ENGINEERING WHITE PAPER

TRICOIL® Recuperative DOAS

A 10,000 CFM, 100% Outdoor-Air Unit Using a Three-Coil Run-Around Loop for Reheat

≈22%	0
Reduction in required chiller capacity	External reheat sources required at design condition

Designed by Eiermann Engineering

Kansas City Intl. (MO) · 1% Enthalpy/MCDB Design Condition · August 31, 2026

1. Purpose

This package presents the final design for a three-coil ("TRICOIL® ") 100% outdoor-air DOAS unit using a recuperative run-around loop for reheat, in place of a separate hot-water or electric reheat source. All five coil selections — precool, dehumidification, and reheat in summer service; preheat and post-heat in winter service — have been confirmed via certified manufacturer selection software (Coil Company EZ-Coil) and are documented in Section 4 and Section 7. Section 6 documents the calculation method used to develop and validate that design intent, retained here so the numbers can be independently checked.

2. Design Basis

Parameter	Value
Project airflow	10,000 SCFM, 100% outdoor air
Outdoor design condition	ASHRAE 1% annual cooling, enthalpy-governed — Kansas City Intl, MO (WMO 724460), 1994–2019 period
Design entering air	89.3°F DB / 78.3°F MCWB, 42.6 Btu/lb enthalpy (74.7°F dew point)
Target supply air	68–72°F DB, ≈ 53°F dew point (nominal DOAS "dry" supply)
Chilled water supply	43°F entering, sized at 10°F rise
Fluid	30% propylene glycol (all coils and loops — unit sees outdoor air year-round)
Face velocity target	400–450 fpm (below the ~550 fpm cooling-coil carryover threshold)
Fin data (all 3 coils)	5/8″ tube, 1.5″×1.299″ sinewave fin, 12 FPI

Note on design basis: the entering air condition above is the 1% Enthalpy/MCDB design point, not the more commonly used 0.4% DB/MCWB peak-dry-bulb point. This choice is intentional, and at first glance counterintuitive: the enthalpy design hour is 6.2°F cooler in dry bulb (89.3°F vs. 95.5°F), but it is also more humid — so its total heat content is actually higher, 42.6 Btu/lb versus 40.7 Btu/lb at the peak-DB point (both computed from the same ASHRAE station data at the site's 14.17 psia standard pressure).

That distinction matters because the dehumidification coil governs the TRICOIL® system's overall capacity (Section 4), and it removes both sensible and latent heat — so its load tracks total heat content, not dry-bulb temperature alone. The hottest hour of the year is not necessarily the hour with the highest total heat content: a somewhat cooler but more humid hour can demand more total cooling capacity, and sizing to peak dry-bulb alone would understate that duty. For that reason, the enthalpy design hour — not the peak-dry-bulb hour — is the correct condition to design against.

3. System Description

Outdoor air passes through three coils in series: a precool coil, a chilled-water dehumidification coil, and a reheat coil. The precool and reheat coils share a closed, independent run-around loop — heat picked up cooling the hot entering outdoor air is carried by that loop to the reheat coil, where it warms the cold, saturated air leaving the dehumidification coil back up to supply temperature. No external heat source is required for reheat under this design condition. The chilled-water loop is dedicated to the dehumidification coil only. At the governing 1% Enthalpy/MCDB entering condition (Section 2), the precool coil's run-around loop water runs cold enough to fall below the entering air's dew point, so the precool coil is not purely sensible — it picks up real latent load and produces condensate alongside the dehumidification coil, consistent with field experience on similar units. The load split between the two coils reflects this.

