ISLAND BREEZE TECHNICIAN CERTIFICATION PROGRAM

Refrigerants and the PT Chart

MODULE F5 | FOUNDATIONS | PREREQ F4

The scene. It is your second week riding along. Your lead tech hooks a gauge set to a condenser on a 105 degree afternoon, glances at the low side gauge for two seconds, and says "evap coil is running about 52, that is a little high, let's check the filter before we even think about charge." He never touched a chart, never opened an app. He read a pressure and his brain instantly translated it into a temperature. That translation is the single most used mental skill in this trade, and this module installs it in your head. By the end of F5 you will look at 130 psig on an R-410A gauge and think "45 degrees" without effort.

Short Version

Every refrigerant has a fixed relationship between its pressure and the temperature where it boils or condenses. That relationship is printed on a pressure-temperature chart, called a PT chart. When liquid and vapor refrigerant exist together, the refrigerant is "saturated," and the PT chart tells you its exact temperature from its pressure, or its exact pressure from its temperature. Your gauges measure pressure; the PT chart converts that to saturation temperature, which is what your diagnosis actually runs on. R-410A is the refrigerant in most systems you will touch, R-454B and R-32 are the new mildly flammable replacements, and they all use POE oil that absorbs moisture from open air. Learn the chart, identify the refrigerant before you connect anything, and never trust cylinder paint color.

Key Values

R-410A PT mini-table (memorize these anchors)

Saturation values, pressure in psig (pounds per square inch gauge). The first three are the temperatures you care about on the suction side. The last four are the temperatures you care about on the head pressure side.

SATURATION TEMPERATURE (F)	R-410A PRESSURE (PSIG)	WHERE YOU SEE IT
40	118	Coil running cold, low end of normal cooling
45	130	Classic healthy evaporator coil target
50	142	Coil running warm, or a mild-load day
95	296	Condensing temp on a mild day
105	340	Condensing temp on a warm day
115	390	Condensing temp on a hot Phoenix day

SATURATION TEMPERATURE (F)	R-410A PRESSURE (PSIG)	WHERE YOU SEE IT
125	445	Condensing temp in extreme heat or with a struggling condenser

GWP and safety class comparison

GWP means global warming potential: how much heat one pound of the gas traps in the atmosphere compared to one pound of carbon dioxide over 100 years. Safety classes come from ASHRAE Standard 34: the letter is toxicity (A means lower toxicity), the number is flammability (1 means no flame propagation, 2L means lower flammability with very slow burning velocity, 3 means highly flammable).

REFRIGERANT	TYPE	GWP	ASHRAE SAFETY CLASS	GLIDE
R-410A	HFC blend (50% R-32, 50% R-125)	1924	A1 (non-flammable)	Negligible (near-azeotropic)
R-32	Single HFC	675	A2L (mildly flammable)	None (pure fluid)
R-454B	HFC/HFO blend (68.9% R-32, 31.1% R-1234yf)	466	A2L (mildly flammable)	About 1.5 F

Note on GWP numbers: you will also see R-410A listed at 2,088. Both are published values from different IPCC assessment reports. Either way the story is the same: R-410A traps roughly four times the heat of R-454B, which is why it is being phased down.

Glide note for R-454B: glide means the refrigerant boils and condenses across a small temperature range instead of at one exact temperature, because its two ingredients have different boiling points. R-454B glides about 1.5 F. That is small enough that service practice feels like R-410A, but it is why R-454B charts show two columns (bubble point and dew point) and why blends with glide are charged as liquid.

Field Checklist: Reading Saturation Off a Gauge Set Correctly

- ☐ Identify the refrigerant from the equipment nameplate before connecting anything. Never assume.
- ☐ **Analog (dial) gauges:** the outer ring is pressure in psig. The inner colored rings are saturation temperature scales, one ring per refrigerant, each labeled (for example R-22, R-404A, R-410A). Find the ring labeled R-410A and read temperature where the needle crosses THAT ring. Reading the wrong ring gives you a wrong temperature with total confidence.
- ☐ **Digital manifold or wireless probes:** select the refrigerant in the menu first. The device computes saturation temperature for whatever refrigerant is selected. If the menu says R-22 and the system holds R-410A, every displayed saturation temperature is garbage.
- ☐ Low side (blue, compound gauge that reads pressure and vacuum) connects to the suction line service port. High side (red) connects to the liquid line service port.

