ISLAND BREEZE TECHNICIAN CERTIFICATION PROGRAM

The Diagnostic Mindset and Process

MODULE D22 | DIAGNOSTICS | PREREQ C21

The scene: It is 4:40 PM in late June and the system is down. The homeowner met you in the driveway, talking before you got the door open. The house is 88 degrees, the kids are at grandma's, and somebody on the phone already told her it is "probably just the freon." You have a van full of parts, a gauge set, a meter, and about an hour of her patience. The fastest-feeling move is to grab the tool that matches her guess and start swapping. The fastest ACTUAL move is to slow down for ten minutes and run a process. This module is that process. It is the single most valuable thing in the entire Diagnostics track, because every test you will ever learn, electrical, refrigerant, airflow, combustion, only works when it is aimed by a method.

In C21 you learned to verify a healthy system without gauges: temperature split of 18 to 22F, a cold suction line around 45 to 60F, a liquid line 10 to 20F over ambient, all recorded after 10 to 15 minutes of runtime on a clean filter. Those numbers were the baseline. Diagnostics is what happens when the numbers come back wrong, or the system will not run long enough to produce them. The skill flips from "prove it is healthy" to "find exactly what is sick, prove it with a measurement, and fix only that." Same instruments. Completely different game.

Short Version

A split system is one machine wearing four costumes: an airflow system, a refrigerant circuit, a line-voltage electrical system, and a low-voltage control system. Faults routinely show their symptom in one costume and hide their cause in another, which is why guess-and-swap fails: the part you swapped was a victim, not the cause. The fix is a fixed sequence, the diagnosis funnel: capture the symptom in the customer's own words, survey the whole system before touching a tool, take measurements, form one written hypothesis, run a confirmation test that can prove the hypothesis wrong, repair, then verify with the same measurements that defined the fault. The iron rule inside the funnel is measurement before parts: no component is replaced without a reading that condemns it. The whole Diagnostics track exists to defeat four industry-wide failure patterns: calling low charge when the real fault is a TXV or airflow, replacing capacitors without finding what killed them, ignoring airflow entirely, and condemning compressors that are not dead. The data says the industry needs the help: surveys of more than 55,000 systems found the charge wrong on over 60 percent, and 95 percent of residential systems fail at least one basic diagnostic test. The tech who measures wins, every time, on every call.

Key Values

ITEM	VALUE	NOTES
Capacitor failure share	About 21 percent of AC service calls (52 of 242 logged calls)	Most common single fault; also the most commonly half-fixed one
Refrigerant leak location	About 80 percent of leaks are in the indoor A-coil	"Low charge" always means a leak; the leak is usually inside
Charge accuracy in the field	Over 60 percent of 55,000+ surveyed units had incorrect charge	NIST-cited survey; much of it is tech-added error, not factory error
Systems failing a diagnostic test	95 percent of residential systems fail at least one (charge, airflow, duct leakage, sizing)	Assume the system you walk up to has more than one thing wrong
Energy wasted by faulty operation	20 to 30 percent of HVAC energy	The cost of undiagnosed faults running for years
Indoor airflow fault cost	30 percent airflow restriction costs about 10 percent COP (NIST TN 1648)	Airflow faults are real capacity thieves, not background noise
Outdoor coil blockage cost	30 percent blockage: about 26 percent capacity, 24 percent COP lost (at 17F test)	Dirty coils punish harder than mild charge errors
Undercharge tolerance	Roughly 25 percent undercharge before COP drops 5 percent	Mildly "low" gauge readings rarely justify adding refrigerant
Liquid line restriction tolerance	No real performance penalty until about 48 percent restricted	A mild drier pressure drop is not the story; a starving TXV is different
Healthy temperature split	18 to 22F return minus supply, stabilized system	The C21 baseline; out of range starts the funnel, never ends it
Minimum stabilization runtime	10 to 15 minutes before performance readings	Readings from a just-started system are noise
Capacitor condemnation rule	More than 6 percent below rated microfarads	The model for every condemnation: a number, against a rating
Design airflow	400 CFM per ton nominal	Every refrigerant reading assumes it; verify before judging charge
TXV targets	Superheat 10F plus or minus 5; subcooling 8 to 12F unless nameplate differs	Memorize now; D24 teaches how to use them together

Field Checklist

The IB diagnostic flow. Every diagnostic call runs these steps in this order.

