogen nearby (the habit starts now)

3. Watch first

Order	Video	Channel	Length	Why
1	Short 24 — Hard vs Soft Copper	HVAC School	7:29	Temper, types, what's legal where
2	Copper Deburring: Tools and Techniques	HVAC School	24:11	The chip war, in depth
3	Copper Tube Bending Tools & Methods	AC Service Tech	8:08	Hands, spring, lever, ratchet
4	Avoid Compressor Damage: The Copper Cutting Rule	HVAC School	11:39	Why chips = dead compressors

4. The idea

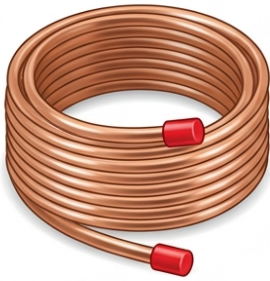
Know your copper

	ACR soft (annealed)	ACR hard-drawn	Plumbing M/L/K
Comes as	25/50 ft coils	10/20 ft sticks	sticks
Bends?	Yes — that's the point	No — use fittings	No
Sized by	OD	OD	nominal ($\approx$ ID) — a "1/2" plumbing stick is 5/8 OD!
State	Cleaned, dehydrated, capped ends	Same	Water-grade: not cleaned/dehydrated for refrigerant
Use	Linesets, mini-splits	Long straight runs, rack work	Not our circuits

The capped ends aren't packaging — they're the dehydration seal. **Re-cap every open tube end, every time you walk away.** Alabama humidity loves an open lineset (moisture + POE oil = acid — the 4.6 villain origin story).

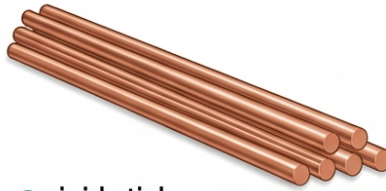
KNOW YOUR COPPER — AND THE SIZE TRAP

ACR SOFT (annealed)



- comes in coils
- BENDS**
- linesets & mini-splits
- ends **CAPPED** = dehydration seal

ACR HARD-DRAWN



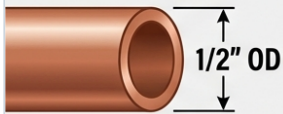
- rigid sticks
- use **FITTINGS**, no bending
- long straight runs

PLUMBING M/L/K



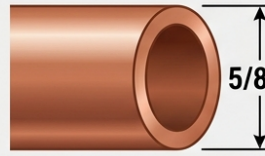
- water grade — **NOT** for refrigerant circuits

THE SIZE TRAP



1/2" OD

REFRIGERATION:
measured by OD — a 1/2 in
ACR tube **IS** 1/2 in outside



5/8" OD

PLUMBING: nominal —
a (half inch) plumbing stick
is actually 5/8 in OD

CLEAN • DRY • CAPPED • NITROGEN WHEN HOT

Cutting — the wheel, never the saw

Tubing cutter: snug the wheel, rotate, quarter-turn tighten, repeat. Light passes — over-tightening ovalizes the tube and work-hardens the cut. **No hacksaws/sawzalls on refrigerant lines:** saw teeth make chips by design, and chips ride refrigerant velocity straight into the compressor or pack the TXV screen (Lesson 1.2's "what fails"). Close-quarters cutters earn their pouch slot inside cabinets.

Deburring — the chip war

Every cut raises a burr: **inner burr** (restricts flow, sheds chips, ruins flares later) and **outer burr** (ruins swage/fitting fit). The discipline:

1. **Point the tube DOWN** (gravity is on your team — chips fall OUT).
2. Ream the inner edge — light, even, just to clean metal.
3. Dress the outer edge.
4. Tap the tube, look inside, wipe the tools.

The 24-minute video compares tools; the rule is tool-agnostic: **down, light, both edges, inspect.** A flare's quality (4.2) is decided HERE.

Bending — the order of preference

1. **Hands** (large radius, big OD soft): thumbs together, work gradually along the bend — never one crush point.