- [ ] Read pressure, convert to saturation temperature, and say it out loud as a temperature: "130 psig, that is a 45 degree coil." Train the habit now.
- [ ] Cross-check against a paper PT chart or a refrigerant slider app until your anchors are memorized.

> **IB STANDARD**
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> Island Breeze trucks stock R-410A for service work on the existing installed base, and R-454B for new RunTru and Goodman and Daikin equipment (Daikin and Goodman platforms also bring R-32 into the mix). Before any refrigerant is added to any system, the tech must positively identify the refrigerant from the nameplate and match it to the cylinder label. Identification before topping off is mandatory, no exceptions, and every charge event gets logged in ServiceTitan with date, system, refrigerant type, and pounds added.

Full Breakdown

What a refrigerant is, and what makes a good one

A refrigerant is a fluid chosen because it boils and condenses at useful temperatures under pressures we can build equipment to handle. In F4 you learned the cycle: the heat absorber (evaporator) boils liquid refrigerant to soak up heat indoors, and the heat rejector (condenser) condenses vapor back to liquid to dump heat outdoors. The refrigerant is the truck that hauls the heat.

Water technically works as a refrigerant. So does propane. So would dozens of fluids. What separates a good refrigerant from a science experiment:

1. **Useful boiling point.** It must boil well below the temperatures we want to cool, at pressures above atmospheric. R-410A boils at roughly minus 52 F at atmospheric pressure. That means even the "low" side of an air conditioner runs at positive pressure, so a small leak pushes refrigerant out instead of sucking air and moisture in.
2. **Manageable pressures.** The pressures at condensing temperatures must be something copper tubing, compressors, and hoses can contain. R-410A pushes this boundary: its critical pressure is about 696 psig, which is why every R-410A tool carries a higher pressure rating than the old R-22 era gear.
3. **High latent heat.** Latent heat (from F3) is the heat absorbed or released during a state change. More latent heat per pound means less refrigerant has to circulate to move the same BTUs.
4. **Chemical stability and compatibility.** It cannot attack the compressor oil, the motor windings, the copper, or the rubber seals.
5. **Safety.** Low toxicity, low flammability. This is the A1 versus A2L versus A3 story covered below.
6. **Environmental footprint.** No ozone destruction, and the lowest practical GWP. This requirement is new in historical terms and it is the reason the refrigerant in the box keeps changing.

No fluid wins all six. Every refrigerant in history is a compromise, and the history section below shows how the compromise keeps shifting.

Saturation: the core concept of this entire trade

Here is the idea everything else in refrigeration hangs on.

At any given pressure, a refrigerant has exactly one temperature where liquid and vapor can exist together. That temperature is the **saturation temperature** for that pressure. At that point the refrigerant is boiling (if heat is going in) or condensing (if heat is going out), and while it changes state, its temperature does not move. All the energy goes into the state change. That is latent heat at work, exactly as you saw with boiling water in F3.

Raise the pressure and the saturation temperature rises. Lower the pressure and it falls. Water does this too: at sea level water boils at 212 F, on a mountain it boils cooler, and in a pressure cooker it boils hotter. Refrigerant obeys the same law, just at temperatures useful for air conditioning.

Now restate the three conditions you met in F4, because saturation is the reference point for all of them:

- **Saturated:** liquid and vapor together, sitting exactly at the saturation temperature for the current pressure. Inside most of the evaporator and most of the condenser, the refrigerant is saturated. A resting cylinder with liquid in it is saturated too, which is why a bottle is the perfect practice tool.
- **Superheated:** vapor only, heated ABOVE saturation temperature. Superheat is the number of degrees above. If saturation is 45 F and the suction line measures 55 F, the vapor carries 10 degrees of superheat. Superheat proves there is no liquid left.
- **Subcooled:** liquid only, cooled BELOW saturation temperature. If saturation at the condenser is 115 F and the liquid line measures 105 F, the liquid carries 10 degrees of subcooling. Subcooling proves there is no vapor left.

