ISLAND BREEZE TECHNICIAN CERTIFICATION PROGRAM

Compressor Diagnostics

MODULE D26 | DIAGNOSTICS | PREREQ D25

The scene: 2:15 PM, 111F, and the condenser in front of you is silent. The customer already got one opinion this morning: "compressor's shot, you need a new system." You put your hand on the compressor shell and it is hot enough to fry an egg. The contactor pulls in, the fan spins, and the compressor does nothing. Your meter reads OL from common to run AND common to start. Open windings, right? Dead compressor, right? Wrong, or at least not proven. That hot shell is hiding a tripped internal overload, and the OL reading you just took is the overload talking, not the windings. Give that compressor ninety minutes with a water mist on the shell and it will ohm out perfect and run for five more years. This module is about the difference between a compressor that IS dead and a compressor that LOOKS dead, because the most expensive diagnostic mistake in residential HVAC is condemning a healthy compressor.

D25 gave you the electrical chain discipline: voltage proven at the load, contactor proven, capacitor measured, before any verdict on the load itself. This module aims that discipline at the biggest, most expensive, most condemned load in the system. You will learn what a scroll compressor's three terminals should read, what its internal protectors do, how to read insulation resistance with a megohmmeter, how Copeland says to functionally check a scroll, and the fixed test sequence that stands between you and failure pattern 4: condemning healthy compressors.

Short Version

A compressor is condemned by a documented test sequence, not by "it won't start." Most "dead" compressors are something else: a failed run capacitor (about 21 percent of all AC calls), low voltage, a tripped internal overload on a hot shell, or a protector doing its job after a system fault. The sequence: verify the capacitor by measured microfarads, verify voltage (a 208-230V scroll must see at least 197V running and is only guaranteed to start at 187V), cool the shell and retest if the overload is open, consider the IPR and TOD (a scroll with its internal pressure relief venting or its thermal disc tripped looks dead and is not), ohm the windings cold (C to S plus C to R should equal S to R), and take a megohm reading to ground with pressure in the shell, never under vacuum. Only after every step is documented with photographed readings does the word "condemned" leave your mouth. The compressor that fails this sequence is truly dead, and the one that passes just saved the customer a system and saved you a reputation.

Key Values

ITEM	VALUE	NOTES
Copeland scroll IPR opening point	550 to 625 psid discharge to suction differential	Internal pressure relief vents discharge gas back to suction; protects against deadheading
Copeland scroll TOD trip point	290F internal discharge gas temperature	Therm-O-Disc; shell must cool before normal operation returns
External discharge line limit	Cut off before the line reaches 260F; 250 to 275F is the danger zone	Measured 6 inches from the compressor on the discharge line
Minimum suction pressure, cooling	55 psig, never lower for more than a few seconds	Below this the scrolls overheat and drive bearings fail early
Low pressure control setting, AC only	Cutout no lower than 55 psig	95 psig prevents evaporator icing; heat pumps may go to 20 psig
Single phase voltage window (208-230V)	Guaranteed start at 187V; must hold at least 197V running; range 197 to 253V	Verify voltage AT the compressor terminals under load
Locked rotor amps (LRA)	Roughly 6 times or more the running amps, lasting 100 to 300 ms on a normal start	Continuous LRA followed by a click means the motor is not turning
Running amps tolerance	More than plus or minus 20 percent off published performance curves indicates a problem	Pull the curve for the exact model; nameplate RLA is a ceiling, not a target
Three phase current imbalance	Over 20 percent leg to leg indicates a problem	Check for single-phasing and supply issues first
Winding resistance math, single phase	C to S plus C to R equals S to R (within meter tolerance)	C to R is lowest (run winding), C to S is higher (start winding)
Copeland ZP20K5 to ZP31K5 three phase windings	Intentionally unequal resistance, up to 30 percent leg to leg	Compare to published values before condemning; unequal does NOT mean shorted on these models
Megohm pass band	100 megohms or more is strong; 20 to 100 megohms passes	Taken at 500V DC with refrigerant pressure in the shell
Megohm caution band	5 to 20 megohms: document and trend; 0.5 to 5 megohms: serious caution, warm the oil, run and retest, acid test	Cold refrigerant dissolved in oil lowers readings; do not condemn on one cold reading in this band
Megohm condemn band	Below 0.5 megohm with corroborating evidence; 0 ohms to ground is a grounded winding, condemned	Corroborate with tripped breakers, burned oil smell, acid test

ITEM	VALUE	NOTES
Megohm under vacuum	NEVER	Thin gas inside an evacuated shell can arc and destroy healthy motor insulation
Internal overload reset time	Minutes to several hours on a hot shell	OL from C to both S and R, with S to R intact, is the overload signature
Shell temperature during faults	Top shell can exceed 350F	Burn hazard; also the reason hot-shell winding tests lie
Capacitor rule (recall)	Replace beyond minus 6 percent of rated microfarads	Capacitor verification is step one of the compressor sequence

Field Checklist

The false condemnation checklist. Run it in order on every "dead compressor" call, and do not skip steps because you are confident. Confidence is how healthy compressors get condemned.

