CASE STUDY · COMMERCIAL HVAC

"Replace the chiller," they said.

The data said clean it.

Biofilm at 8× rated fouling. Found from panel data. No new chiller.

CASE STUDY · COMMERCIAL HVAC · CHILLER DIAGNOSTICS · INDEPENDENT · NO CHEMISTRY SOLD

An energy consultant said replace the chiller. The panel data said clean it.

A commercial office tower ran two 500-ton water-cooled centrifugal chillers. An energy consultant flagged one machine's specific power well off design and recommended replacing it, and a capital project was already moving. A structured diagnostic built only on data the chiller already reports found the real problem: biofilm on the condenser tubes, insulating at roughly eight times the fouling the machine was rated to tolerate. The cause was a pump energy retrofit, not the chemistry program. The machine was cleaned, the cause corrected, and the replacement cancelled.

ASSET	ON THE TABLE	FOULING FOUND	CONDENSER APPROACH	OUTCOME
Two 500-ton centrifugals	**Replace the chiller**	**~8× rated**	**4.6 → 1.9 °F**	**~$450K cost avoided**

Challenge — What Was Happening

A cooling tower can be inspected. A chiller cannot. The bundles sit inside a pressure vessel with refrigerant on the other side of the tube wall, so their condition is invisible until someone pulls a waterbox.

An energy consultant recommended **replacing the machine**. The owner was being asked to choose between two guesses: "old machine" from the mechanical side, or "the index was high, so it must be scale" from the chemistry side.

Nobody had trended approach against the machine's own baseline, so a problem building for **fourteen months** had no visible history.

Intervention — What We Did

- Took **one stabilized panel data set** at a duplicated load and compared it to the machine's commissioning baseline
- **Closed the heat balance first** to prove the data could be trusted
- Worked the **Chillers in the Dark decision trees** to separate waterside, refrigerant-side, and flow causes before opening the machine
- Quantified fouling against the **AHRI-rated allowance** and wrote down the ranked hypothesis
- Confirmed with the cheapest tests at an outage already scheduled. **No lab budget, no teardown**

Diagnosis — Working The Trees

What The Panel Data Showed

- Heat balance closed within **0.5%** at 91% load
- Condenser approach **1.8 °F** at commissioning, **4.6 °F** now; evaporator barely moved
- Condenser ΔP unchanged: a surface film, not a restriction
- Specific power 0.639 → 0.672 kW/ton, about **+5%**

What Was Ruled Out, And What Wasn't

- Pump flow verified, but a **VFD added 14 months earlier**
- At part load, tube velocity sat **below the OEM minimum** most of each day
- Saturation index mild, cycles steady: no scaling driver
- Dip slide counts up an **order of magnitude**. Branch: biofilm

Root Cause

ROOT CAUSE FINDING

Physical cause: biofilm with early under-deposit attack. LMTD rose from 5.26 to 8.55 °F and U fell from about 312 to 190 Btu/h·ft^2·°F, a 39% loss and a fouling factor near **0.0021, roughly 8× the 0.00025 AHRI condenser allowance**. At the outage: soft gray-brown slime, no hard crust, no fizz in dilute acid, high organic fraction on ignition, and shallow pits with black paste showing sulfate-reducing bacteria starting to attack.

Latent root cause: a mechanical decision, not a chemistry failure. Condenser flow was cut to save pump energy with no review of tube velocity, biocide, or filtration. The same heat-balance gate caught the second machine: computed flow of 969 gpm against a nameplate 1,100 would have inflated its fouling factor by a third and triggered an unneeded cleaning.

The fix: enhanced-tube cleaning, minimum pump speed raised to hold tube velocity in the OEM window, continuous oxidant control, side-stream filtration, and monthly approach and ΔP trending. Commitment: within 0.5 °F of baseline in two weeks. Result: **2.1 °F at 14 days, 1.9 °F at 45**.

RESULTS DELIVERED

~$450K cost avoided

Chiller replacement cancelled — condenser approach restored to within 0.1 °F of commissioning

COST AVOIDED	APPROACH	FOULING FOUND	SPECIFIC POWER
~$450K	**4.6 → 1.9 °F**	**~8× rated**	**~5% back**

RESULTS DELIVERED

- **Cancelled** a replacement that would not have fixed the problem
- **Restored** approach to 1.9 °F against a 1.8 °F baseline
- **Stopped** early SRB under-deposit attack before it pitted through
- **Prevented** an unneeded cleaning on the second machine

ECONOMICS

- Cost avoided: **~$450K** typical installed replacement (equipment, removal, rigging, install, engineering, commissioning)
- About 5% specific power recovered, **~$4,900/yr on one machine**
- Diagnosis cost: panel data, a spreadsheet, and tests already on the truck
- Monthly trending now catches the next problem in months, not a year

The chiller is sealed, but it is not silent. Read against its own baseline, the data it already reports settles the argument before anyone spends money on the wrong fix. "The chiller lost efficiency and we don't know why" is usually a documentation problem, not a technical one.

Cost avoidance reflects a typical U.S. installed cost to replace a 500-ton water-cooled centrifugal chiller (equipment, removal, rigging, installation, engineering, commissioning); energy figures modeled from panel data. Details generalized to protect client confidentiality.