Why a technician cares: your gauges cannot see inside the coil, but they read pressure, and pressure tells you saturation temperature exactly. Compare saturation temperature to an actual line temperature from a clamp thermometer and you know precisely where the refrigerant stands. That comparison IS superheat and subcooling, and F6 is devoted to it. F5's job is to make the pressure-to-temperature translation automatic.

PT chart fluency: reading it both directions

A PT chart is a table with two columns: temperature and pressure. One column in, the other column out. You must be fluent in both directions, because the field demands both.

Direction one: pressure to temperature. This is the everyday direction. Your gauge reads 130 psig on an R-410A system. The chart says 130 psig sits at 45 F. You now know the evaporator coil is boiling refrigerant at 45 F. The gauge gave you a pressure; the chart turned it into the temperature your diagnosis runs on.

Direction two: temperature to pressure. This is the prediction direction. It is 95 F outside and a healthy condenser typically condenses about 20 to 25 degrees above outdoor air, so you expect a condensing temperature near 115 to 120 F. The chart says 115 F is 390 psig. Before you ever connect, you already know roughly what the high side gauge should read. If it reads 480, something is wrong and you knew it within seconds. Direction two is also how you verify a cylinder: a resting R-410A cylinder at 75 F should sit near its 75 F saturation pressure. If it reads well above chart pressure, the cylinder contains air or other non-condensable gas, or the wrong refrigerant.

Your gauges have the PT chart built in. That is what the inner temperature rings on an analog gauge are: a PT chart wrapped into a circle, one ring per refrigerant. A digital manifold is a PT chart in software: it measures pressure and displays saturation temperature for the refrigerant you selected. The numbers in both trace back to laboratory property data published by NIST, the National Institute of Standards and Technology, whose REFPROP database is the source nearly every chart, gauge ring, and slider app is computed from. The tools are fast, but the tech who also knows the anchors by memory (40 is 118, 45 is 130, 115 is 390) catches the wrong-ring and wrong-menu mistakes that fool everyone else.

One more definition pair you will meet on blend charts: **bubble point** is the saturation point where the first bubble of vapor forms in liquid, and **dew point** is the saturation point where the first drop of liquid forms in vapor. For a pure refrigerant they are the same line. For a blend with glide they split into two columns. Field rule for later modules: subcooling uses the bubble point column, superheat uses the dew point column. For R-410A the two are so close you can ignore the difference.

R-410A deep dive

R-410A is the refrigerant in the overwhelming majority of systems Island Breeze services today, so it gets the deep treatment.

What it is. R-410A is a blend: 50 percent R-32 and 50 percent R-125 by weight. Two different molecules in one bottle.

Why it behaves like a single fluid. Most blends fractionate, meaning the components boil at different rates so the mixture's makeup shifts as it boils, creating glide. R-410A's two components happen to cooperate so closely that its boiling and condensing lines are nearly identical. The technical term is **near-azeotropic** (an azeotrope is a blend that behaves exactly like a pure compound). Practical result: one PT line works, glide is negligible, and field practice treats R-410A like a pure fluid. This is a property of R-410A specifically, not of blends in general. Do not carry that habit to other blends.

Pressures versus old R-22. R-22 at a 40 F coil runs about 68 psig; R-410A runs 118. R-22 condensing at 115 F runs around 243 psig; R-410A runs 390. R-410A operates at roughly 50 to 60 percent higher pressure across the board. That is why R-410A demanded a whole new generation of compressors, gauges, hoses, and recovery machines rated for the higher pressures, and why you never connect R-22 era equipment to an R-410A system. Its critical temperature (the temperature above which the refrigerant cannot condense no matter the pressure) is about 160 F, with a critical pressure near 696 psig. Those two numbers explain hot-climate behavior: when outdoor air pushes condensing temperatures into the 120s and 130s, R-410A is operating uncomfortably close to its ceiling and efficiency falls off.