Before touching the compressor

1. Power off, verified dead, capacitor discharged through a bleed resistor (F1, F8 habits).
2. Photograph the wiring at the contactor, capacitor, and compressor terminals before pulling anything.
3. Hand near the shell (do not grab it): hot shell means the overload may be open and your winding readings may lie.

Step 1: Capacitor verified

1. Wires off, meter on capacitance mode, read HERM section against rating.
2. Apply the rule: more than 6 percent below rating fails. Replace and retest the system before any compressor verdict.

Step 2: Voltage verified

1. Power restored, call for cooling. Voltage at the load side of the contactor with the compressor trying to start: at least 197V on a 208-230V unit, 187V minimum during the start attempt.
2. Voltage sagging hard at start with a good capacitor: check connections, contactor drop (over 5V across closed contacts fails), and supply.

Step 3: Overload cooled

1. If the shell is hot and windings read open from common: kill power, cool the shell (shade, time, a gentle water mist on the shell, never on terminals or electrical parts), and retest. Budget up to several hours.
2. While it cools, find out WHY it overheated: dead condenser fan, dirty coil, low charge, short cycling.

Step 4: IPR and TOD considered

1. Evidence of deadheading (condenser fan out, blocked coil) or discharge temps near 260F means the IPR may have vented and the TOD may have tripped. Both reset with cooling. Neither is a failed compressor.

Step 5: Windings tested cold

1. Power off, verified dead, wires off the compressor terminals. Ohm C to R, C to S, S to R.
2. Healthy: C to R lowest, C to S higher, the two should sum to S to R. OL on one winding with the other two intact: open winding. All three near zero or far below published values: shorted. OL from C to both with S to R intact: that is the overload, go back to Step 3.

Step 6: Megohm read

1. Megohmmeter at 500V DC, one lead on a winding terminal, one on clean bare metal (scrape paint at a service valve braze or designated shell point).
2. System under refrigerant pressure, never under vacuum.
3. Read against the ladder: 20 megohms and up passes, 0.5 to 20 needs context and trending, below 0.5 condemns only with corroboration, 0 to ground condemns.

Then, and only then: the verdict

1. Run the functional check if it will run: gauge response, amp draw against the published curve, discharge line temperature.
2. Document every reading with photos in the job record. The verdict is the last line of the story, never the first.

> **IB STANDARD**
>
> No compressor is condemned at Island Breeze without the full six step sequence in the ServiceTitan job record: photographed capacitor reading, voltage reading under load, shell temperature or overload state note, winding ohms (all three pairs), megohm reading with test voltage stated, and amp draw if it runs. Every reading photographed, every photo attached before the verdict is entered. A condemnation without the sequence is an incomplete diagnosis, and it gets reopened.

Full Breakdown

Failure pattern 4: the condemned innocent

The diagnostics track is organized around the ways diagnoses go wrong, and this module attacks the most expensive one: condemning a compressor that is not dead. It happens for understandable reasons. The compressor is sealed, so you cannot look inside. It is the biggest load in the system, so when nothing runs, suspicion lands on it. Its protective devices shut it down in ways that perfectly imitate death. And on a 111F afternoon with a sweating customer, "it needs a compressor" ends the uncomfortable conversation fast.

But walk the math of what that mistake costs. A wrongly condemned compressor means a replacement compressor or a replacement system that fixes nothing, because the real fault (the weak capacitor, the starved airflow, the low charge) is still there waiting for the new equipment. It means a warranty claim that the manufacturer's teardown will deny when the returned compressor tests fine, and manufacturers do tear them down. Copeland has published functional check doctrine for decades precisely because a large share of compressors returned under warranty have nothing wrong with them. Every one of those returns started with a tech who skipped the sequence.

So here is the frame for everything that follows: the compressor is innocent until a documented test sequence proves it guilty. Your job on a no-start call is to run the trial, not to deliver the sentence.

What is inside the can

You learned the scroll's job in the core track: two spiral plates, one orbiting against the other, squeezing suction gas toward a center discharge port. Around that mechanism, a hermetic compressor (hermetic means the motor and the compression mechanism share one welded steel shell, cooled by the refrigerant itself) carries everything you will be testing today:

- **The motor windings.** On single phase, a run winding and a start winding joined at a common point, brought out to the three terminals you know from F8: C (common), R (run), S (start). The run capacitor sits in series with the start winding, full time, PSC style.
- **The internal overload.** A temperature and current sensitive protector buried in the motor, wired in series with the common terminal. When motor temperature or current goes too high, it opens, and everything downstream of common goes dead. This one device causes more false condemnations than any other, and it gets its own section below.
- **The IPR valve.** The internal pressure relief valve watches the pressure difference between discharge and suction. If that differential climbs to 550 to 625 psid, the valve opens and vents hot discharge gas back to the suction side inside the shell. This is the compressor's defense against deadheading (pumping against a blocked or fanless condenser with nowhere for the pressure to go).
- **The TOD.** A Therm-O-Disc, a bimetal disc that reacts to discharge gas temperature. When internal discharge gas exceeds 290F, the TOD trips and the compressor shuts down until things cool. The TOD is the backstop for overheating events the IPR makes worse: vented 550 psid discharge gas is very hot, and recirculating it spikes internal temperature fast.
- **The scroll set and bearings.** The mechanical heart. Scroll tips and bearing surfaces are what slugging, flooding, and overheating actually destroy.