1. Intake at the door

- [ ] Let the customer talk first; write their exact words down
- [ ] Ask the six intake questions (what is it doing, when did it start, what changed, does it ever work, any sounds or smells or breaker trips, has anyone worked on it)
- [ ] Map their words to a fault family BEFORE touching the equipment, and hold it loosely

2. System survey, no tools yet

- [ ] Thermostat: mode, setpoint, display alive, call active
- [ ] Filter: pulled and judged; a loaded filter invalidates every later reading
- [ ] Air handler: blower running? Coil iced? Water in the pan? Float switch tripped?
- [ ] Outdoor unit: fan spinning? Compressor humming, silent, or short cycling? Coil condition? Breaker and disconnect position?
- [ ] Listen and smell at both units; thirty seconds of attention here saves thirty minutes later

3. Measurements

- [ ] Non-invasive first: temperature split, suction and liquid line temps, amp draws
- [ ] Escalate to invasive (gauges, wire-off electrical tests) only when the survey or the numbers justify it
- [ ] Record every reading as it is taken, not from memory in the truck

4. Hypothesis

- [ ] State one suspected fault, in writing, in the job record
- [ ] The hypothesis must explain ALL the evidence, not just the loudest symptom

5. Confirmation test

- [ ] Choose the one test that can prove the hypothesis WRONG
- [ ] A component is condemned only by a measurement against a published spec

6. Repair

- [ ] Fix the confirmed fault and its root cause, with the customer's approval, documented

7. Verification

- [ ] Rerun the measurements that defined the fault; healthy numbers, recorded
- [ ] Minimum 10 to 15 minutes of stabilized runtime before the final readings

8. Close-out

- [ ] All readings and the written hypothesis trail in ServiceTitan
- [ ] Full photo documentation per the close-out standard

IB STANDARD

The IB diagnostic flow is the sequence on every diagnostic call, every tech, every time: intake, survey, measure, hypothesize, confirm, repair, verify, document. The written hypothesis is not optional paperwork. It is the step that separates diagnosis from guessing, and it is what the next tech, the warranty claim, and the callback review all read. A call with a parts swap and no recorded readings is treated as an incomplete diagnosis regardless of whether the system happens to be cooling.

Full Breakdown

One machine, four costumes: system-first thinking

Recall the anatomy from the Core track: a split system is an evaporator and blower inside, a compressor and condenser outside, a metering device between them, and a thermostat running the show. The rookie mistake is to treat those as separate territories, the "refrigerant stuff," the "electrical stuff," the "duct stuff." The system does not work that way. It is one machine operating in four domains at once:

- **Airflow:** blower, filter, ductwork, both coils as air-side surfaces. Moves heat to and from the refrigerant.
- **Refrigerant circuit:** compressor, condenser, metering device, evaporator, the charge itself. Moves heat between the coils.
- **Line-voltage electrical:** contactor, capacitors, motors, compressor windings, the 240V supply. Powers the work.
- **Controls:** thermostat, 24V transformer, safety switches, boards, defrost and float circuits. Decides when work happens.

Here is the part that defines the entire Diagnostics track: a fault in one domain routinely shows its symptom in a different domain. The system is so interconnected that the place where you SEE the problem is frequently not the place where the problem LIVES.

Watch how it plays out:

- **An iced evaporator coil** looks like a refrigerant problem. It is just as often an airflow problem: a collapsed filter or a dead blower stops warm air from reaching the coil, the coil temperature falls below freezing, and ice grows. The ice is real. The "low charge" is a guess.
- **A dead run capacitor** looks like an electrical problem, and it is one, but a dirty condenser coil is often the killer: blocked fins drive head pressure up, amp draw up, cabinet temperature up, and heat is what cooks capacitors. Replace the capacitor and skip the coil, and you have scheduled your own callback.
- **A tripping breaker** looks like a compressor problem. Sometimes it is. It is also a weak capacitor forcing locked-rotor inrush, a shorted fan motor, or a wire rubbed bare against sheet metal, all of which are far cheaper than the conclusion "compressor's shot."
- **A "not cooling" complaint with everything running** looks like a charge problem. NIST's fault testing says a 30 percent indoor airflow restriction by itself costs about 10 percent COP and a meaningful slice of

filter or a crushed flex duct.

System-first thinking means you refuse to commit to a domain until the whole machine has been surveyed. The symptom buys you a starting suspicion, never a conclusion. Every module after this one teaches you deep tests inside one domain; this module teaches you to pick the right domain to go deep in.

The industry's report card, and why this module exists

You might assume that trained techs mostly get this right and the process is just polish. The measured reality says otherwise, and it is worth staring at, because these numbers describe the competition and the bar:

- A survey of more than 55,000 units found the refrigerant charge incorrect on over 60 percent of them.
- 95 percent of residential systems failed at least one diagnostic test: charge, evaporator airflow, duct leakage, or equipment sizing.
- Faulty operation wastes an estimated 20 to 30 percent of the energy HVAC consumes in homes.

Think about what the 60 percent number means. Systems leave the factory with a specified charge. Most of that error was added in the field, one well-meaning "topped it off" at a time, by techs treating gauge pressure as a verdict instead of a clue. The NIST fault testing makes the irony sharper: a system tolerates roughly 25 percent undercharge before its efficiency drops even 5 percent, and a liquid line restriction does essentially nothing until it is about half blocked. The faults that punish hardest in the NIST data are airflow and mechanical ones, the very faults gauge-first habits skip past.

This is also where the maintenance data from C21 reconnects. Capacitors are about 21 percent of all service calls, the single biggest slice, and 80 percent of refrigerant leaks hide in the indoor A-coil. Diagnostics is mostly not exotic. It is a small set of common faults, misdiagnosed in a small set of predictable ways. Learn the predictable ways and you are ahead of most of the industry on day one.