Why it is being phased down. R-410A contains no chlorine, so it is completely innocent in the ozone story. Its problem is GWP: at 1,924 (or 2,088 by the older accounting) it is a potent greenhouse gas. Under the AIM Act, the federal law that phases down HFC production, new residential equipment manufactured after January 1, 2025 cannot use it. Critical fact techs get wrong: the phase-down applies to NEWLY MANUFACTURED equipment, not to service. R-410A remains legal to produce for service use, legal to install in existing systems, and will be serviced for decades. You are not breaking any rule by recharging an R-410A system in 2030. You are breaking rules if you vent it, and you are creating a disaster if you put anything else in an R-410A system.

Oil: R-410A runs POE oil, covered below.

Refrigerant families and history: the ozone story, then the GWP story

The refrigerant in the cylinder has changed three times in living memory, and each change makes sense once you know the two environmental problems behind it.

CFCs: the originals. Chlorofluorocarbons, molecules built from chlorine, fluorine, and carbon. R-12 was the king: stable, non-toxic, non-flammable, cheap, and it cooled everything from car AC to refrigerators from the 1930s onward. The fatal flaw took fifty years to discover: CFCs are so stable they drift intact up to the stratosphere, where ultraviolet light cracks the chlorine off, and each freed chlorine atom catalytically destroys ozone molecules, on the order of one hundred thousand ozone molecules per chlorine atom. The ozone layer is the shield that blocks hard ultraviolet radiation. The Montreal Protocol, the 1987 international treaty on ozone-depleting substances, ended CFC production in the United States as of January 1, 1996.

HCFCs: the bridge. Hydrochlorofluorocarbons add hydrogen to the molecule, which makes it less stable, so most of it breaks down before reaching the stratosphere. Less chlorine delivered means less ozone destroyed, but not zero. R-22 was the residential AC workhorse for decades. Because HCFCs still carry chlorine, they were always a bridge: United States production of new R-22 ended in January 2020. Systems running R-22 survive on reclaimed supply only, and finding R-22 on a job is a flag that the equipment predates roughly 2010.

HFCs: the ozone fix. Hydrofluorocarbons contain no chlorine at all. Zero ozone depletion potential. R-134a took over automotive, and R-410A took over residential AC starting in the 2000s. Problem solved? The ozone problem, yes. But HFCs are strong greenhouse gases, and once refrigerants were scored by GWP, R-410A's number put a target on it. The Kigali Amendment to the Montreal Protocol and the AIM Act in the United States now phase HFC production down.

HFOs and the low-GWP era. Hydrofluoroolefins are fluorine-based molecules with a weak double bond that makes them fall apart in the lower atmosphere within days, so they trap almost no heat. R-1234yf is the flagship HFO. The mainstream residential answers are R-32 (an HFC, but with a much lower GWP of 675, used by Daikin and Goodman) and R-454B (a blend of R-32 and the HFO R-1234yf, GWP 466, used by Trane, RunTru, Carrier, Lennox, and York). The trade-off this generation accepted: mild flammability. That is the A2L story previewed below.

The pattern to remember: R-12 solved cooling and created the ozone problem. R-22 softened the ozone problem. R-410A eliminated the ozone problem and inherited the GWP problem. R-32 and R-454B shrink the GWP problem and introduce a flammability trade-off. Every generation is a compromise, and your career will probably see one more swing.

Refrigerant oils: mineral versus POE, and why moisture is the enemy

Refrigerant circulates with oil in it. The oil's job is to lubricate the compressor, but the refrigerant drags a little oil through the entire circuit, so oil and refrigerant must stay mixed and must return to the compressor. Oil and refrigerant are chosen as a pair.

