

Superheat & Subcooling: What They Actually Tell You

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 1 • HVAC Fundamentals • Appendix A Competency 3 (direct setup for 15-16) Class time: ~5 hrs (1.5 video/classroom + 3.5 bench — this one gets extra reps)

1. What you'll be able to do

- Define superheat and subcooling in plain words and compute both from two measurements each.
- **Measure superheat** on a running system: suction pressure → saturation temp, suction line temp, subtract.
- **Measure subcooling**: liquid pressure → saturation temp, liquid line temp, subtract.
- Say what each number is FOR: superheat protects the **compressor** (no liquid comes back); subcooling proves a **full liquid line** feeds the metering device.
- Recognize healthy ranges: superheat ~8-14°F at the condenser (TXV system), subcooling ~8-12°F (or the nameplate target).

After 1.3 you can read what's happening inside the coils. This lesson measures what's happening at their exits — and those two exit numbers are 80% of refrigerant-side diagnosis.

2. Tools & materials

- Manifold gauges or wireless probes (Fieldpiece/Testo style)
- Pipe-clamp thermocouple (NOT an IR gun — see gotchas)
- P/T cards from 1.3
- Running shop unit(s); worksheet with blank superheat/subcool computation tables

3. Watch first

Order	Video	Channel	Length	Why
1	Superheat and Subcooling Explained! Step by Step	AC Service Tech	11:39	The concepts, clean
2	Exactly What is Superheat and Subcooling? Live AC Unit	AC Service Tech	9:25	Measured on real equipment
3	How to Check Superheat and Subcooling	AC Service Tech	14:16	Full measurement procedure
4	Why Measure BOTH on a TXV System?	AC Service Tech	7:45	Why one number is never enough
Trick	Measuring SH & SC Without Pressures	AC Service Tech	9:51	Probes-light diagnosis preview

4. The idea

Superheat — how far past boiling the vapor has gone

In the evaporator, refrigerant boils at saturation (say 40°F). By the time the last droplet boils off, the vapor keeps absorbing heat and **rises above** saturation. At the evaporator exit the vapor might be 50°F:

$$\text{SUPERHEAT} = \text{actual line temp} - \text{saturation temp} = 50 - 40 = 10^\circ\text{F}$$

What it tells you:

- **Superheat exists → the line is pure vapor.** Liquid cannot be above its boiling point; if it's superheated, the liquid is all gone. **The compressor is safe.**
- **Too little (0–3°F):** liquid is making it to the end of the coil — flood-back risk, compressor killer.
- **Too much (20°F+):** the coil ran out of liquid early — starving (undercharge, restriction, or huge load).
- Superheat is the evaporator's report card: did we feed this coil the right amount of refrigerant for the heat coming in?

Subcooling — how far below condensing the liquid has dropped

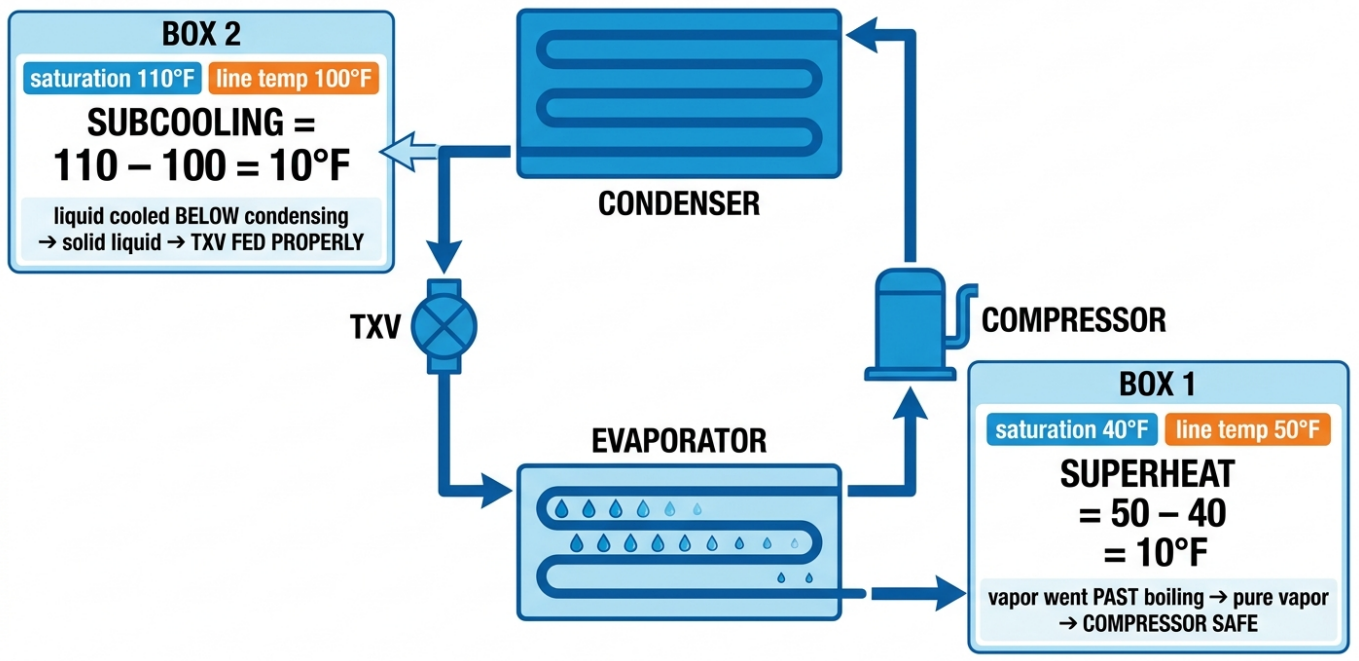
In the condenser, vapor condenses at saturation (say 110°F). Once it's all liquid, it keeps cooling **below** saturation. At the condenser exit the liquid line might be 100°F:

$$\text{SUBCOOLING} = \text{saturation temp} - \text{actual line temp} = 110 - 100 = 10^{\circ}\text{F}$$

What it tells you:

- **Subcooling exists → the line is solid liquid.** Vapor can't be below its condensing point; if it's subcooled, it's all liquid. **The metering device is being fed properly.**
- **Too little (0–4°F):** vapor bubbles in the liquid line — not enough refrigerant stacked in the condenser (usually undercharge).
- **Too much (18°F+):** liquid is piling up in the condenser (usually overcharge, or a restriction backing liquid up).
- Subcooling is the condenser's report card: how much liquid is stacked and ready to feed the valve?

SUPERHEAT & SUBCOOLING — THE TWO EXIT EXAMS

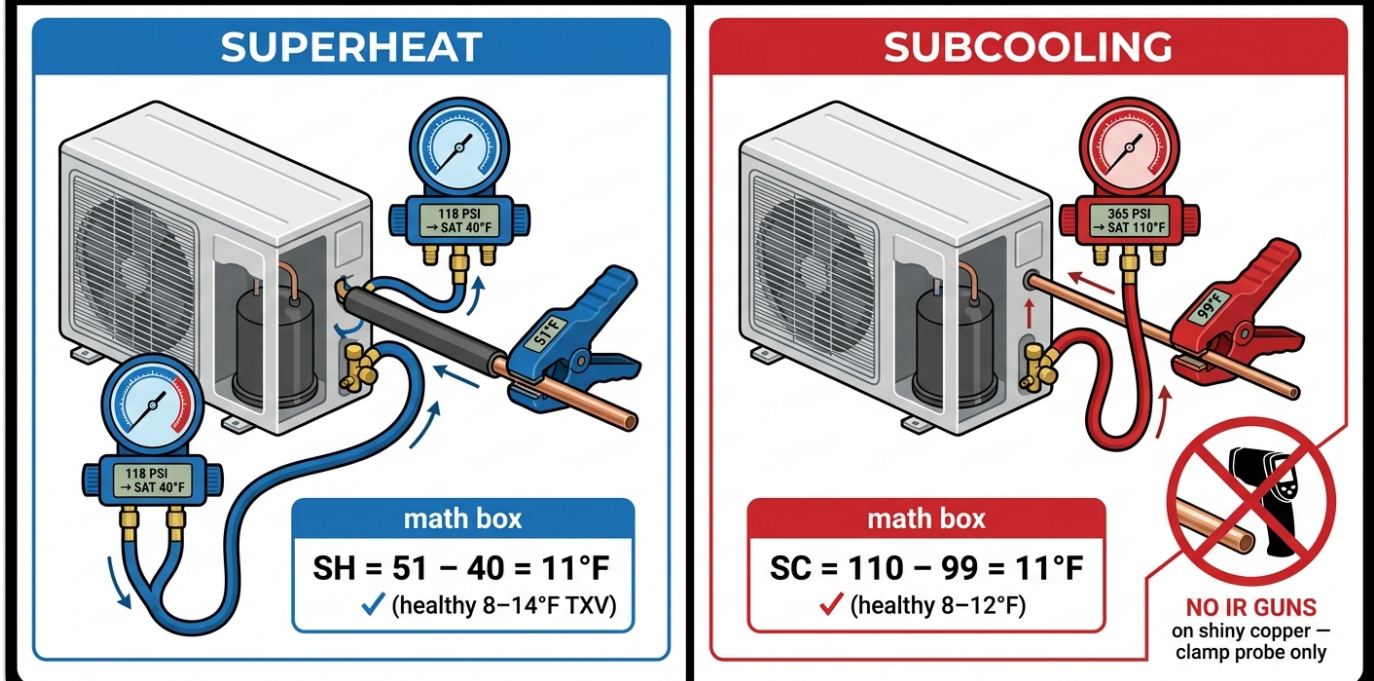


The two-thermometer picture

Each number needs exactly two measurements — one pressure (converted to saturation by your gauge/P/T chart, Lesson 1.3) and one pipe temperature (clamp probe):