2. **Bending spring** (the field standby): slide over (or into) the tube, bend over the knee, gradual. Slightly overbend, relax back — springs release easier.
3. **Lever bender** (the precision tool): marks aligned, smooth pull to the angle scale — repeatable 90s/45s, tightest legal radius.
4. **The sand trick** (oddball big bends): pack, cap, bend, pour out, BLOW CLEAN with nitrogen.

Minimum radius $\approx 5 \times$ diameter as a working rule; a kink is a restriction forever (it shows up in Unit 5 as your liquid-line restriction practice case — find the kink with a temperature drop). Fittings beat heroic bends: a clean 90 with two brazes beats a wrinkled hand bend on anything that matters.

The hygiene religion (memorize as a creed)

Clean. Dry. Capped. Nitrogen when hot (4.4). Always.

Chips kill compressors. Moisture makes acid. Oxide scale plugs screens. Every Unit 4 skill is one front of the same war.

5. Bench procedure

1. **ID relay:** sort the copper pile by type/temper/size — including the planted plumbing stick ("1/2 nominal" = 5/8 OD — measure it, feel the trap).
2. **Cut gauntlet:** 10 cuts each across sizes/temper: square (checked against a speed square), round (no ovalizing), deburred both edges, chip-free interior (instructor flashlight check). 9/10 to pass.
3. **Deburr comparison:** same cut, three different tools — inspect under the bench magnifier; pick your pouch tool with reasons.
4. **Bend ladder:** hand-bend a sweep in 5/8 soft; spring-bend a 90 in 3/8; lever-bend 90 and 45 in 1/4 and 3/8 to marks ($\pm 5^\circ$, no flat spots — checked with the gauge). One DELIBERATE kink on scrap: feel how little force it takes, cut it open, see the restriction.
5. **Hygiene drill (running all class):** any tube left uncapped on a bench costs the team a point. By end of day capping is involuntary.

Checkout: one cut-deburr-bend sequence on 3/8 soft to a drawn spec (length $\pm 1/16$, $90^\circ \pm 5^\circ$, chip-free, capped when handed over). Comp 5 (cut/bend portion) at guided level.

6. Field gotchas

- **The plumbing-supply trap:** "1/2 copper" at the supply house $\neq$ 1/2 ACR. Order by OD and say ACR. Mixed sizing wastes truck rolls weekly somewhere.
- **Linesets dragged through attics uncapped** arrive full of insulation and dead wasps. Cap to drag, cut fresh after the pull.

- **Reusing old linesets** (changeouts): flush vs replace decision (mineral→POE residue, R-22 history, kinks in walls) — the full decision tree is in 8.7/Unit 5; today's relevance: INSPECT what you can see and never trust a previous kink.
- **Work-hardening:** soft copper hardens as you bend/move it — a lineset flexed back and forth at the service valve WILL crack there eventually (the 1.2 leak-spot list, "corrosion + vibration"). Bend once, support properly (clamps/cushions).
- **Tube in contact with dissimilar metal or concrete** = future leak (galvanic + abrasion). Sleeve and isolate — Unit 9's penetration rules generalize.

7. Competency link

- **Comp 5** begun (cut/bend); flare/swage 4.2; braze 4.3–4.4; the full Comp 5 checkout is the Unit 4 capstone in 4.6's pressure-test/evac sequence.

8. Check yourself

1. ACR soft vs hard-drawn vs plumbing copper — one use and one difference each.
 2. Refrigeration sizing is by ___; a "1/2" plumbing stick is actually ___ OD.
 3. Why no saws on linesets — give the two destinations of the chips.
 4. The four-step deburr discipline, including the gravity rule.
 5. Why do tube ends come capped, and what's our recap rule?
 6. Minimum bend radius rule of thumb? What is a kink, hydraulically?
 7. Rank the three bending tools for: a tight precise 90 in 3/8; a gentle sweep in 5/8.
 8. What two ingredients make acid inside a system, and which lesson's villain is that?
 9. When does a fitting beat a bend?
 10. Recite the hygiene creed.
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