- **Mineral oil** is refined from petroleum. It mixes properly with the old chlorine-bearing refrigerants, so R-12 and R-22 systems ran mineral oil.
- **POE (polyolester) oil** is a synthetic oil that mixes properly with HFCs and the new A2Ls. R-410A, R-32, and R-454B all run POE.

The pairing is not optional. HFC refrigerant in mineral oil will not carry the oil around the circuit; it settles out in the coils and the compressor starves. This is one of several reasons "drop-in" refrigerant swaps are a myth.

POE's dark side: it is hygroscopic. Hygroscopic means it actively pulls water vapor out of the air, and POE grabs moisture fast and holds it so tightly a vacuum pump struggles to pull it back out. Moisture inside a refrigeration circuit is poison: water plus refrigerant plus heat brews acid, acid attacks compressor motor windings, and free water can freeze into ice at the metering device and block it. Field discipline that follows directly from this chemistry: keep POE containers sealed until the moment of use, do not leave an opened system sitting open to air, cap line sets, and treat the filter drier (the moisture-absorbing cartridge in the liquid line) plus a deep vacuum as mandatory whenever a system is opened. Module C15 turns this into full procedure; F5's job is to make sure you know WHY the rules exist.

Cylinder basics

- A resting cylinder containing liquid refrigerant is saturated, so the PT chart predicts its pressure exactly from its temperature. This makes cylinders both your practice tool and your purity check: a cylinder reading far above chart pressure for its temperature contains air or the wrong product.
- **Do not trust paint color.** For decades each refrigerant had a signature color (R-22 green, R-410A rose) and techs grabbed bottles by color. The industry guideline changed: new refrigerant cylinders are now light gray-green (call it gray) across the board, with the refrigerant identified by the printed label and markings only. A2L cylinders add a red band or red marking to flag flammable contents, and they use left-hand thread connections so non-A2L equipment does not connect by accident. The only identification that counts is the label. Read it every time.
- Fill limit for recovery cylinders is 80 percent of capacity, because a liquid-full cylinder that warms up has no vapor space left and hydraulic pressure can rupture it.
- Never expose a cylinder to temperatures above 125 F and never heat one with a flame.

> **PHOENIX FIELD NOTE**
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> The 125 F cylinder limit is not a hypothetical here. A closed service van parked in the sun on a 115 F Phoenix afternoon can push interior temperatures past 140 F, and a cylinder is saturated, so its internal pressure climbs the PT curve the whole way up. Run the numbers: an R-410A cylinder at 125 F is sitting at 445 psig before anything has gone wrong. Store cylinders low in the truck, shaded, secured upright, and never in a sealed box that bakes. If a bottle has been riding in a hot truck, let it cool before you trust its pressure reading for anything diagnostic.

A2L preview: what is coming (full module is A31)

You will see the term A2L on new equipment, new cylinders, and new tools, so here is the orientation. Full handling procedures, tooling, sensor systems, and code requirements are Module A31, after you have charging and diagnostic skills to attach them to.

- A2L is an ASHRAE 34 safety classification: A means lower toxicity, 2L means lower flammability with low burning velocity. A2L refrigerants can ignite, but only from serious ignition sources like open flames, and they burn slowly, at less than about 10 centimeters per second of flame speed. Household items like light switches and static from your hand cannot ignite R-454B.

- R-454B and R-32 are the two A2Ls you will meet, in new equipment manufactured from 2025 on. A2L equipment is marked: flammability labels, and red-marked service ports.
- The two non-negotiables you need TODAY, even before A31: never put an A2L refrigerant into a system designed for R-410A (no retrofits, no drop-ins, prohibited and dangerous), and never mix refrigerants in a system or a cylinder, period. Mixing R-454B into R-410A creates oil and pressure problems and contaminates every machine that later touches that charge.
- A2L work requires A2L-rated tools (recovery machine, leak detector, hoses) and supplemental training. You will get both.

IB STANDARD

Island Breeze requires A2L supplemental certification (ESCO Institute or HVAC Excellence) before a tech touches 2025-or-newer A2L equipment, on top of EPA 608. Dispatch enforcement flags uncertified techs on A2L jobs automatically. Until you hold that card, your role on an A2L system is observation only.