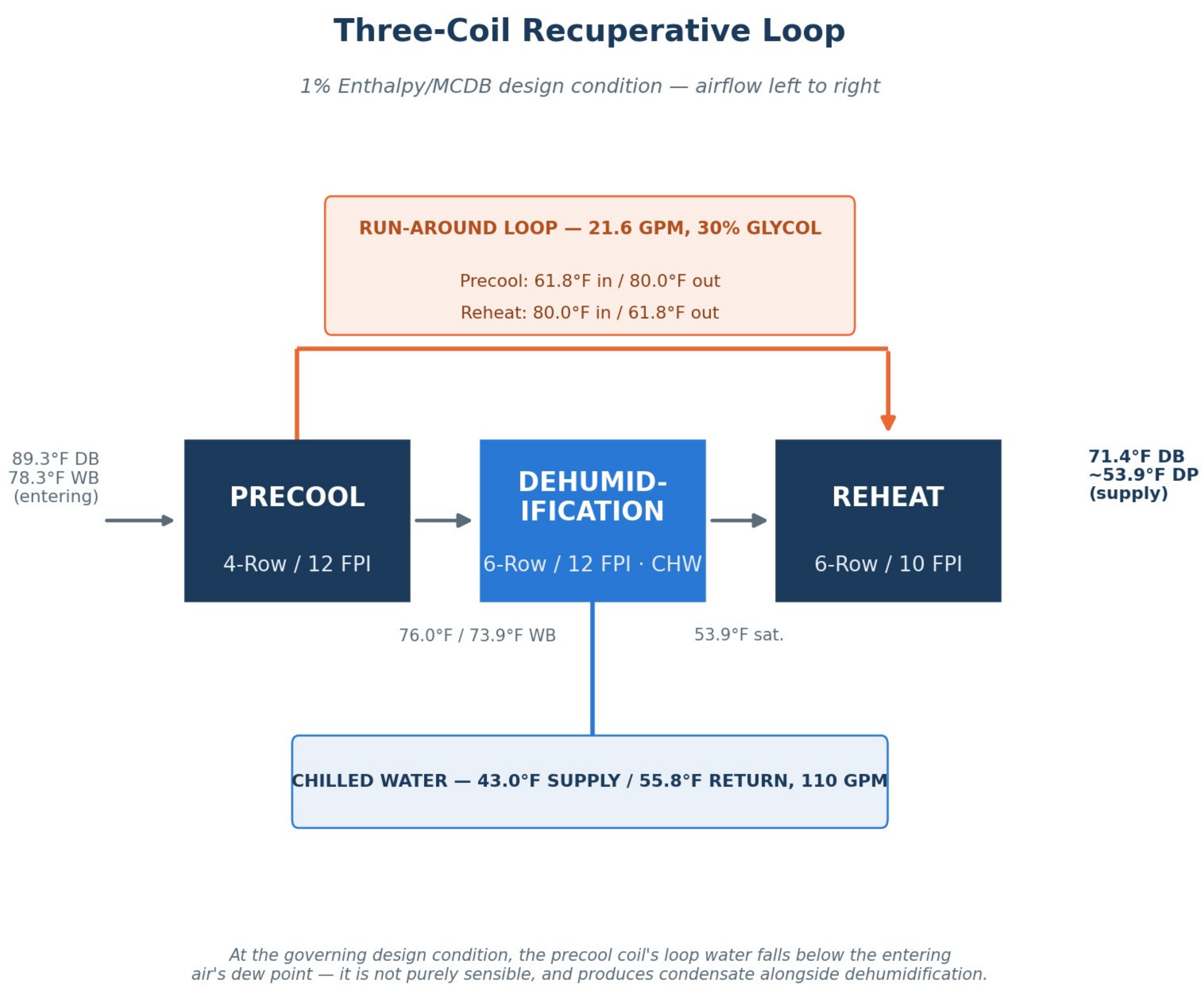


Figure 1 — AHU coil section, airflow left to right, at the 1% Enthalpy/MCDB design condition. Outdoor air 89.3°F DB/78.3°F WB enters the precool coil (4-row), through dehumidification (6-row, CHW), through reheat (6-row), to supply air 71.4°F DB/~53.9°F DP. Run-around loop: 80.0°F precool-leaving/reheat-entering, 61.8°F reheat-leaving/precool-entering, 21.6 GPM, 30% glycol. CHW: 43°F supply/55.8°F return, 110 GPM, dedicated to the dehumidification coil.