Notice what that list means diagnostically: a scroll compressor carries three separate devices whose entire purpose is to shut the compressor down and make it look dead while protecting it from a SYSTEM problem. The overload, the IPR, and the TOD are messengers, exactly like the safety switches in F8. Condemning the compressor because a protector operated is shooting the messenger.

Winding tests: ohming C, S, and R

Power off, verified dead, capacitor discharged, all three wires off the compressor terminals. Photograph first. Then ohm the three pairs.

What healthy reads. The run winding (C to R) is wound with heavier wire and reads the lowest resistance, often around 1 to 4 ohms on residential scrolls. The start winding (C to S) is finer wire and reads higher, often 2 to 8 ohms. And because R to S is a path through both windings in series, **C to R plus C to S should equal S to R** within your meter's tolerance. That sum check is the signature of a healthy single phase motor and it costs you ten extra seconds. Use a quality meter and zero your leads, because at these low resistances, lead resistance and corroded terminals can add a misleading ohm.

Open winding. OL (infinite resistance) across one pair that should read low. A true open run or start winding means a broken conductor inside the motor, and there is no repair: that compressor is condemned, IF the reading is real. Two things fake it. The first is the internal overload, covered next. The second is bad contact: a burned terminal, a corroded spade, your probe on the insulation. Clean, press, retest before you believe any OL.

Shorted winding. Resistance far below the published value for that model, or a sum check that does not add up, means turn to turn shorts: insulation between adjacent loops of wire has broken down and current is shortcutting the winding. Symptoms upstream: high amp draw, breaker trips, overload cycling. A short between the two windings shows the same way in the sum math. Confirm against published winding resistance for the exact model when the numbers are marginal; "it reads kind of low" is not a verdict.

Grounded winding. Continuity from any terminal to the shell. On your ohmmeter, ANY reading to clean bare shell metal is bad news, but here is the limit of the ohmmeter: it tests with a few volts and only catches insulation that has already failed completely. Insulation that is failing, that breaks down only under real operating voltage, reads OL on an ohmmeter and fails at 240V. That is why the ground test that counts is the megohm test, two sections down.

Three phase footnote for light commercial work. Three phase compressors have three identical-looking windings with no start capacitor, and two traps. First, single-phasing: lose one supply leg and a three phase motor hums, will not start, and draws high amps on the remaining legs. The compressor is fine; the supply is broken. Second, Copeland ZP20K5 through ZP31K5 three phase models have **intentionally unequal winding resistances, up to 30 percent leg to leg**. A tech who expects three equal readings condemns these healthy compressors for "a shorted winding." Compare to the published values for the model before any verdict. Also remember from the core track that a miswired three phase scroll runs backward, makes no pressure differential, and trips its overload: under an hour of reverse running does no damage, fix the phasing and move on.

The internal overload trap

This is the single most common way healthy compressors die on paper. Burn the mechanism into memory.

The internal overload sits **in series with the common terminal, inside the shell**. When it opens, the path from C to the windings is broken. Your meter now reads:

- C to R: OL
- C to S: OL
- S to R: normal resistance (the two windings in series are still intact, the overload is not in that path)

That pattern, **open from common to both terminals with S to R intact, is not an open winding. It is a tripped overload, and a tripped overload is a temporary condition.** A motor with a genuinely open winding shows OL on one winding pair while the other pair still reads to common, or fails the sum check; it does not politely disconnect common from everything at once. The overload does exactly that, by design.

The overload opened because the motor got too hot or pulled too much current: locked rotor attempts from a dead capacitor, low voltage, deadheading, low charge starving the motor of cool suction gas. The shell may be far too hot to touch (during fault conditions the top shell can exceed 350F). And here is the part that ruins diagnoses: **the overload cannot reset until the motor cools, and on a hot shell on a hot day that takes anywhere from minutes to several hours.** A tech who ohms a hot compressor, reads OL to common, and writes "open windings, condemned" has just failed this module. Kill the power so it stops cooking, cool the shell, retest. If C to R and C to S come back when the shell is cool, the windings were never open.

While it cools, do the real work: something tripped that overload. Dead condenser fan? Filthy coil? Capacitor at minus 15 percent? Charge low enough to starve the cooling of the motor (D24's territory)? Find it, or the new start will end the same way.