PHOENIX FIELD NOTE

Get comfortable now with what hot-climate head pressure looks like on the PT chart, because Phoenix runs the right-hand edge of it. A textbook 95 F day condenses around 115 F, which is 390 psig on R-410A. A 115 F Phoenix afternoon pushes condensing temperatures toward 130 F and beyond, and the gauge climbs past 445 toward 500 psig on a system that is perfectly healthy. A new tech who learned "400 psig is high" from a mild-climate book will misdiagnose half the systems in this valley in July. Saturation math first, judgment second: convert the pressure to a condensing temperature, subtract the outdoor air temperature, and judge the SPLIT, not the raw pressure.

Common Mistakes

1. **Reading the wrong scale ring or menu setting.** The R-22 ring on an analog gauge and the R-22 menu choice on a digital manifold will both happily convert your R-410A pressure into a wrong temperature. Every saturation reading starts with confirming the refrigerant setting matches the nameplate.
2. **Treating every blend like a single fluid.** R-410A earned that treatment by being near-azeotropic. R-454B has glide, R-407C has serious glide, and blends as a class fractionate when vapor-charged. Learn each refrigerant's behavior; never assume.
3. **Leaving POE oil or an opened system exposed to air.** POE is hygroscopic and the moisture it grabs becomes acid and ice inside the circuit. Cap it, seal it, vacuum it. An open line set on a humid day is absorbing the seed of a future compressor failure.
4. **Topping off without identifying the refrigerant.** Unknown system history plus abnormal pressures means a possibly mixed or mystery charge. Adding more on top makes it worse and contaminates your gauges, hoses, and recovery cylinder. Nameplate first, label second, and when the charge is suspect: recover it, evacuate, and recharge with virgin refrigerant. Never top off a suspected mix.

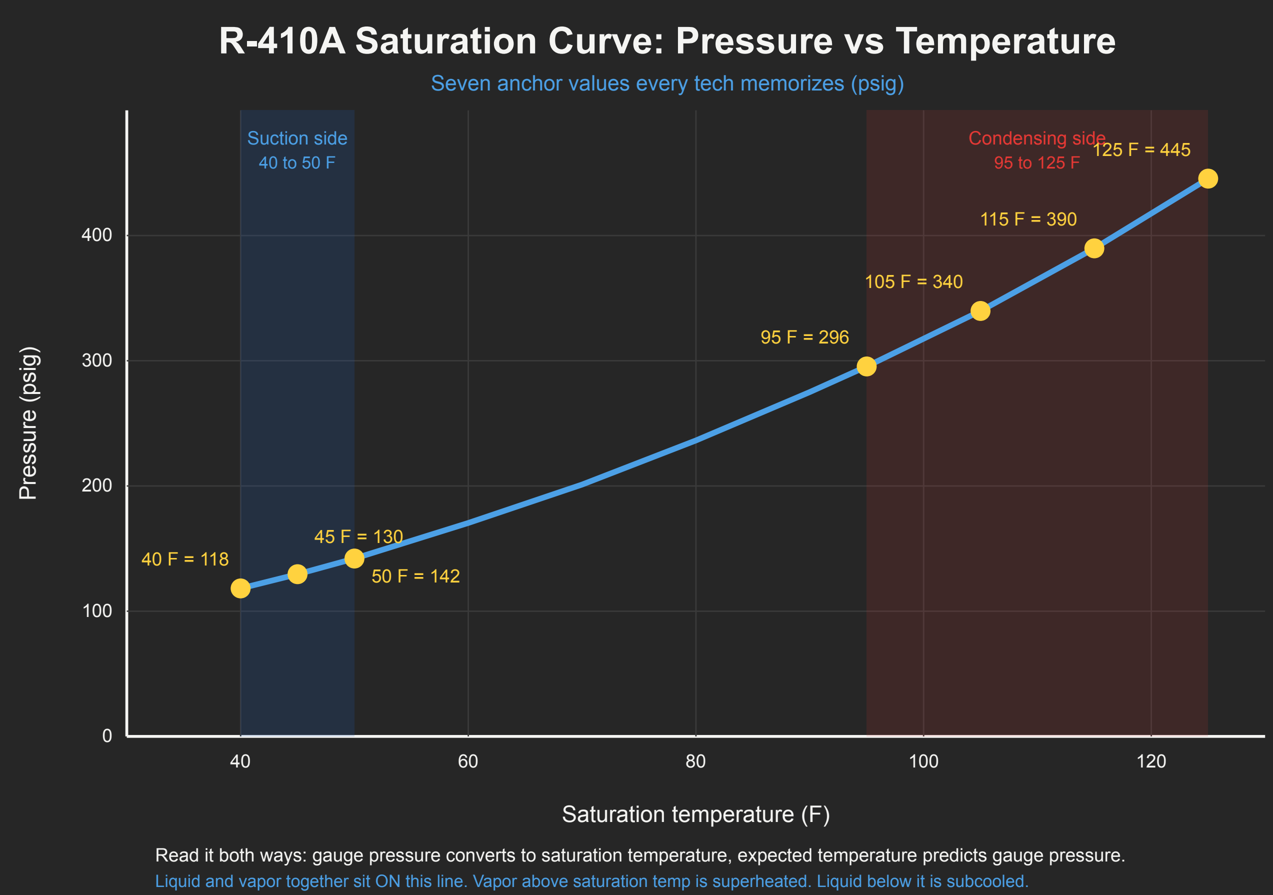
5. **Judging raw pressure instead of saturation temperature.** 445 psig means nothing by itself. 445 psig as "125 F condensing on a 95 F day" means trouble; the same 445 on a 118 F afternoon is close to normal. Convert first, judge second.