4. Coil Schedule

Rows, FPI, face size, and fluid conditions below are sufficient to independently verify each coil selection against standard manufacturer selection software (e.g., Coil Company EZ-Coil, or equivalent).

	Precool	Dehumidification	Reheat
Duty	Precool + partial dehum.	Total (sens.+lat.)	Sensible reheat
Airflow	10,000 SCFM	10,000 SCFM	10,000 SCFM
Rows / FPI	4 / 12	6 / 12	6 / 10
Face size (at 400 fpm)	25.0 sq ft	25.0 sq ft	25.0 sq ft
Entering air DB/WB	89.3°F / 78.3°F	76.0°F / 73.9°F	53.9°F
Leaving air DB/WB	76.0°F / 73.9°F	53.9°F (sat.)	71.4°F
Fluid	30% PG (loop)	30% PG (CHW)	30% PG (loop)
Entering fluid temp	61.8°F	43.0°F	80.0°F
Leaving fluid temp	80.0°F	55.8°F	61.8°F
Flow rate	21.6 GPM	110.0 GPM	21.6 GPM
Capacity	190 MBH total / 149 sens. / 41 lat.	673 MBH total / 245 sens. / 428 lat.	190 MBH

5. Energy Savings — The Case for TRICOIL®

The recuperative run-around loop reduces the load the chilled-water plant must carry, by recovering heat from the entering outdoor air that would otherwise be rejected, and using it for reheat instead of drawing on a separate heat source.

	Without recuperation (conventional 2-coil DOAS)	With TRICOIL® recuperation	Difference
Dehumidification coil load	862 MBH	673 MBH	−189 MBH
Equivalent chiller tons	71.8 tons	56.1 tons	−15.8 tons (−22%)
Reheat source	Separate hot water / electric, ~189 MBH	Recovered heat — no external source	−189 MBH external reheat

At this design condition, the TRICOIL® configuration cuts required chiller capacity by roughly 22% and eliminates the need for a separate reheat energy source entirely — both a first-cost and an operating-cost argument, not just an operating-cost one. The precool coil now carries part of the cooling and dehumidification duty itself (Section 3), so this comparison nets its capacity against a conventional single-coil system sized for the same total duty, rather than treating precool as pure heat recovery with no cooling effect of its own.

6. Calculation Basis — Preliminary Model and Its Validation

These numbers come from a psychrometric model (bypass-factor/apparatus-dew-point method for the wet dehumidification coil; effectiveness-NTU crossflow for the two dry coils), with its free constants calibrated against a series of actual selections program run across a range of row counts, tube velocities, fin spacing (10 and 12 FPI), and face sizes — including a face area nearly 3x larger than the smallest calibration point. Independent test points (configurations never used to fit any constant) landed within:

- Cooling coil capacity: 0.6–6% of the reference selection software, across the tested range
- Heating coil capacity: 0.3–2.9% of the reference selection software, across the tested range
- Leaving air conditions: generally within 0.2–1.0°F of the reference selection

This preliminary sizing and concept-validation model was used to develop the initial design intent — rows, FPI, target face velocity, and the linked water-loop temperatures — before certified selections were run. It has no access to any manufacturer's proprietary fin/tube performance data, so it was never a substitute for that certified selection step. Each coil in Section 4 and Section 7 has since been run through the manufacturer's actual selection software (Coil Company EZ-Coil) using the entering conditions, airflow, and fluid data this model produced; the capacity and pressure-drop numbers reported in this document are those certified results, not this preliminary model's output.