The diagnosis funnel

The funnel is the shape of every competent diagnosis: wide at the top, where every fault is still possible, narrowing stage by stage until exactly one confirmed fault remains. Seven stages. The discipline is refusing to skip ahead.

Stage 1: Symptom. The customer's report, in their words, written down. "Blowing but not cold." "Trips the breaker every afternoon." This is data, not noise; the intake section below turns it into a starting fault family.

Stage 2: System survey. Eyes, ears, nose, hands, on the whole machine, before any tool comes out. Thermostat calling? Filter loaded? Blower moving air? Outdoor fan spinning? Compressor humming or silent? Ice anywhere? Water anywhere? Burnt smell? The survey kills entire fault families in minutes. A spinning outdoor fan with a silent compressor is a completely different funnel than a totally dead condenser, and you learn which one you have without removing a single screw.

Stage 3: Measurements. Numbers, taken in escalating order of invasiveness, exactly as C21 trained: temperature split and line temps first, amp clamps next, gauges and wire-off component tests only when the evidence justifies them. Every reading recorded as taken.

Stage 4: Hypothesis. One sentence, written in the job record: "Suspect failed run capacitor, HERM section, secondary to heavily fouled condenser coil." A real hypothesis names the fault AND accounts for all the evidence. If your hypothesis explains the warm supply air but not the breaker trip, it is not done.

Stage 5: Confirmation test. The single test that can prove the hypothesis wrong. Capacitor hypothesis: microfarad reading against the rating, condemned beyond minus 6 percent. This is the stage that separates diagnosis from storytelling, and it deserves its own section below.

Stage 6: Repair. Fix the confirmed fault and its root cause, with approval, documented. Root cause matters: the capacitor AND the coil cleaning, or you only treated the symptom of the symptom.

Stage 7: Verification. The funnel ends where C21 began: a stabilized system, 10 to 15 minutes of runtime, and the same measurements that defined the fault now reading healthy, recorded. "It's blowing cold now" is not verification. A 19F split, 14.1 amps against an 18.9 RLA, and a 52F suction line are verification.

Two properties make the funnel powerful. First, it is cheap insurance: stages 1 and 2 cost ten minutes and no parts, and they prevent the expensive wrong turn at stage 6. Second, it is honest: because the hypothesis is written BEFORE the confirmation test, you cannot quietly rewrite history when the test surprises you. The funnel turns being wrong into a normal, recoverable step, loop back to stage 3 with new data, instead of a buried mistake riding out of the driveway in a customer's invoice.

Measurement before parts

Here is the iron rule of the entire track, and it has no exceptions: **never replace a component without a reading that condemns it.**

A condemning reading is a measurement, compared against a published specification, that the component fails. The capacitor model from F8 and C21 is the template: rated 45 MFD, floor at minus 6 percent is 42.3, measured 38.9, condemned, photographed, replaced. Every component you will ever condemn follows the same grammar: a number, against a spec, recorded. Windings against the manufacturer's resistance and megohm specs (D23 and D26). Charge against superheat and subcooling targets (D24). Airflow against static pressure tables (D25). The specs change; the grammar never does.

The opposite of measurement before parts has a name in the trade: the parts cannon. Swap the capacitor; still broken. Swap the contactor; still broken. Swap the board; works now, maybe, for a while. The parts cannon sometimes lands a hit, which is exactly what makes it dangerous: it teaches the tech that guessing works, right up until a compressor gets condemned on a guess.

Why the rule holds even when you are "sure":

1. **Confident guesses are wrong constantly.** The 60 percent wrong-charge statistic is a monument to confident guessing. A capacitor can look perfect, no bulge, no leak, and be stone dead; it can look ugly and measure fine. Appearance proves nothing. Symptoms overlap. Only the number knows.
2. **An unmeasured swap destroys the evidence.** Replace a part without testing it and you have spent the customer's money on a coin flip AND lost the reading that would have told you where the real fault was.
3. **The reading is the warranty trail.** "Compressor megohm reading condemned against spec, photo attached" survives a warranty review and a callback dispute. "Tech believed compressor was bad" survives neither.

4. **The reading catches the root cause.** The measurement that condemns a part is usually taken close enough to the scene to show you the killer: the condemned capacitor sitting in a cabinet behind a fouled coil, the failed blower motor downstream of a collapsed filter. Swappers see parts; measurers see stories.

There is one honest-sounding objection: "measuring takes longer." On one call, sometimes, by minutes. Across a week it is not close, because the parts cannon pays its time back in callbacks, second trips, and warranty returns of parts that were never bad. The measured diagnosis is the fast one. It just front-loads the work.

> **IB STANDARD**
>
> At Island Breeze, the condemning reading goes in ServiceTitan before the replacement part goes in the system: the measured value, the spec it failed against, and a photo of the meter on the component. No reading, no replacement. This applies with extra force to compressors: a compressor is never condemned on symptoms alone, and the full test sequence it must fail first is the subject of D26.

