

The Charge Diagnosis Matrix: What SH + SC Combinations Confess

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 5 • Refrigerants, EPA 608 & Charging • Comps 15-16 capstone, feeds Comp 20 & 42 Class time: ~4 hrs (1 video + 3 scenario bench) — the thinking lesson of Unit 5

1. What you'll be able to do

- Read **superheat + subcooling AS A PAIR** and recite the matrix cold:

SH	SC	Verdict
HIGH	LOW	Undercharged (or a leak doing the undercharging — 4.7)
HIGH	HIGH	Liquid-line restriction (plugged drier, kinked line, starving/failed TXV)
LOW	HIGH	Overcharged
LOW	LOW	Low evaporator load (airflow! dirty filter/coil, weak blower) or TXV overfeeding
NORMAL	NORMAL (but capacity poor)	Look elsewhere: airflow delivery, non-condensables, compressor (6.7)

- Add the **third witnesses** that break ties: line temperature drop across a restriction (find it with touch/IR — the kink confesses a ΔT), head pressure level, amp draw, frost lines.
- Diagnose the three classic look-alikes that freeze coils — **low charge vs low airflow vs restriction** — without guessing (the 5.4 trap round, now with the full toolkit).
- Narrate a verdict with evidence: "SH 24, SC 14, 18° drop across the drier — restriction at the drier, not charge."

2. Tools & materials

- The bench fleet, each riggable: undercharge / overcharge / pinched liquid line (the 4.1 kink!) / blocked filter / restricted drier
- Gauges/probes, clamps, IR gun (for restriction hunting — its legit job), amp clamp

- The matrix card (laminated, wallet-size — students keep it until it's memory)

3. Watch first

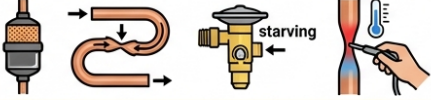
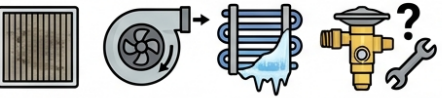
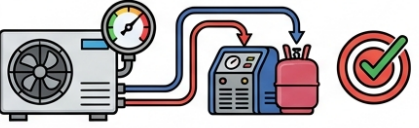
Order	Video	Channel	Length	Why
1	Troubleshooting with Sat Temps, SH & SC — 5 Possible Problems	AC Service Tech	18:48	The matrix, taught
2	Indicators: Restriction vs Low Airflow vs Low Charge	AC Service Tech	9:58	The three look-alikes split
3	Liquid Line Restriction — High Side & Subcooling	AC Service Tech	7:25	The HIGH/HIGH row explained
4	Restriction Found: Bad TXV	AC Service Tech	13:35	A real one, caught
5	Frozen Coil: Restriction vs Airflow vs Charge	AC Service Tech	10:14	The ice tree
6	TXV Diagnosis: SH, SC & Split Temps	HVAC School	13:41	Valve-specific reads

4. The idea

Why pairs, not numbers

One number has many mothers; two numbers have few. High superheat alone = undercharge OR restriction OR huge load. But high SH **with low SC** = the system is genuinely short of refrigerant everywhere; high SH **with HIGH SC** = plenty of refrigerant, stacked behind a blockage that won't let it reach the coil. The pair points; the third witness convicts.

THE CHARGE DIAGNOSIS MATRIX – READ THE PAIR

	SUBCOOLING LOW	SUBCOOLING HIGH	THIRD WITNESSES
SUPERHEAT HIGH	UNDERCHARGED — and a low charge IS a leak: find it 	LIQUID-LINE RESTRICTION — drier, kink, starving TXV — hunt the temp DROP 	 temp drop across a component = restriction marker  head pressure  amp draw  frost lines
SUPERHEAT LOW	LOW EVAPORATOR LOAD — AIRFLOW first (filter/blower/ice) or TXV overfeeding (check the bulb) 	OVERCHARGED — recover to target 	
	BOTH NORMAL but cooling poor → look OUTSIDE the circuit: ducts, non-condensables, compressor 		

Row by row (the reasoning, not just the table)