> **PHOENIX FIELD NOTE**
>
> Phoenix is the false condemnation capital of America for exactly this reason. A compressor shell sitting in direct sun inside a 115F ambient cabinet sheds heat slowly, so internal overloads that would reset in 45 minutes in a mild climate can hold open for two or three hours here. Crews who do not know the trap diagnose "open windings" all summer. Shade the cabinet, mist water on the shell (shell only, never the terminal box or wiring), go handle the airflow and electrical findings you already have, and retest before you leave. The second opinion that saves a Phoenix customer's compressor is usually just a cooler shell and a tech who waited.

Megohm testing: insulation resistance

Your ohmmeter pushes a few volts through what it measures. The compressor motor lives at 240V, with spikes beyond that at every start. Insulation that is aging, wet, or contaminated with acid can hold off a 9V meter test all day and break down the moment real voltage hits it. The instrument that finds failing insulation before it fails completely is the **megohmmeter** (a "megger"): it applies a high DC test voltage, 500V DC for our work, and measures the leakage current through the insulation to ground, displayed as resistance in megohms (millions of ohms). Higher is better: more megohms means less current sneaking through the insulation.

How to take the reading. Power off, verified dead, capacitor discharged, all wires off the compressor terminals. One megohmmeter lead on a winding terminal, the other on clean bare shell metal or an unpainted service valve surface; scrape to bright metal, because paint and oxide fake high readings. Apply the 500V test and let the reading settle. Test each terminal to ground. Use 500V DC on hermetic compressors, not the 1000V range; the motor shares its shell with refrigerant and oil, and the higher test voltage adds risk without adding diagnostic value here.

Two absolute rules before any benchmark:

1. **Never megohm a compressor, or any part of a system, while it is under vacuum.** Inside an evacuated shell there is no dense gas to insulate the spaces between motor parts, and a high voltage test in that thin atmosphere can arc across internal clearances and destroy perfectly healthy insulation. This is the same physics behind the core track rule about never starting a compressor in a deep vacuum. Megohm with refrigerant pressure in the shell, or with the system at a nitrogen holding charge, never at 500 microns.
2. **A cold hermetic compressor reads lower than the motor deserves.** Refrigerant dissolves into the oil, and refrigerant-laden oil conducts better than dry insulation, so a cold soaked compressor can read in the low megohms with nothing wrong. Readings rise as the compressor runs and the oil warms and outgasses. This is why the caution bands below demand a warm retest before any verdict.

The ladder. Read your result against this:

- **100 megohms and up:** strong, healthy insulation. Pass.
- **20 to 100 megohms:** normal for a compressor with years on it. Pass.
- **5 to 20 megohms:** caution. Nothing is condemned here, but something is going on: moisture in the system, contaminated oil, insulation aging. Document the reading, check the system's moisture history (was it evacuated to 500 microns at install?), and trend it at the next visit. A reading that holds at 12 megohms for three years is a personality; a reading that fell from 80 to 12 in one season is a trajectory.
- **0.5 to 5 megohms:** serious caution, not a verdict. First question: is the compressor cold soaked? Run it if it will run, warm the oil, retest. Pull an oil or refrigerant acid test. A reading in this band on a warm compressor with acid in the oil is a motor on its way out; the same number on a cold shell at 7 AM may be refrigerant dilution and nothing more.
- **Below 0.5 megohm:** condemn territory, with corroboration. Pair the reading with evidence: breaker or GFCI trips, a burned electrical smell in recovered refrigerant, failed acid test, megohm reading still on the floor after warming.
- **Zero, or continuity on a plain ohmmeter to ground:** grounded winding. The insulation has failed to the shell. Condemned, full stop, and the system gets treated as a burnout: recovery, filter driers per the core track burnout procedure, and an investigation into what cooked it.

One more discipline point: the megohm reading is one line of the story, not the whole story. A compressor is condemned electrically by grounded windings, a true open winding, or shorted windings confirmed against published values, with the megohm reading as supporting evidence. It is never condemned by a single cold 2 megohm reading and a hunch.

The Copeland functional check: when it runs but you doubt it

Now the other half of the craft: the compressor starts and runs, and the question is whether it is actually pumping, or the compressor will not start and you need to know whether a protector is holding it down. Copeland publishes a functional check doctrine for scrolls, and its first commandment is about what you must NOT do:

Never close the suction service valve to "see how low it pulls." That old reciprocating-compressor trick starves a scroll of the suction gas that cools its motor and lubricates its bearings, and it will damage a scroll in seconds. The same physics sets the operating floor you already know: **never run a scroll below 55 psig suction for more than a few seconds** in cooling service. A scroll is checked with the system as its load, never against a closed valve, and never with the compressor used as a vacuum pump.

The legitimate sequence, in order:

1. **Voltage.** Correct supply at the unit, at least 197V holding on a 208-230V single phase scroll, 187V minimum available during the start attempt, measured at the load side under load. All other voltages: within plus or minus 10 percent of nameplate.
2. **Wiring and switchgear.** Connections tight, contactor contacts proven (the D25 and F8 tests), capacitor measured. You did these in steps 1 and 2 of the sequence; the functional check assumes them.
3. **Overload state.** Open overload on a hot shell: cool and wait, as above.
4. **Fans.** Condenser and indoor fans running. A scroll behind a dead condenser fan is minutes from an IPR and TOD event.