7. Winter Operating Mode

At the 99.6% annual heating design condition for Kansas City Intl (2.4°F DB, Section 2), heating duty is carried by the same two coils used for summer precool and reheat duty (Section 4), now repurposed as a preheat stage and a post-heat stage on the run-around loop, supplemented by a hot-water source. Both coils are confirmed via certified selection runs at 21.6 GPM — the same loop flow rate used for the summer run-around duty.

Air path: outdoor air (2.4°F) → preheat coil (precool, 4 row/12 FPI) → dehumidification coil (dormant, straight through — dry, cold outdoor air needs no dehumidification) → post-heat coil (reheat, 6 row/10 FPI) → supply air (70.0°F). Water path: the post-heat coil's leaving water (44.5°F) returns directly to the preheat coil's entering connection, closing the loop. The preheat coil's leaving water (22.2°F) is blended with the hot-water source via a three-way control valve to reach the 93.0°F blended supply temperature confirmed entering the post-heat coil — roughly a 51% source fraction if the source runs at ≈160°F, though the actual source temperature and blend ratio depend on the plant supplying it. All loop flow passes through both coils in series at all times — there is no bypass path around either coil.

Parameter	Preheat (Precool Coil)	Post-Heat (Reheat Coil)
Duty	Sensible preheat	Sensible post-heat
Airflow	10,000 SCFM	10,000 SCFM
Rows / FPI	4 / 12	6 / 10
Entering air DB	2.4°F	23.4°F
Leaving air DB	23.4°F	70.0°F
Fluid	30% PG (loop, return)	30% PG (loop, blended)
Entering fluid temp	44.5°F (loop return)	93.0°F (blended supply)

Parameter	Preheat (Precool Coil)	Post-Heat (Reheat Coil)
Leaving fluid temp	22.2°F	44.5°F (closes loop)
Flow rate	21.6 GPM	21.6 GPM
Fluid velocity	2.65 fps	2.71 fps
Capacity	227 MBH	504 MBH

Total winter heating duty is 731 MBH (227 + 504), consistent with the air-side energy balance from 2.4°F to the 70.0°F supply air condition the certified coils actually land on. Unlike the summer run-around loop, this is not self-contained — the loop alone cannot sustain net heating (a closed loop returns to the same state each cycle with no net energy gain), so essentially all 731 MBH must come from the hot-water source at the blend point, regardless of how the duty splits between the two coils.
Both figures are certified selection software output (Coil Company EZ-Coil), not a preliminary estimate — no effectiveness-NTU modeling was needed for this section. Air-side and fluid-side energy balances were checked independently and match the reported capacities within about 0.3%.

Leaving water off the preheat coil (22.2°F) remains above the ~10–11°F freeze point for 30% propylene glycol, providing adequate margin under sustained winter operation.

