Example 8: NR Restaurant, Single Zone, DOAS Units Configured as Rooftop Unit

SYSTEM TAG: T24ACM-SZVAVDFHP

PROJECT VISION

California Title 24 compliance modeling requires translating mechanical system designs into CBECC 2025 software objects, a process for which little practical guidance exists. Developed as part of the *Addressing Complex HVAC Systems in Code Compliance* project, funded by Southern California Edison through the CalBEM working group, each example walks through how a recognizable HVAC system type translates into CBECC objects, what Title 24 2025 Part 6 requires, and what assumptions were made.

PREPARED FOR
Southern California Edison
CalBEM Working Group 3

PREPARED BY
A2 Efficiency & West Monroe

2026

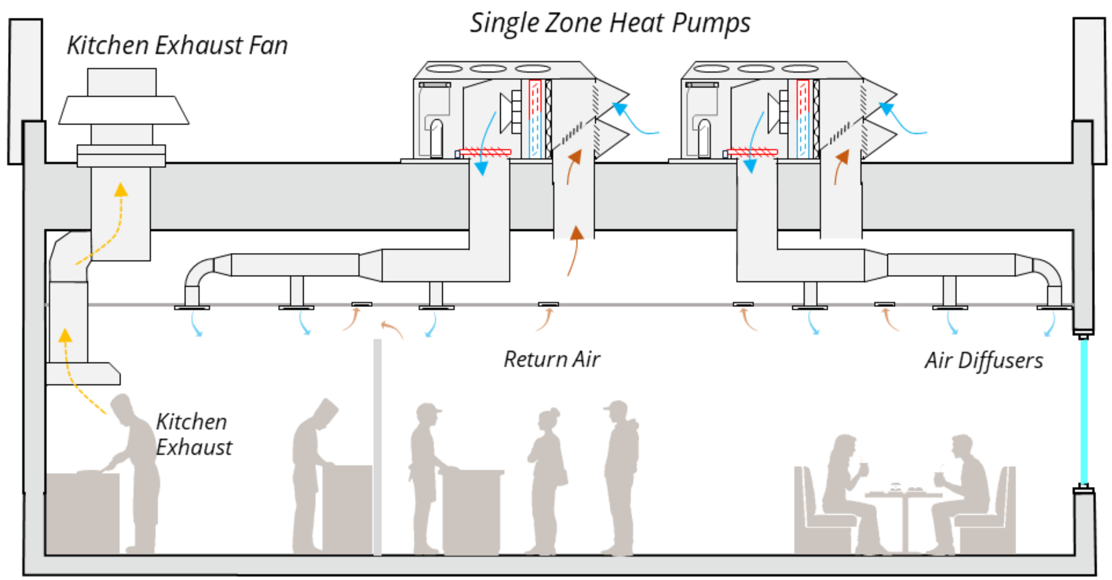
Example 8: NR Restaurant, Single Zone, DOAS Units Configured as Rooftop Unit

System Tag: T24ACM-SZVAVDFHP
Title 24 2025 ACM: System c3

Mechanical Description

The building is conditioned by two independently controlled packaged rooftop units, each serving a single occupied space; one the dining area, one the food preparation area. Both units are configured as mixed-air, rooftop units with AC and furnaces. A kitchen exhaust system maintains building pressure, relieving air through the hoods. The kitchen hood operates as a constant-volume commercial kitchen exhaust fan, ducted directly to outdoors. No heat recovery is provided on the exhaust air.

The primary rooftop equipment selected in this example can be configured as mixed-air, rooftop units or, as dedicated outdoor air systems, and were labeled by the manufacturer as 'DOAS units'. This example demonstrates how the configuration of a system should always reflect the architecture of the airflow and control, rather than the label of products specified by a manufacturer.



The diagram shows a standard fast-food restaurant, with one single zone unit serving the dining area, another serving the serving and cooking area. The exhaust fan runs to maintain indoor air quality with air transferring from dining area as needed to maintain exhaust.

Mechanical Details

Two SZ VAV AC systems were applied to the fast-food restaurant prototype, with both thermal zones conditioned by their respective packaged rooftop unit. The Kitchen zone is also served by a continuous hood exhaust.

Ventilation: Outdoor air delivered through each RTU as a fraction of the total supply air to each zone.

Ventilation control: The Dining zone uses CO_2 based demand-controlled ventilation with a VAV terminal modulating supply between min and max airflow. The Kitchen zone ventilation is constant with VAV terminal modulating supply between min and max.