5. **Gauge response.** Gauges on, compressor energized. A pumping compressor pulls suction down and pushes head up within seconds. Watch what the needles say: - **Pressures separate normally, amps near the curve:** the compressor pumps. Whatever the complaint is, it is not the compressor. - **Pressures barely separate, amp draw well below the published curve, compressor sounds smooth:** low compression. The scroll set is damaged or worn, or the compressor is running in reverse (three phase). On single phase with correct rotation, sustained low compression with low amps is the one pattern that legitimately condemns a runner. Confirm: correct charge in the system first (D24 rules apply; a system with almost no refrigerant in it also makes weak pressures), then verdict. - **Pressures equalized, compressor running, amps low, and it just went through a high head event:** suspect the IPR is venting. Remove the cause of the high head before judging the compressor.
6. **Amps against the curve.** Pull the published performance data for the exact model and compare running amps at your operating condition. More than plus or minus 20 percent off the curve indicates a problem. Nameplate RLA is a maximum rating for sizing wire and protection; the curve is the diagnostic reference.
7. **Discharge temperature.** Clamp a probe on the discharge line about 6 inches from the shell. Approaching 250 to 275F is the danger zone, and protective shutdown should be happening before the line hits 260F. A compressor running that hot has a system problem feeding it: low charge, high compression ratio, return gas too warm.

IPR and TOD: the compressor that plays dead

Put the two internal protectors together and you get the scenario this module opened with, so walk it end to end.

A condenser fan motor dies on a July afternoon. The compressor keeps pumping into a coil that cannot reject heat, head pressure climbs, and the discharge to suction differential hits the IPR's 550 to 625 psid window. The IPR opens and vents discharge gas straight back to suction inside the shell. Catastrophe avoided: pressure stops climbing. But that vented gas is brutally hot, and recirculating it sends internal discharge temperature through the TOD's 290F trip point in short order. The TOD trips. The motor circuit opens. The compressor stops.

Now you arrive. The condenser fan is obviously dead, you find that in two minutes. You replace the fan motor, call for cooling, and the compressor does not start. The shell is scorching. Windings read OL from common. Every instinct says the compressor died with the fan motor.

It did not. It protected itself, twice, exactly as designed. The TOD and the overload need the shell to cool before they reset, and on a Phoenix afternoon that is an hour or three. The IPR closed again on its own as soon as the differential fell. **A scroll with the IPR venting or the TOD tripped looks exactly like a dead compressor and is not.** Cool it, retest the windings, restart it, run the functional check, and write down all of it.

The flip side of the same coin: protectors that operated are telling you the system hurt the compressor. Document the event and the cause. Repeated IPR and TOD trips are not a lifestyle a compressor survives long term; each event cooks the oil a little. Fix the cause, note the history, and set expectations honestly in the record.

Mechanical failure modes: how compressors actually die

Compressors are condemned electrically (grounded, shorted, truly open) or mechanically. The mechanical modes matter because every one of them has an upstream cause that will kill the replacement too if you do not name it.

- **Failed scroll set (low compression).** The scroll tips are damaged or worn past sealing. The signature is the functional check pattern: runs smooth, pressures will not separate, amps well below the curve. Cause it by slugging, by overheating events that cooked the oil, or by long term flooding that washed the bearings until the scrolls ran out of true. On reciprocating compressors the same condition is called failed valves and shows the same way: weak pressures, low amps, and on a recip you may also see suction and discharge pressures equalize fast on the off cycle.
- **Bearing failure.** Drive bearings starve when oil is diluted by liquid refrigerant or carried away during floodback, and when low suction pressure (below 55 psig) overheats the works. The path is noise, rising amps, then locked rotor: the compressor hums at locked rotor amps, the overload trips, repeat. Before you call locked rotor, remember that a dead run capacitor produces the same hum and trip on a perfectly good motor. Capacitor first, always.
- **Slugging.** Liquid refrigerant or a slug of oil arrives at the scrolls while running. Liquid does not compress, and something gives: scroll tips, recip valves. Slugging is violent and audible, a knocking rattle at start or during operation. Upstream causes: massive floodback from a stuck-open TXV or gross overcharge, or a flooded start after off-cycle migration.
- **Flooding and flooded starts.** The slow version of the same poison. Liquid refrigerant migrates to the shell during the off cycle (refrigerant always condenses at the coldest point, and at 2 AM that is often the compressor), dilutes the oil, and the next start runs the bearings on solvent instead of lubricant. Continuous floodback during running does the same damage on a schedule. The fixes live upstream: correct charge, working crankcase heater where one is required, accumulator on the systems that need one, TXV doing its job. This is D24's territory and the recall matters here: **when a compressor dies of slugging or flooding, the compressor is the victim, not the cause.** Replace it without fixing the charge-side problem and you will replace it again.
- **Overheating death.** Chronic low charge or restricted suction runs the compressor below 55 psig, return gas comes back too warm and too thin to cool the motor, oil breaks down, and the motor insulation cooks until the megohm ladder catches it or the windings short. Again D24: the undercharge was the disease, the compressor failure was the symptom.