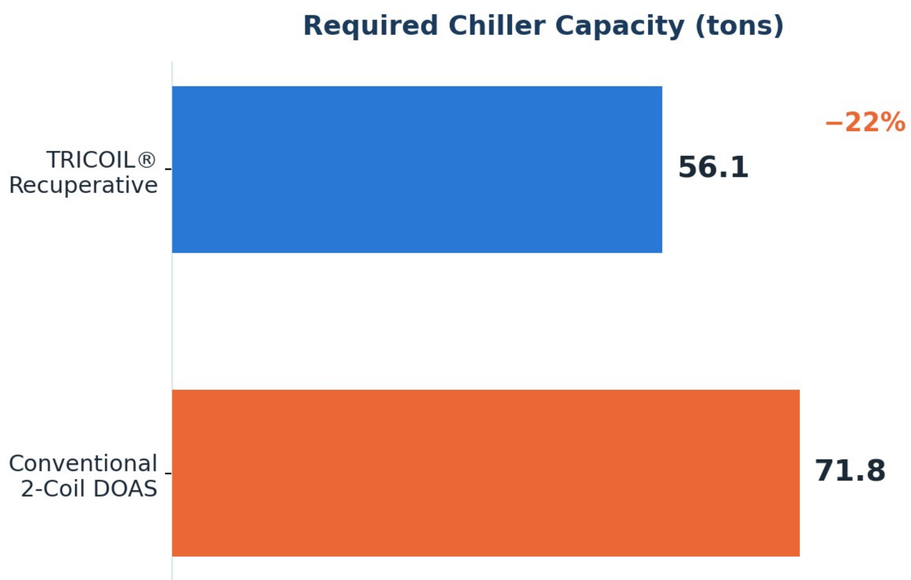
8. Summary

The TRICOIL® recuperative run-around loop delivers clear, measurable value on this 10,000 CFM DOAS: roughly a 22% reduction in required chiller capacity, complete elimination of a separate reheat energy source, and coil selections confirmed against certified manufacturer software in both summer and winter operating modes. By carrying dehumidification and reheat on a single closed loop instead of three independent systems, TRICOIL® turns heat that a conventional design would simply reject into useful capacity — a simpler, more efficient outdoor-air system with a straightforward first-cost and operating-cost case behind it.

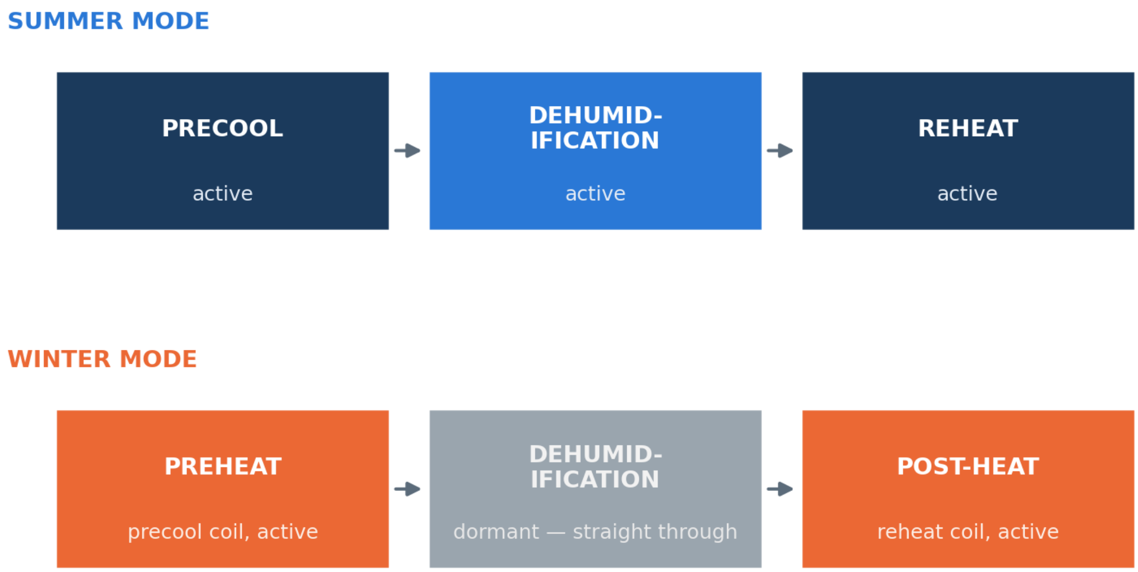
Eiermann Engineering developed this design from first principles — building and validating a preliminary psychrometric model, then confirming every coil selection against certified selection software before arriving at the performance figures presented here. That combination of rigorous calculation and practical coil engineering is what makes this TRICOIL® design a compelling alternative to conventional multi-coil DOAS systems.

Illustrations

Both graphics below restate figures already presented earlier in this document — no new data.



Required Chiller Capacity — Conventional 2-Coil DOAS (71.8 tons) vs. TRICOIL® Recuperative (56.1 tons). Restates the Section 5 table.



Summer vs. Winter Airflow — Summer Mode (Precool → Dehumidification → Reheat, all active) and Winter Mode (Preheat → Dehumidification [dormant] → Post-Heat). Reflects Sections 3 and 7.