Symptom intake: the diagnosis starts at the door

Recall from C21 that the customer intake aimed your maintenance inspection. On a diagnostic call the intake is worth even more, because the customer has been living with the fault. They have observed it for days or weeks under conditions you cannot reproduce in one visit. Their vocabulary is not technical, but it is honest, and their words map to fault families with surprising reliability.

Ask six questions, in roughly this order, and write the answers down before touching the unit:

1. **What is it doing, in your words?** Do not interrupt, do not translate yet. "It blows but it's not cold" and "nothing comes on at all" are different funnels from the first sentence.
2. **When did it start, and was it sudden or gradual?** Sudden points electrical or mechanical: something broke. Gradual points at fouling, leaks, and wear: something is fading. A leak at the A-coil announces itself over weeks; a capacitor dies between lunch and dinner.
3. **What changed around the same time?** A storm (capacitor failures cluster after thunderstorms), a power outage, a new filter, a remodel, a new thermostat, landscapers around the condenser. The fault often has a birthday and a cause living together.
4. **Does it ever work?** Always-broken and sometimes-broken are different families. "Fine in the morning, quits by afternoon" is a heat-sensitive fault, usually electrical: a marginal capacitor or motor that survives at 85F ambient and fails at 110F.
5. **Any sounds, smells, ice, water, or breaker trips?** Each one is a flag: hum-then-click at the condenser, burning smell at the air handler, ice on the big line, water at the secondary drain, a breaker that needs resetting.
6. **Has anyone worked on it recently?** The most diplomatic and most important question. Recent work means recent hands, and recent hands are a leading cause of loose wires, wrong charge, and parts that do not match the nameplate. This includes our own hands; check the job history.

Then map their words to fault families. The map is a starting bias for the survey, never a verdict:

CUSTOMER SAYS	FIRST-SUSPECT FAULT FAMILY	AND KEEP IN MIND
"Blowing, but not cold"	Refrigerant circuit or outdoor unit electrical	Verify the outdoor unit is actually running before anything else
"Nothing happens at all"	Controls and power: thermostat, 24V, breaker, float switch	A tripped float switch is a controls symptom with a condensate cause
"I saw ice on it"	Airflow first, then charge	Ice is a symptom, never a root cause; thaw before diagnosing
"Quits in the afternoon heat"	Heat-sensitive electrical: capacitor, marginal motor	Catch it failed, or heat-soak it; it will pass tests at 8 AM
"Trips the breaker"	Line-voltage electrical: shorted motor, compressor, wiring	Reset once to observe, never twice; D23 takes it from there
"Runs all the time, never catches up"	Capacity loss: fouled coils, airflow, slow leak, or just a 115F day	In a Phoenix heat wave, long runtime alone is not a fault
"Some rooms are hot"	Airflow and ducts	Refrigerant cannot fix a duct problem; D25 territory
"Water on the floor / ceiling stain"	Condensate system	C21 already trained this one end to end
"It hums, then clicks off"	Capacitor or locked rotor	The classic capacitor presentation, the 21 percent club
"It's never been right since [event]"	Whatever family the event touched	The event is evidence; treat the date as part of the symptom

The intake earns its minutes twice. Once at the start, aiming the survey. And once at the end, because the verification step has to answer the symptom the customer actually reported. A system with a perfect split that still leaves the back bedroom hot did not get fixed; it got serviced.

PHOENIX FIELD NOTE

Phoenix loads the intake in three specific ways. First, the afternoon-failure pattern is epidemic here: a capacitor or motor that is marginal at 90F fails at 112F, so "works in the morning" in June is a heat-sensitive electrical flag until proven otherwise, and a part that passes your test at 9 AM has not been proven healthy for 4 PM. Second, monsoon season stacks faults: storm surges kill capacitors and boards, storm dust loads condenser coils, and storm humidity spikes condensate volume, so an August call can honestly have three birthdays in one week. Third, the customer's urgency is real: an extended outage in a Phoenix summer is a health event, especially for elderly customers, and the pressure to "just get it cooling" peaks exactly when shortcut diagnostics are most tempting and most expensive. The funnel is how you move fast without guessing: ten disciplined minutes, then certainty.

The four failure patterns

The entire Diagnostics track is organized around four misdiagnosis patterns. They are not rookie quirks; they are the standing failure modes of the whole industry, visible in the national data and in the second-opinion calls you will run on other companies' work. Each pattern gets named here and defeated in depth by a later module. Memorize them as a set: when a diagnosis is going wrong, it is almost always going wrong in one of these four directions.