- **HIGH SH / LOW SC — undercharged:** not enough liquid to seal the condenser (SC dies) and the coil runs out early (SH climbs). Before adding: **why is it low?** (4.7 — a leak is the diagnosis; the charge is the symptom.)
- **HIGH SH / HIGH SC — restriction:** liquid piles up BEFORE the blockage (SC high, head often high) while the coil starves AFTER it (SH high). **Find the blockage with temperature:** liquid line should lose almost nothing end-to-end; a marked temp DROP across one component (drier! kink! TXV inlet screen) marks the spot — a restriction is an accidental metering device, and metering makes cold (1.1's two-inch trick, weaponized). Frost AT the restriction in bad cases.
- **LOW SH / HIGH SC — overcharged:** stacked liquid (SC up) floods the coil late (SH down). Usually man-made (the gas-and-go artist). Recover to target.
- **LOW SH / LOW SC — low load or overfeed:** the coil can't boil what it's fed — because the AIR isn't bringing heat (filter/blower/iced coil) or the valve overfeeds (bulb loose). Check airflow FIRST (always), then the bulb (1.2).
- **NORMAL / NORMAL but it cools poorly:** charge is innocent. Ducts leaking/undersized (Unit 10-11), non-condensables (high head + normal SC after a sloppy install — the 4.6 sermon), or a compressor not compressing (6.7's low-amps/low-split signature).

The frozen-coil tree (the service-call version)

Ice = the coil ran below 32°F long enough. **THAW FULLY FIRST** (gauges on ice lie — low-side pressure reads the ice's restriction, not the system). Then run and read: high SH/low SC → charge/leak; low/low + weak air → airflow; high/high + a cold spot mid-liquid-line → restriction.

The 80/15/5 field split (airflow/charge/metering) says check the filter before the gauges — every time, forever.

5. Bench procedure — scenario gauntlet

1. **Matrix drills (paper):** 12 SH/SC pairs → verdicts + reasoning sentence. 100% before the bench.
2. **The five rigs:** teams rotate through five pre-rigged bench faults (under, over, kinked liquid line, blocked filter, plugged drier). At each: measure SH+SC, call the row, hunt the third witness (IR the liquid line! check the filter! clamp the amps!), deliver the narrated verdict. Instructor scores verdict AND evidence.
3. **The look-alike duel:** two units both barely cooling — one undercharged, one with a crushed return. Same complaint, same supply temp; the pairs split them in four minutes. Time it.
4. **The frozen one:** the iced bench coil (instructor froze it overnight): students must REFUSE to diagnose until thawed (the pass), then run the tree.
5. **Verdict language reps:** every find stated in the format: numbers → row → witness → verdict → next action. This sentence structure is the service ticket and the customer explanation in one.

Checkout: two unknown rigs, full verdicts with third-witness evidence, zero parts-cannon guesses. **The Unit 5 written exam covers 5.1-5.7; the matrix is half the points.**

6. Field gotchas

- **The matrix assumes stable conditions** (10-15 min runtime, sane airflow). Reading gauges in the first 90 seconds = astrology.
- **TXV hunting** (slow SH/SC oscillation, 1.4) can tour multiple rows — average over minutes, don't snapshot.
- **Restrictions hide in driers** so often that a temp probe across the drier is a standard service-call move (and a plugged drier after a burnout repair is telling you about the burnout, 6.7).
- **Two faults at once happen** (undercharged AND filthy filter): fix airflow, re-stabilize, re-read before touching charge — layered faults peel in airflow-first order.
- **Non-condensables masquerade as overcharge** (high head) but SC reads normal-ish and the condenser exit runs hot — the history ("who opened this system last, and did they pull a vacuum?") closes the case.
- **Write the pair on every ticket even when "it's fine."** Today's normal numbers are next year's baseline (4.5's log discipline, lifetime version).

7. Competency link

- **Comps 15-16 capstone**; the diagnostic spine of Comp 20 (Unit 6), the freeze tree of 7.10, the heat-mode rethink in 8.5, and the inverter translation in 9.6.
- Unit 5 closes after 5.8 (A2L) with the written exam.

8. Check yourself

1. Recite the matrix — all five rows with verdicts.
 2. Why does a restriction read HIGH/HIGH while an undercharge reads HIGH/LOW? Tell it as a story about where the liquid is.
 3. The third witness for a restriction — what do you measure and what marks the spot?
 4. LOW/LOW: which two suspects, and which one do you check first by law of the program?
 5. Why must an iced coil thaw before gauges mean anything?
 6. Normal pair, lousy cooling — name three suspects outside the refrigerant circuit.
 7. High head, normal-ish SC, hot condenser exit, system opened last month by parties unknown. Leading theory?
 8. The frozen-coil field split: 80/15/5 — what are the three and what's the first physical act on arrival?
 9. Compose a verdict sentence for: SH 4, SC 16, after a "tune-up" by a competitor.
 10. Why does the pair go on the ticket even when everything's healthy?
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