The teardown habit: when you do condemn a compressor and swap it, the old one is evidence. Note what the oil looked like coming out (dark and burned smelling means overheating or burnout; treat the system accordingly with the burnout drier procedure from the core track). The autopsy is what keeps the new compressor alive.

The verdict: a documented sequence or nothing

Everything above collapses into one professional discipline, the false condemnation checklist:

1. **Capacitor verified.** Measured microfarads against rating, minus 6 percent rule.
2. **Voltage verified.** Under load, at the unit, against the 187/197/253 window.

3. **Overload cooled.** Hot shell plus OL to common means wait, cool, retest. Always.
4. **IPR and TOD considered.** Any high head or overheating event in the story means the protectors are suspects before the motor is.
5. **Windings tested cold.** All three pairs, sum check, compared to published values when marginal.
6. **Megohm read.** 500V DC, pressure in the shell, never under vacuum, judged against the ladder with the cold-oil caveat.

THEN the verdict, with every reading photographed and recorded. Not before. A compressor that fails this sequence is dead and you can stand behind the call in front of the customer, the manufacturer's warranty teardown, and your own boss. A compressor that passes it just survived the most dangerous moment of its life: the moment a tech in a hurry almost wrote it off.

One boundary to point forward: everything in this module assumes a single speed PSC scroll on contactor control, which is most of what Phoenix runs today. Inverter driven variable speed compressors are a different animal: the drive electronics sit between your meter and the motor, winding readings and amp behavior follow different rules, and condemning them has its own sequence. That is module A33 in the advanced track. Do not apply today's ohm expectations to an inverter compressor.

Common Mistakes

1. **Ohming a hot compressor and condemning "open windings."** OL from common to both terminals with S to R intact is a tripped internal overload, and it can take hours to reset on a hot shell. Cool it and retest. This single mistake is most of failure pattern 4.
2. **Skipping the capacitor because "the compressor is obviously locked."** A dead run capacitor makes a healthy compressor hum at locked rotor amps and trip the overload, a perfect locked rotor impression. Capacitors are about 21 percent of all AC service calls. Measure it first, every time.
3. **Megohm testing under vacuum.** High test voltage in an evacuated shell can arc internally and destroy healthy insulation, turning a diagnostic into an execution. Pressure in the shell first, always.
4. **Condemning on a single cold megohm reading in the caution band.** Refrigerant dissolved in cold oil drags readings down. Warm the oil, retest, acid test, then judge. Below 0.5 megohm needs corroboration; only a true ground (zero) is a one-reading verdict.
5. **Closing the suction service valve to "test the pump."** That test damages a scroll in seconds and proves nothing. The functional check is gauges, amps against the published curve, and discharge temperature, with the system as the load.
6. **Condemning a three phase Copeland for unequal winding resistances.** ZP20K5 through ZP31K5 models are built with up to 30 percent leg to leg difference on purpose. Compare to published values. And when a three phase unit hums and trips, check for single-phasing before blaming the motor.
7. **Replacing a slugged or flooded compressor without fixing the upstream cause.** The stuck TXV, the overcharge, the dead crankcase heater that killed the first compressor is patiently waiting for the second one. The compressor autopsy and the D24 charge-side diagnosis are part of the job.

8. **Verdict without documentation.** "Compressor's bad, trust me" does not survive a warranty teardown or a second opinion. Six steps, photographed readings, then the verdict.

DARREL FIELD WISDOM (to be recorded)

1. Tell the story of a compressor you saw condemned (by someone else, or almost by you) that turned out to be healthy. What had actually happened, what did the retest show, and what did the save mean for that customer?
2. Walk through your own closest call: a time you were one signature away from condemning a compressor and something made you run one more test. What was the test, and what is your personal tripwire now?
3. What has slugging and flooding damage taught you about root cause? Describe a compressor autopsy that changed how you diagnosed the system around it.
4. On a Phoenix summer afternoon, how do you actually manage the cool-down wait on a tripped overload: what do you tell the customer, what do you work on while you wait, and how long have you seen one take to reset?
5. What does a compressor sound like in its last season? Give the rookies your ear training: the start rattle, the hum that is not quite right, the sounds that send you for the clamp meter and the megohmmeter.

Module Visuals

FALSE CONDEMNATION CHECKLIST

THE FALSE CONDEMNATION CHECKLIST

A compressor is condemned by a documented test sequence, not by "it won't start." Six steps, in order, every time.

STEP 1: CAPACITOR VERIFIED

Wires off, capacitance mode, HERM section vs rating. Replace beyond minus 6%.
About 21% of all AC calls are this part. A dead cap fakes a locked rotor perfectly.

STEP 2: VOLTAGE VERIFIED

At the load side, under load. 208-230V scroll: 197V minimum holding, 187V start floor.
Check contactor drop (over 5V across closed contacts fails) and connections.