Cooling: Single-stage DX cooling on Dining RTU and 2-stage DX cooling on the Kitchen RTU.

Heating: Natural gas furnace at each rooftop unit, mixed fuel equipment matching real world examples for this occupancy type.

Capacity control: VSD supply fan at each unit modulated to meet zone load through VAV no-reheat terminal box.

Economizing: Yes. Differential enthalpy economizer on both rooftop units, integrated with mechanical cooling.

Heat Recovery: None. Kitchen hood exhaust is exempt from heat recovery requirements.

Mechanical Capacities and Sizing

Systems were sized based on the as-built equipment selection documented in the source building's actual mechanical drawings given the proximity of the building size to the prototype for both zones. Outdoor air for the Dining zone was sized to the zone ventilation requirements, with CO_2-based DCV at the VAV terminal modulating supply between a minimum and maximum airflow. Outdoor air for the Kitchen zone was set to match both the zone ventilation requirement for kitchen/cooking occupancy and the makeup air requirement against the continuous hood exhaust. The Kitchen VAV terminal holds a constant minimum airflow floor with no CO_2 DCV applied. Cooling efficiencies were entered at the mandatory minimum efficiencies, both gas furnaces were entered with mandatory minimum AFUE matching drawing specs.

Kitchen Exhaust System

Exhaust (cfm)	Control	Hood Type	Air Path
2,400	Constant Volume	Wall Canopy, Heavy, 10 ft	Ducted to outdoors not in return air path

Zone Airflow Balance

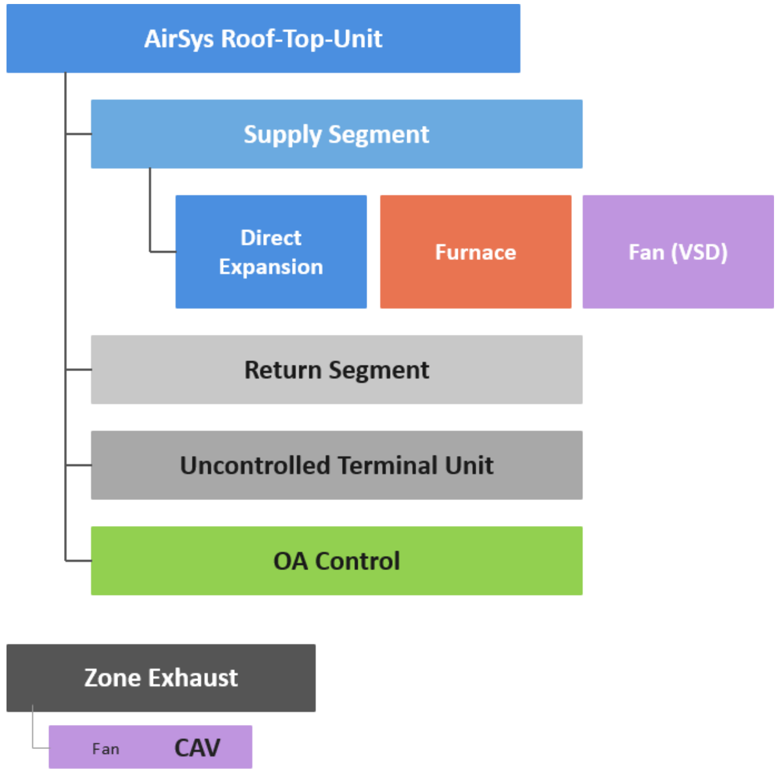
Zone	Sup. (cfm)	Min OA (cfm)	Return (cfm)	Exh. (cfm)	Net Pressurization
Dining	2,000	1,200	500 to 1300	—	Positive (700 cfm transfer air to Kitchen)
Kitchen	4,500	1,700	Up to 2,800	2,400	Balanced (pulling 700 cfm air from Dining)
Building Total	***6,500***	***2,900***		***2,400***	***Net +500 cfm OA***

Code Compliance Software Configuration

Each RTU was entered as a Package SZ VAV AC (SZVAVAC) air system serving a single thermal zone, with return air ductwork explicitly modeled (return air segment Path = Direct on each system). Outdoor air control was configured at the OA controller object for each system: DifferentialEnthalpy economizer, Integrated, with 71°F dry-bulb and 28 Btu/lb enthalpy high-limit lockouts. The Dining OA controller carries MaxOARat: 1.0 to allow full economizer modulation; the Kitchen OA controller has no MaxOARat set, fixing OA volume at the terminal minimum.

