Checking The System (and Charge) Without Gauges

First, checking the charge without gauges is a balancing act, a trade off. We get more accurate readings when we connect gauges but we also -

1. Lose some refrigerant
2. Risk contaminating the system with moisture and air
3. Risk leaving a leak at the schrader cores and caps

Like everything your **best INITIAL diagnosis tools are your hands, eyes and ears**. Look for dirt buildup, spot oil, listen for abnormal sounds, feel the lines and condenser discharge air when approaching the condenser, check for dirty blower wheels, evaporators, filters and grilles when approaching the indoor unit. Look for wire and refrigerant tube rub outs, look inside drain cleanout tees and in pans for gunk and buildup, look inside condensers for wires laying on the tubing, pay attention to disconnects that are loose, Belts and sheaves that are worn, high voltage connections that are getting discolored, capacitors that are bulging or leaking, electrical whips that are coming apart, stat wires that are nicked or bare, air handlers that are sagging or out of level, ducts full of mildew and broken or damaged line insulation. In refrigeration look for icicles hanging down, broken insulation on drains and suction lines, dirty EVERYTHING and damaged doors and door seals.

THERE IS NO TEST PROCEDURE THAT REPLACES AN AWARE TECHNICIAN. NOTICE EVERYTHING, QUOTE TO REPAIR EVERYTHING. BE PROACTIVE, WALK THE SITE, FIX PROBLEMS BEFORE THEY OCCUR. LOOK BEYOND THE FIRST PROBLEM AND EVEN THE FIRST SYSTEM. CONSIDER THE SPACE VENTILATION, INSULATION AND OCCUPANTS. READ MANUFACTURER DATA TAGS, LOOK AT THE BACK OF PANELS AND READ MANUFACTURER INSTALLATION AND SERVICE DATA WHENEVER POSSIBLE.

This means that we **only connect gauges when** there is a good reason to do so, such as -

1. We have not touched the unit recently and want to make sure it is operating 100% (on air conditioning only, in small refrigeration you still don't connect in this case)
2. We made a significant repair that may impact operation
3. We need to "set" a charge because the system is newly started or we made a refrigerant circuit repair.
4. Your readings or your gut tells you are out of range or a problem may exists.

On a system that has been properly commissioned you will have prior readings to go off of. Keep in mind that some benchmarks like DTD (Evaporator to return air design temperature difference), CTOA (Condensing Temperature Over Ambient), Subcool and Superheat on a TXV system and Static Pressures.

Readings like suction pressure, head pressure and superheat and subcooling on a fixed metering device system and air temperature split will vary with load conditions. If you have system historical data you can often use it to learn about the system and its history before you begin taking readings.

When checking an air conditioning system without gauges do it in the following steps (these are subject to change and adjustment based on historical benchmarks, abnormal conditions and manufacturer specs) -

1. Visually inspect the unit for all the above listed items AND note if the metering device is a piston or a TXV
2. Measure the outdoor temperature in the shade entering the condenser
3. ADD the CTOA based on the SEER rating or age
4. Subtract the nameplate subcooling or 10° if there is no nameplate
5. Compare to the liquid line temperature. If +/- 3° on a TXV system or +/- 5° on a Piston the liquid temperature is in range
6. You may also check the air temperature leaving the condenser fan and it will usually be about ½ of the target CTOA (Condensing Temperature Over Ambient). So on a VERY old system with a CTOA of 30°F the condenser discharge air will generally be 15°F +/- 3°F and on a brand new high SEER unit with a CTOA of 15°F it will be 7.5°F +/- 3°F
7. Also note how much warmer the liquid line is than the outdoor temperature. It should be between 3° and 20° warmer than the outdoor temperature. If it is above or below that range, connect gauges.
8. Measure the suction line temperature outside. If it is at or above 65° the compressor is in danger of overheating / oil breakdown. If the suction line is 40° or below the unit is in danger of freezing. Stop and connect gauges.
9. Go inside and check the wet bulb and dry bulb temperature at the air handler / furnace inlet (return right before the inside unit or in the filter tray, cabinet make sure to keep the sensor out of “line of site” from the evap coil)
10. Take the return dry bulb (DB) and subtract 35°F (DTD), this is your target coil temperature difference
11. If the system has a TXV add in 10° for superheat, if it is a fixed orifice (piston) then add in the target superheat based on a superheat chart or using the SuperHeatCalc app. This gives you target suction line temperature at the evaporator.
12. Compare the target suction line temperature to the actual suction line temperature at the evaporator is it is within +/- 5°F it is within range. Outside of that range connect gauges.