STEP 3: OVERLOAD COOLED

Hot shell + OL from common to both terminals + normal S to R = open overload.
Kill power, cool the shell, retest. Reset can take HOURS. Find what overheated it.

STEP 4: IPR AND TOD CONSIDERED

Any high head or overheat event in the story? IPR opens at 550 to 625 psid, TOD trips at 290F. A scroll riding its protectors looks dead and is not. Both reset with cooling.

STEP 5: WINDINGS TESTED COLD

All three pairs, wires off. C to R lowest, C to S higher, the two sum to S to R.
Compare marginal numbers to published values for the exact model.

STEP 6: MEGOHM READ

500V DC, terminal to bright bare metal, pressure in the shell, NEVER under vacuum.
20 megohms and up passes. Low cold readings get a warm retest before judgment.

THEN, AND ONLY THEN: THE VERDICT

Every reading photographed in the job record before "condemned" is spoken or written.

WHY IT EXISTS

Failure pattern 4: condemning healthy compressors.

A wrong condemn buys the customer a new compressor and keeps the real fault: the weak cap, the dead fan, the low charge.

Warranty teardowns find a large share of returned compressors have nothing wrong with them.

THE FRAME

The compressor is innocent until the sequence proves it guilty. You run the trial, you do not deliver the sentence first.

Skipped steps are how innocents die.

Inverter driven compressors follow a different sequence: module A33. Do not apply these ohm expectations to a drive controlled motor.

FUNCTIONAL TEST SEQUENCE

THE SCROLL FUNCTIONAL CHECK

Diagnosis by voltage, wiring, overload state, fans, gauge response, and amps against the published curve.

1. VOLTAGE AT THE UNIT

208-230V single phase: at least 197V holding, guaranteed start at 187V, range 197 to 253V. Others: nameplate +/- 10%.

2. WIRING, CONTACTOR, CAPACITOR

Connections tight. Contactor proven (over 5V drop fails). Capacitor measured: replace beyond minus 6% of rating.

3. OVERLOAD STATE

Hot shell + OL from common = open overload, not open windings. Cool the shell and retest. Budget hours.

4. FANS RUNNING

Condenser and indoor fans both proven. A scroll behind a dead condenser fan is minutes from an IPR and TOD event.

5. GAUGE RESPONSE

Energize. A pumping scroll pulls suction down and pushes head up within seconds. Watch the needles, then the amps.

6. AMPS AGAINST THE PUBLISHED CURVE

More than +/- 20% off the curve = problem. Three phase imbalance over 20% = problem. RLA is a ceiling, not a target.

7. DISCHARGE LINE TEMPERATURE

Probe 6 inches from the shell. Danger zone 250 to 275F; cutoff should act before the line reaches 260F.

WHAT THE RUN TELLS YOU

Pressures separate, amps near curve:
PUMPING. The compressor is not your problem.

Pressures barely separate, amps WELL below curve, runs smooth: LOW COMPRESSION, failed scroll set.
Confirm charge first (D24), then condemn.

Equalized after a high head event, amps low: suspect IPR venting. Fix the cause, then judge.

NEVER DO THESE TO A SCROLL

1. Close the suction service valve to "see how low it pulls." Damages a scroll in SECONDS.
2. Run below 55 psig suction for more than a few seconds: overheated scrolls, early bearing death.
3. Use the compressor to evacuate a system, or start it in a deep vacuum: internal arcing risk.

The system is the load. Test it as a system.

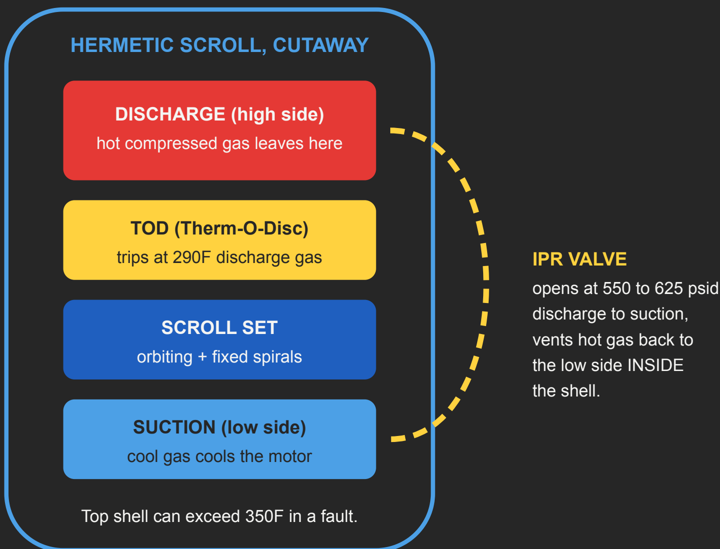
NUMBERS TO KNOW COLD

IPR opens: 550 to 625 psid differential
TOD trips: 290F internal discharge gas
Minimum suction in cooling: 55 psig
Locked rotor amps: about 6x running, 100 to 300 ms
Amp tolerance: +/- 20% of the published curve

Steps 1 through 4 clear the suspects around the compressor. Steps 5 through 7 put the compressor itself on the stand.