Pattern 1: Misreading the charge. The tech connects gauges, sees low suction pressure, declares "low on freon," and adds refrigerant. But low suction pressure has three parent faults, not one: an actual undercharge, a restricted or failing TXV feeding the coil too little, and low airflow feeding the coil too little heat. All three produce similar gauge readings; only the full set of measurements, superheat, subcooling, pressures, temps, and amps read together, tells them apart. Add charge to an airflow or TXV fault and you have made the system worse and the diagnosis harder. This is the engine behind the 60 percent wrong-charge statistic, and remember the NIST tolerance finding: a system shrugs off roughly 25 percent undercharge before losing even 5 percent efficiency, so mildly odd pressures almost never justify the hose and the top-off. **D24 teaches the charge misdiagnosis triangle and the full read-everything-together method.**

Pattern 2: Capacitors without root cause. Capacitors are the most-replaced part in the trade, 21 percent of calls, and the most under-diagnosed. A capacitor that died young usually had help: a fouled condenser coil cooking the cabinet, a dragging fan motor overloading it, chronic voltage problems, or storm surge. The tech who swaps the capacitor and leaves has fixed the part and shipped the killer, and the new capacitor inherits the same death sentence. The capacitor swap is the beginning of that diagnosis, not the end: the question "what killed it" must be asked and answered on every capacitor call. **D23 teaches capacitor testing WITH root cause analysis, plus motors, boards, and 24V circuit tracing.**

Pattern 3: Ignoring airflow. Airflow is the invisible domain: no gauge port, no spark, no hiss, so weak techs skip it. The data says skipping it is expensive: NIST measured about a 10 percent COP loss from a 30 percent indoor airflow restriction, and a 30 percent blocked outdoor coil cost about a quarter of the system's capacity in their testing. Dirty filters, matted blower wheels, fouled coils, crushed flex, closed registers, and undersized returns are everywhere, 95 percent of systems fail at least one such test, and airflow faults are the great impersonators: they fake low charge on the gauges and "weak compressor" on the thermometer. Airflow gets verified BEFORE the refrigerant circuit gets judged. Always. **D25 teaches static pressure diagnosis and the full airflow workup.**

Pattern 4: Condemning healthy compressors. The compressor is the most expensive component and the scariest call, which warps judgment around it. A compressor that will not start might be a failed capacitor. A silent compressor might be sitting on its internal thermal overload, which after a hard afternoon can need hours to reset, plenty of time for a hasty tech to declare it dead. A breaker trip might be a shorted fan motor on the same circuit. Compressor manufacturers have reported for years that a large share of returned "failed" compressors test fine, condemned healthy and cut out anyway. The rule from this module applies at maximum strength: a compressor is condemned only by the full measured test sequence, never by symptoms, silence, or fear. **D26 teaches winding tests, megohm benchmarks, and the Copeland functional checks.**

These four patterns share one root: each one substitutes a plausible story for a measurement. The funnel and the measurement-before-parts rule are the antidote to all four at once, which is why this module is the gateway:

master the mindset here, and D23 through D29 are tools added to a working method, instead of rituals bolted onto guesswork.

Verification and close-out: the call is not done until it is proven and written

The last two funnel stages deserve their own habits, because they are where good diagnoses go to die.

Verification is re-measurement, not vibes. Whatever readings defined the fault, those same readings, taken on the repaired and stabilized system, are what close the call. The system gets its 10 to 15 minutes of runtime, exactly as C21 drilled, and then: the split back inside 18 to 22F, the amps back under nameplate, the suction line back to cold-drink cold. The verification readings also answer the original symptom in the customer's words: the afternoon-failure system gets an extended runtime test or a documented plan, the hot back bedroom gets checked at the bedroom register. And the numbers go in the record, where they become the baseline the next tech, possibly you, diagnoses against next year.

Documentation is the diagnosis made permanent. Every reading, the written hypothesis, the condemning measurement with its photo, and the verification numbers, all in ServiceTitan before you leave.

> **IB STANDARD**
>
> Diagnostic calls close to the same 8-photo ServiceTitan standard as every Island Breeze job, with the diagnostic additions: the meter on the condemned component, the component's nameplate, the root cause finding, and the verification reading at close. The full close-out standard, photo by photo, plus how to walk a customer through findings without jargon, is the subject of D30. For now the rule is simple: if it was measured, it is in the record; if it was condemned, there is a photo of why.

Where the track goes from here

This module deliberately stops at the method. The deep tests live ahead, and pointing at them is part of the map:

- **D23 Electrical Diagnostics:** the hopscotch method, motor and board diagnosis, 24V circuit tracing, and capacitor root cause. The staged-fault practical begins there; D22 has no practical because mindset is examined on every later bench.
- **D24 Refrigerant Circuit Diagnostics:** the charge misdiagnosis triangle, and reading superheat, subcooling, pressures, temps, and amps as one picture, with the NIST fault sensitivities as the backbone.
- **D25 Airflow Diagnostics:** static pressure, duct restrictions, blower problems, and dirty coil detection.
- **D26 Compressor Diagnostics:** the full condemnation sequence, megohm benchmarks, and the Copeland functional checks.
- **D27 through D29:** leak detection mastery, gas furnace diagnostics, heat pump diagnostics, each one the funnel applied to a specialty.
- **D30:** the diagnostic call as a professional performance: intake, explanation, documentation, close-out.

Every one of those modules assumes the funnel is already running in your head. Learn it here, on paper, while nothing is broken, because the first time you really use it, somebody's house will be 88 degrees and climbing.