13. Compare the indoor suction temp to the outdoor suction temp. 1°F of change per 20’ of lineset is allowable.
14. Compare the indoor liquid line temp to the outdoor liquid line temp. 1°F change per 30’ of lineset is allowable.
15. Check temp drop across all exposed line filter driers. Recommend replacement if there is a drop of 3°F or more across a filter drier and perform further testing if you get even 1°F of drop with the same, accurate thermistor clamp.
16. Use a Delta T chart to calculate target evaporator air temperature split like this one if the split is within +/- 3°F then it is within range. If higher then check for airflow issues and blower settings. If lower then connect gauges.
17. When checking an RTU (Rooftop Unit) or residential package unit you will often have easy access to the compressor, in this case check the suction temp entering the compressor and the liquid temp leaving the compressor. The suction temperature should be above 35°F and below 65°F entering the compressor and the discharge line temperature should be below 220°F and above 150°F on a properly functioning RTU. **NOTE: on an RTU make sure you are not attempting to measure liquid line temperature / CTOA rules when connecting to the DISCHARGE line. Also make sure that panels are in place for the condenser, blower and evaporator sections when run testing. When there is something that looks like a liquid line drier but it is in the discharge line it is a muffler not a filter / drier**
18. Check amps against manufacturer rating plates or part data plates if the compressor, blower or condensing fan motor are aftermarket
19. Check capacitors, preferably while running
20. Check the incoming voltage to the contactor and ensure it is within 5% of the rated voltage. In general this means ensuring that voltage is over 198V from leg to leg on a 208V System and over 228V on a 240V system. This is based on the NEC 215-2(d) suggested guideline not manufacturer specs so it isn’t set in stone.
21. Confirm that the voltage imbalance on a 3 phase system does not exceed 2%
22. When applicable check TESP and Static Pressure Drop across coil and filters against benchmarks
23. Confirm drainage / test and inspect float protection devices

BEWARE of these common readings mistakes

- **Reading air temperatures in sunlight**. If the sun is shining on a probe it will always read too high

- **Reading air temperature in a place that is “line of site” to a cold or hot surface like a coil, heat strips, heat exchanger etc...** It is always best to have a probe in an area shielded from other hot or cold surfaces
- **Reading line temps in an uneven area of the tubing**. The sensor on your temp clamp must have full, flat, tight contact to the line being read
- **Trusting tools without testing tools**. All tools require proper care and maintenance and must and can be tested. They can either be tested against other tools or against a known constant (like the freezing temp of water) or they can be calibrated by a lab. Know your tools and learn how to test them.
- **Taking pressure readings without a fully depressed schrader core**. When checking refrigerant pressures or measuring vacuum with a micron gauge the cores must be fully depressed (pushed in). If your hoses or couplers are not FULLY depressing the cores you will see odd readings. When in doubt replace the schrader with a core tool and try another hose.

This process is not theory or a diagnosis guideline, it is simply a practical process for verifying PROPER operation for range of common air conditioning equipment. If you find readings that are outside of the guidelines listed you will need to connect gauges and further diagnose the system. Before using this this guideline it is highly recommended that you read and understand the following training modules -

The Basic Refrigerant Circuit
Common refrigerant Circuit Terms
The 5 Pillars of Refrigerant System Diagnosis
Checking a Charge W/O Gauges Article by Jim Bergmann
Checking a Charge W/O Gauges Parts one and two
Charging an Air Conditioner by TruTech Tools
The Case for Checking The Charge Without Gauges
Air Conditioning Diagnosis Guide

The best tools for following this process are -

Testo Smart Probes
Testo 115i Clamp only
Testo 605i for WB and DB
Cooper Clamp