What Is Next

F6 takes the saturation temperatures you can now produce on demand and turns them into the two most important numbers in diagnosis: superheat and subcooling, measured on a live unit.

Module Visuals

1 R410A PT CURVE



2 REFRIGERANT FAMILY TIMELINE

Refrigerant History: Two Problems, Four Generations

First the industry fixed ozone depletion, now it is shrinking GWP

1930s — 1990s — 2000s — 2025+

CFC
R-12

Chlorofluorocarbon
Stable, safe, cheap

Ozone harm: SEVERE
Chlorine destroys ozone

GWP: very high

US production banned
January 1, 1996

Montreal Protocol 1987

HCFC
R-22

Adds hydrogen, breaks down before stratosphere

Ozone harm: REDUCED
Still carries chlorine

GWP: high

New production ended
January 2020

Reclaimed supply only

HFC
R-410A

No chlorine at all
50% R-32 + 50% R-125

Ozone harm: ZERO
Ozone problem solved

GWP: 1,924

No new equipment after
January 1, 2025

Service continues legally

Low-GWP A2L
R-32 and R-454B

R-32: single HFC, GWP 675
R-454B: R-32 + HFO
R-1234yf, GWP 466

Ozone harm: ZERO

GWP: 675 / 466

Trade-off: mildly flammable (A2L)