Common Mistakes

1. **Diagnosing from the symptom's domain.** Ice means refrigerant, breaker means compressor, warm air means charge: each of these reflexes is wrong about as often as it is right, because faults cross domains. The survey covers the whole machine before any domain gets the deep dive.
2. **Gauges first.** Connecting gauges before checking the filter, the blower, and the coils reads the refrigerant circuit through an airflow fault, and produces the exact misreadings that built the 60 percent wrong-charge statistic. Non-invasive measurements come first, every call, and C21 already taught you why every connection costs charge and core life.
3. **Firing the parts cannon.** Replacing parts in order of cheapness until the symptom stops is not diagnosis, and the customer pays for every miss. No reading, no replacement. Ever.
4. **Skipping the written hypothesis.** An unwritten hypothesis quietly mutates to match whatever the tech did. Writing one sentence before the confirmation test is the cheapest integrity check in the trade.
5. **Treating the capacitor swap as the whole repair.** The new capacitor works and the killer, a fouled coil, a dragging motor, chronic voltage trouble, stays on site. Every capacitor call answers two questions: is it dead, and what killed it.
6. **Condemning anything in a hurry, compressors most of all.** A thermal-overload-tripped compressor looks dead for hours and tests open at the wrong terminals. The expensive conclusion requires the full measured sequence, not the loudest symptom of the worst afternoon.
7. **Quitting at "it's cooling now."** Without verification readings on a stabilized system, you do not know that it is fixed, and without the record, nobody else ever will. The funnel ends at recorded numbers, not at cold air from a register.
8. **Steamrolling the intake.** The customer watched this fault for two weeks; you get one afternoon. Talking past them throws away the cheapest evidence on the call, and answering a complaint they did not make is how a technically perfect repair becomes a callback anyway.

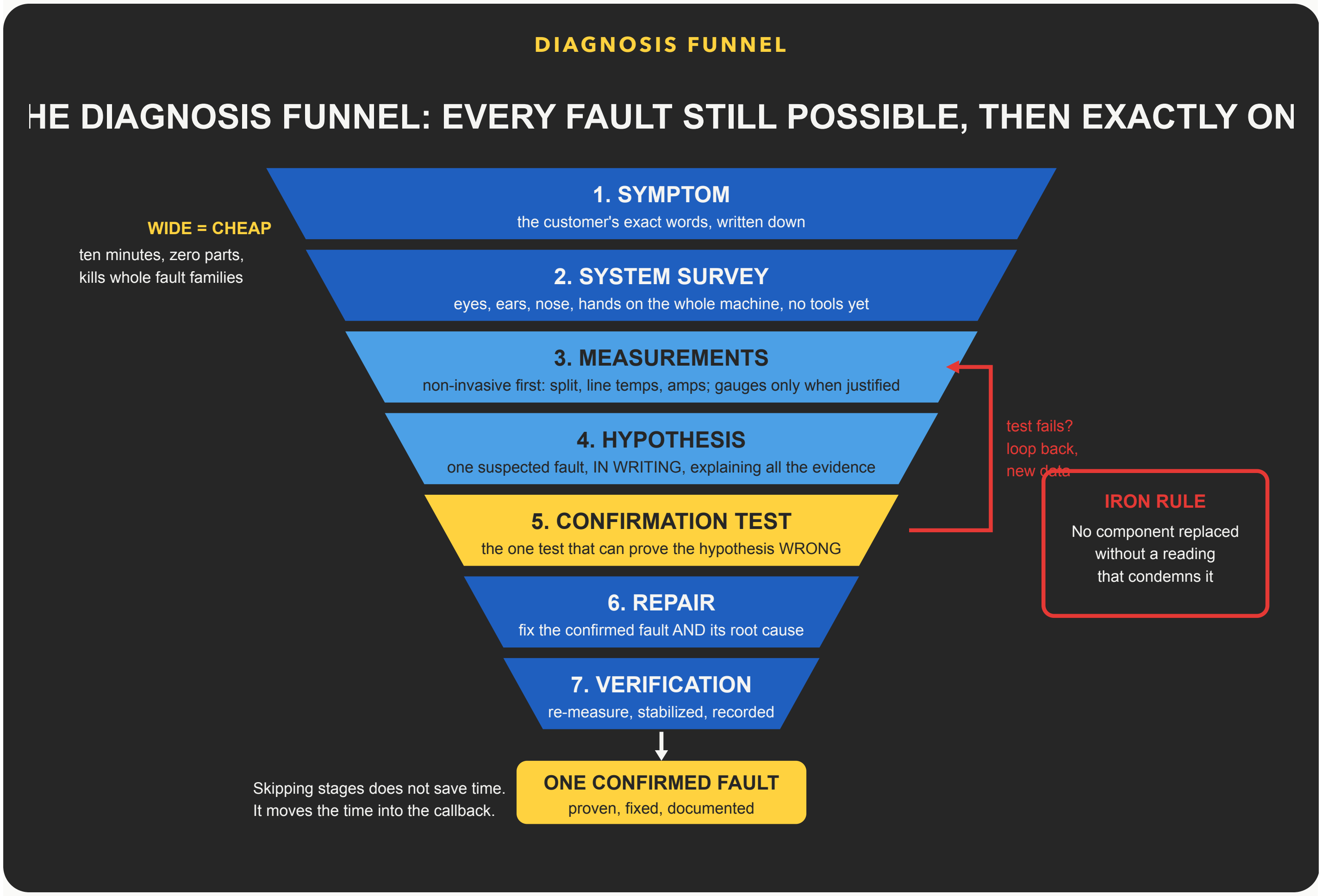
Next module: D23, Electrical Diagnostics, where the funnel gets its first full toolbox: capacitor testing with root cause analysis, motor and board diagnosis, and tracing a 24V circuit like you built it.