	Pressure from	Temp clamp on	Math	Healthy (typical)
Superheat	LOW side port	Suction line at the condenser, near the service valve	line temp – sat temp	8–14°F (TXV)
Subcooling	HIGH side port	Liquid line at the service valve	sat temp – line temp	8–12°F or nameplate

HOW TO MEASURE — TWO NUMBERS, TWO TOOLS EACH



Why both, and which one charges the system

- **TXV system:** the valve actively holds superheat steady (that's its job, Lesson 1.2) — so superheat alone can't show charge level. **Charge by SUBCOOLING**, watch superheat as the safety check.
- **Fixed orifice:** nothing self-adjusts — superheat swings with charge. **Charge by SUPERHEAT** (against a target table — Unit 5).
- One number can lie; two numbers tell a story. The full SH/SC diagnosis matrix (low/low, high/high, high/low...) is Lesson 5.7 — today is making the two measurements bulletproof.

5. Bench procedure

Round 1 — compute on paper (15 min). Worksheet drills, P/T card allowed: 1. R-410A, low side 118 psig, suction line 51°F → SH? (40°F sat; 11°F ✓ healthy) 2. R-410A, high side 365 psig, liquid line 99°F → SC? (110°F sat; 11°F ✓) 3. Low side 118 psig, suction line 41°F → SH 1°F. Healthy or scary? (Scary — flood-back.) 4. High side 365 psig, liquid line 109°F → SC 1°F. What's the first suspicion? (Low charge — bubbles in the liquid line.) 5. Six more mixed drills until the two subtraction directions are automatic (students reliably flip one — drill it out NOW).

Round 2 — measure on the live unit. Each student, full sequence, alone: 1. Verify refrigerant (plate) → connect gauges (ritual from 1.3). 2. Clamp temp probe on suction line near the service valve — clean copper, snug clamp, insulate over the clamp. 3. Read suction pressure → sat temp. Read clamp. Compute SH on the worksheet before announcing it. 4. Clamp on liquid line. Read high side → sat temp. Compute SC. 5. State the verdict: "Superheat __ , subcooling __ — compressor [safe/at risk], liquid line [full/bubbling], charge [looks right / suspicious — and why]."

6. Instructor secretly varies conditions for the next student (block some condenser airflow, drop the blower a tap) — numbers move, verdicts must follow.

Checkout: unaided full measurement + computation + one-sentence interpretation of each number, twice, on two different setups. Both subtractions in the correct direction both times.

6. Field gotchas

- **IR guns lie on shiny copper** — low emissivity reads way off. Pipe-clamp thermocouple, always, snug on cleaned copper.
- **Flipping the subtraction** is THE classic apprentice error. Anchor it: superheat = line above saturation (vapor got hotter); subcooling = line below saturation (liquid got cooler). If you compute a negative, you flipped it — or something is genuinely wrong; recheck before celebrating either.
- **Let it run 10-15 minutes first.** Numbers on a system that just started are noise.
- **Where you clamp matters.** Suction temp taken at the evaporator exit vs at the condenser end differ (line gains heat in between) — manufacturer targets specify WHERE. Our default: at the outdoor unit, near the valves.
- **TXV hunting:** SH/SC slowly swinging $\pm 3-4^{\circ}\text{F}$ in rhythm — note it, average it, full story in Unit 5.
- **Never charge anything from today's lesson alone.** Measurement $\neq$ charging procedure. Airflow must be verified before refrigerant verdicts (the Unit 11 drum we'll beat all program).

7. Competency link

- **Competency 3** — completed at depth (cycle + saturation + SH/SC = the full conceptual core).
- Direct foundation for **Comp 15** (superheat charging, 5.4), **Comp 16** (subcooling charging, 5.5), and the diagnosis matrix (5.7).

8. Check yourself

1. Define superheat in one sentence without the word "superheat."
2. Why does the presence of ANY superheat guarantee no liquid is entering the compressor?
3. Low side 118 psig (R-410A), suction line 53°F . Superheat? Healthy on a TXV?
4. High side 317 psig (R-410A, sat 100°F), liquid line 91°F . Subcooling?
5. Subcooling reads 2°F . What's in the liquid line besides liquid, and what's the usual cause?
6. Superheat reads 25°F . Is the coil flooded or starved? Name two possible causes.
7. Which number does a TXV hold steady, and what do you charge by on a TXV system because of it?
8. Why is an IR thermometer the wrong tool for line temps?

9. You compute superheat = -4°F . What did you probably do, and what's the other (bad) possibility?
10. Superheat protects the __; **subcooling proves the** ____ is being fed solid liquid.
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