IPR AND TOD: THE COMPRESSOR THAT PLAYS DEAD

Two internal protectors that shut a scroll down, imitate death, and reset on their own when the shell cools.



THE DEADHEAD STORY

1. Condenser fan dies on a July afternoon. Heat has nowhere to go. Head pressure climbs.

2. Differential hits 550 to 625 psid. IPR opens, vents discharge to suction. Pressure stops climbing.

3. Recirculated gas is brutally hot. Internal discharge passes 290F. TOD trips. Compressor stops.

4. You arrive: hot shell, OL from common, no start. Every instinct says dead compressor.

5. Fix the fan. Cool the shell. TOD and overload reset. Windings retest perfect. It runs.

A SCROLL WITH THE IPR VENTING OR THE TOD TRIPPED LOOKS DEAD AND IS NOT.

Both reset with cooling. Reset takes minutes to hours on a hot Phoenix shell. Retest before any verdict.

The protectors are messengers: each trip says the SYSTEM hurt the compressor. Find and fix the cause, document the event, and remember that repeated IPR and TOD trips cook the oil a little every time.

Condemning a compressor because a protector operated is shooting the messenger.

THE MEGOHM LADDER: INSULATION TO GROUND

500V DC test, terminal to clean bare metal, refrigerant pressure in the shell. Higher reading = healthier insulation.

100 MEGOHMS AND UP
Strong, healthy insulation.
PASS

20 TO 100 MEGOHMS
Normal for a compressor with years on it.
PASS

5 TO 20 MEGOHMS
Moisture, contamination, or aging. Check evacuation history.
CAUTION: document and TREND at next visit

0.5 TO 5 MEGOHMS
Cold oil soaked with refrigerant reads low on a HEALTHY motor. Warm the oil, run it, retest. Pull an acid test.
SERIOUS CAUTION: never condemn on one cold reading here

BELOW 0.5 MEGOHM
Condemn territory WITH corroboration: breaker trips, burned oil smell, failed acid test, still low after warming.

ZERO (continuity to ground)
GROUNDED WINDING. CONDEMNED. Treat system as a burnout.

NEVER UNDER VACUUM
An evacuated shell has no dense gas to insulate the motor internals. 500V in thin gas can ARC across clearances and destroy healthy insulation.

Megohm with refrigerant or nitrogen pressure in, never at 500 microns.

TEST SETUP
Power off, verified dead. Capacitor discharged. Wires OFF the terminals. Scrape to bright metal for the ground lead: paint and oxide fake high readings.

WHY 500V, NOT 9V
An ohmmeter tests at a few volts and only catches dead shorts. The motor lives at 240V plus start spikes.

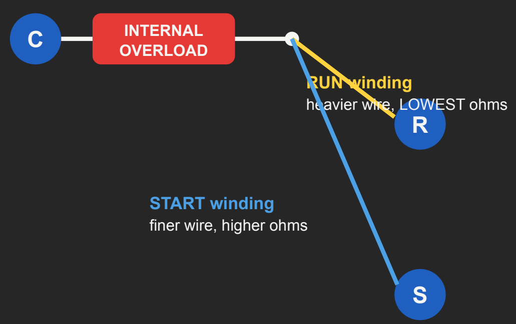
Use the 500V DC range on hermetic compressors, not the 1000V range.

The megohm reading is one line of evidence, not the whole verdict. Pair it with windings, history, and an acid test.

WINDING TEST MAP: C, S, R

Power off, verified dead, capacitor discharged, wires OFF the terminals. Photograph first.

INSIDE THE SHELL (single phase scroll)



Overload sits in series with C, INSIDE the can.

HEALTHY = THE SUM CHECK

C to R (lowest) + C to S (higher) = S to R

Example: 1.9 + 3.4 = 5.3 ohms

Zero your leads. Clean terminals. Compare marginal numbers to published values for the exact model.

THREE PHASE TRAPS (light commercial)

Copeland ZP20K5 to ZP31K5: windings are UNEQUAL on purpose, up to 30 percent leg to leg. Compare to published values before condemning.

Hums + high amps on two legs = single-phasing. Miswired rotation = no differential, overload trips. **The supply is the suspect, not the motor.**

WHAT THE PATTERNS MEAN

OPEN WINDING: one pair reads OL, others intact
Broken conductor. Clean terminals, retest, then condemn.

SHORTED: far below published value, sum fails
Turn to turn shorts. High amps, breaker trips upstream.

GROUNDED: any continuity terminal to shell
Confirm with megohm test. Zero to ground = condemned.

THE FALSE DEATH PATTERN

C to R = OL C to S = OL S to R = NORMAL

That is the OVERLOAD open, not the windings.

Hot shell (can exceed 350F in faults). Kill power, cool the shell, retest. Reset can take minutes to HOURS on a Phoenix afternoon.

Then find what overheated it: capacitor, fan, charge.

A hot compressor that reads open from common has not been tested yet. Cool it and retest before any verdict.