Full handling: module A31

Ozone depletion — severe, then reduced, then zero from HFCs onward

GWP — ignored at first, now the driving number: 1,924 down to 466

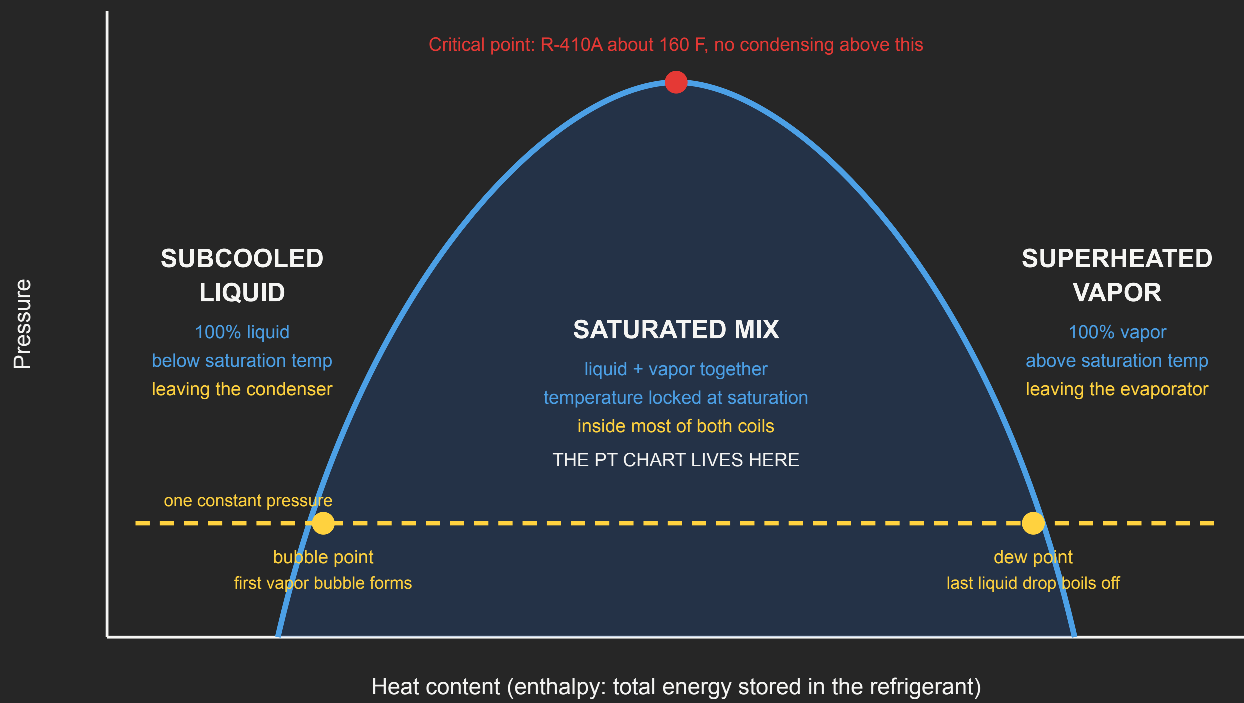
Pattern: each generation fixes the last generation's environmental problem and accepts a new trade-off.

Field rule that never changes: the refrigerants are NOT interchangeable. Nameplate and label decide, every time.

3 SATURATION DOME

The Saturation Dome: Three States, One Map

Where the refrigerant is liquid, vapor, or both at once



Pure fluids and R-410A: bubble and dew sit at one temperature. Blends with glide (R-454B, about 1.5 F): the two points split apart.

4 SAFETY CLASS LADDER

Refrigerant Safety Classes: The Flammability Ladder

ASHRAE Standard 34: letter = toxicity, number = flammability

A = lower toxicity, B = higher toxicity. 1 = no flame propagation, 2L = lower flammability with slow flame, 2 = flammable, 3 = highly flammable.
Every refrigerant in this course is class A: lower toxicity. The number is what changes.

increasing flammability ↑

A3
HIGHLY FLAMMABLE

Example: R-290 (propane)
Ignites easily, burns fast. Small charge limits.
Niche equipment only. Not residential split systems.

A2L
MILDLY FLAMMABLE

Examples: R-32 (GWP 675), R-454B (GWP 466)
Can ignite, but only from serious sources like open flame.
Burns slowly: flame speed under about 10 cm per second.
New equipment from 2025 on. A2L tools + training required (A31).
Cylinders: red marking, left-hand threads. Red service port marks.

A1
NO FLAME PROPAGATION

Examples: R-410A (GWP 1,924), R-22, R-12
Will not carry a flame. The installed base you service today.
Standard tooling. Flammability is not the hazard; pressure is.

Never put an A2L refrigerant into a system built for A1. No retrofits. No drop-ins. No mixing. Ever.

A2L handling procedures, sensors, and charge limits are covered in full in module A31.