DARREL FIELD WISDOM (to be recorded)

1. Tell the story of the call that taught you measurement before parts: the time you, or a tech you were working with, replaced a part on a confident guess and got burned. What did the miss cost, and what changed in how you work afterward?
2. You run second opinions on other companies' diagnoses. What is the misdiagnosis you see most, the "low on freon" call, the condemned compressor that was not dead, something else, and how do you break the news to a homeowner who already paid for the wrong answer?
3. Walk through a call where the customer's words at the door cracked the case, a detail in how they described the symptom that pointed you somewhere the readings alone would not have gone, or would have reached much slower.

4. Describe a compressor you almost condemned, or watched someone condemn, that turned out to be healthy. What saved it, and what is your personal rule before you will ever write the word compressor on a diagnosis?
5. It is the seventh call of a 115F July day and everyone, including you, wants the shortcut. What do you actually do, in your head and with your hands, to keep running the full sequence when you are tired, behind, and the customer is begging for fast?

Module Visuals



FOUR FAILURE PATTERNS

THE FOUR FAILURE PATTERNS THIS TRACK EXISTS TO DEFEAT

1. MISREADING THE CHARGE

Low suction pressure has THREE parent faults: real undercharge, a starving TXV, low airflow. Topping off the wrong one makes it worse.

Charge wrong on over 60% of 55,000+ units.
~25% undercharge before COP even drops 5%.

Antidote: read everything together.

D24

2. CAPACITORS WITHOUT ROOT CAUSE

A capacitor that died young had help: fouled coil, dragging motor, surge. Swap the part, ship the killer, schedule your own callback.

Capacitors: 21% of all service calls.
The most replaced AND most under-diagnosed part.

Antidote: always ask what killed it.

D23

3. IGNORING AIRFLOW

No gauge port, no spark, so weak techs skip it. Dirty coils, loaded filters, crushed flex, and duct static fake low charge on the gauges.

30% airflow restriction = ~10% COP (NIST).
30% blocked outdoor coil = ~26% capacity.

Antidote: verify airflow BEFORE judging charge.

D25

4. CONDEMNING HEALTHY COMPRESSORS

A silent compressor may be on its thermal overload for hours. A breaker trip may be the fan motor. Fear condemns; meters acquit.

A large share of returned "failed" compressors test fine at the factory.

Antidote: full measured sequence, never sympto

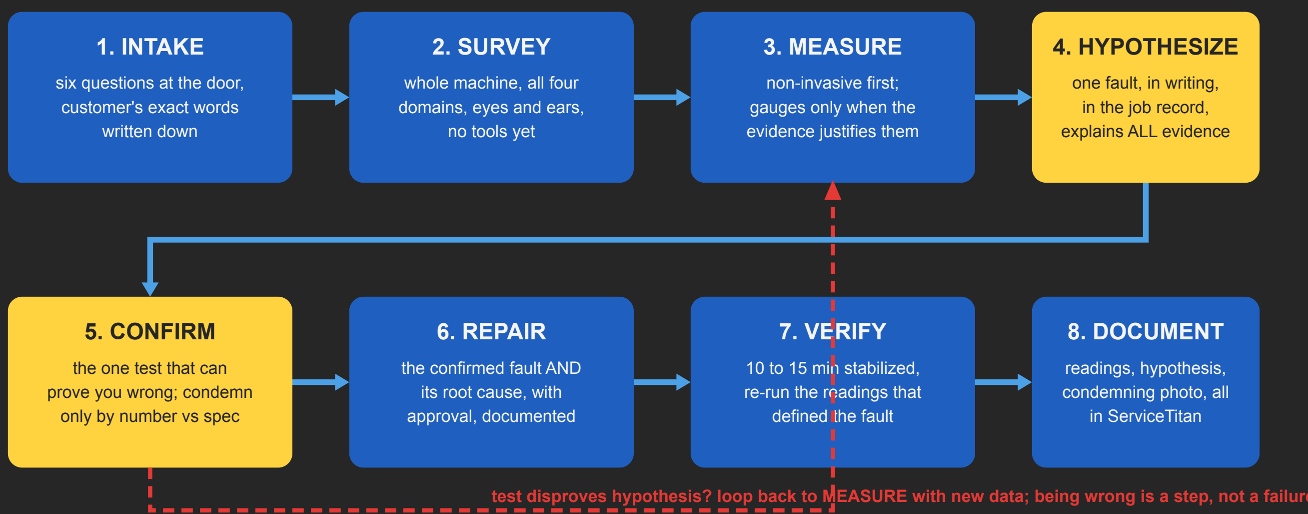
D26

All four patterns share one root: a plausible story substituted for a measurement.

The funnel plus "no reading, no replacement" defeats all four at once.

IB DIAGNOSTIC FLOW

THE IB DIAGNOSTIC FLOW: EVERY CALL, EVERY TECH, EVERY TIME



IRON RULE

No reading, no replacement. A condemnation is a measured value, against a published spec, with a photo of the meter on the part.

CLOSE-OUT

IB 8-photo ServiceTitan standard, plus the condemned part, its nameplate, the root cause, and the verification reading. Full detail: D30.

SYMPTOM INTAKE CARD

SYMPTOM INTAKE: THE SIX QUESTIONS AND THE FAULT-FAMILY MAP

ASK AT THE DOOR, WRITE EVERY ANSWER

1. What is it doing, in your words?
listen first, do not translate yet

2. When did it start, sudden or gradual?
sudden = broke; gradual = fouling, leak, fade

3. What changed around the same time?
storm, outage, new filter, new stat, remodel

4. Does it ever work?
"fine mornings, quits afternoons" = heat-sensitive

5. Sounds, smells, ice, water, breaker trips?
each one is a flag pointing at a domain

6. Has anyone worked on it recently?
recent hands cause loose wires and wrong charge

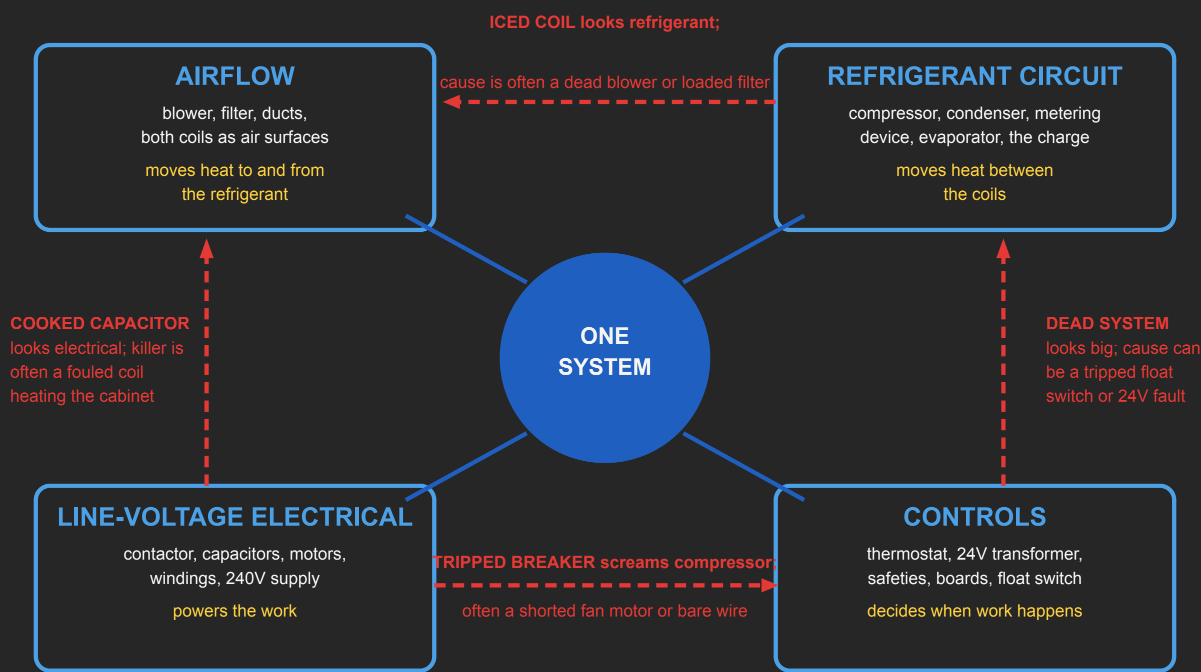
The customer watched this fault for weeks.
You get one afternoon. Their words are the cheapest evidence on the call.

THEIR WORDS	FIRST SUSPECT
"Blowing, but not cold"	refrig. or outdoor elec.
"Nothing happens at all"	controls and power
"I saw ice on it"	airflow first, then charge
"Quits in the afternoon heat"	heat-sensitive electrical
"Trips the breaker"	line-voltage electrical
"Runs all the time, never catches up"	capacity loss family
"Some rooms are hot"	airflow and ducts
"Water on the floor / ceiling stain"	condensate system
"It hums, then clicks off"	capacitor / locked rotor
"Never been right since [event]"	whatever the event touched

THE MAP IS A STARTING BIAS, NEVER A VERDICT
Survey all four domains anyway. Verification must answer the customer's words at the end of the call.

SYSTEM FIRST MAP

ONE MACHINE, FOUR DOMAINS: THE CAUSE HIDES NEXT DOOR



RULE: survey all four domains before going deep in any one.

The symptom buys a suspicion. Only a measurement buys a conclusion.