Cooling efficiencies were entered at code minimum (EER 11.0 on RTU-1, EER 10.8 on RTU-2) rather than the drawing-rated IEER values (14.6 and 14.0). This addresses the AHRI 920 (DOAS rating) vs AHRI 340/360 (RTU rating) standard mismatch when DOAS-rated equipment is installed in a coupled-RTU configuration. The compliance-eligible efficiency entry uses the AHRI 340/360 minimum for the equipment's installed function.

The Kitchen thermal zone was assigned the KitchenExhaust system reference (ExhSysRef = KitchenExhaust) and configured with FullyDuctedExhFlag = 0 on that exhaust system, instructing the simulation engine to permit transfer air from adjacent zones rather than treating the hood as a closed return loop. Hood inputs at the Kitchen space include KitExhHoodFlow (2,400 cfm), KitExhHoodLen (10 ft), KitExhHoodStyle (WallMountedCanopy), and KitExhHoodDuty (Heavy).



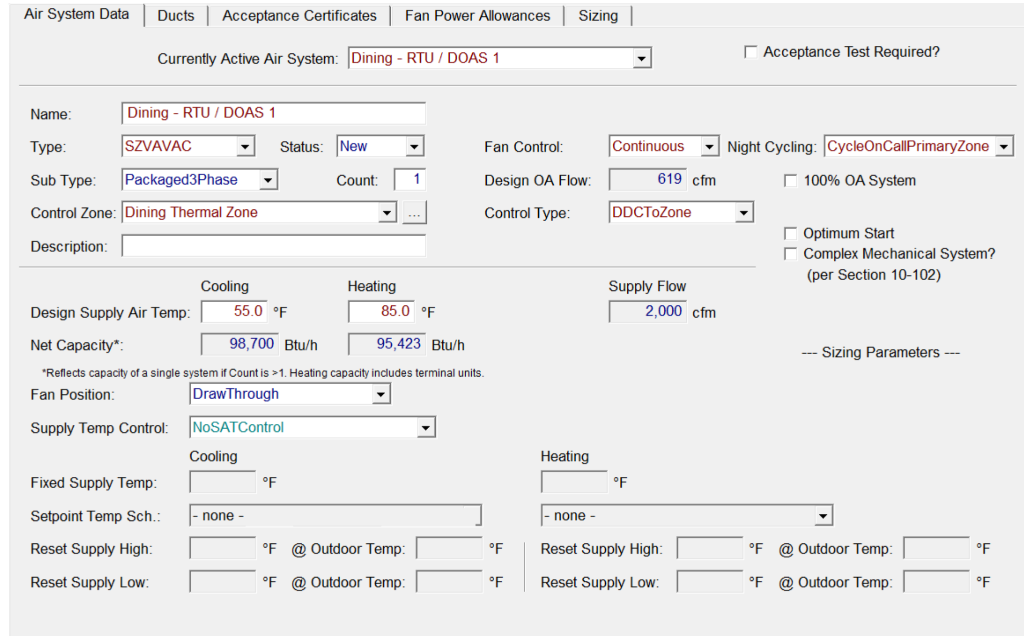
CBECC Object Locations

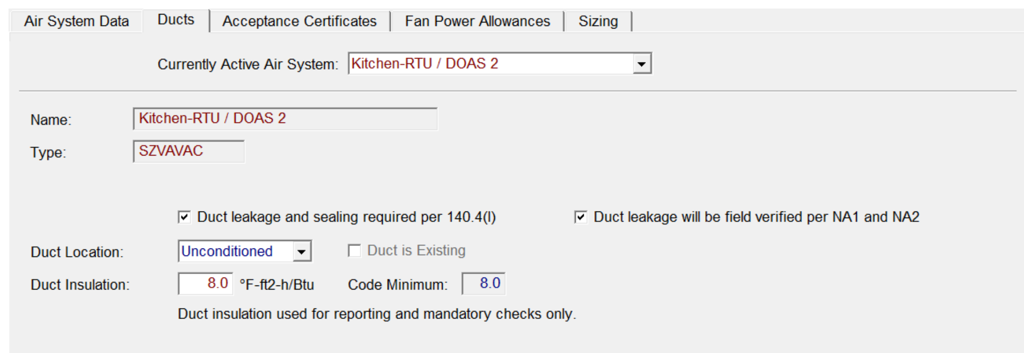
The model is made up of three systems; two air-systems one for dining, one for the kitchen, and a zone system for the kitchen exhaust.

Air Systems

The dining system is shown here for key inputs on the air-system input screen.

The unit was assumed to be ducted on the roof in an unconditioned space with duct insulation and duct leakage testing.





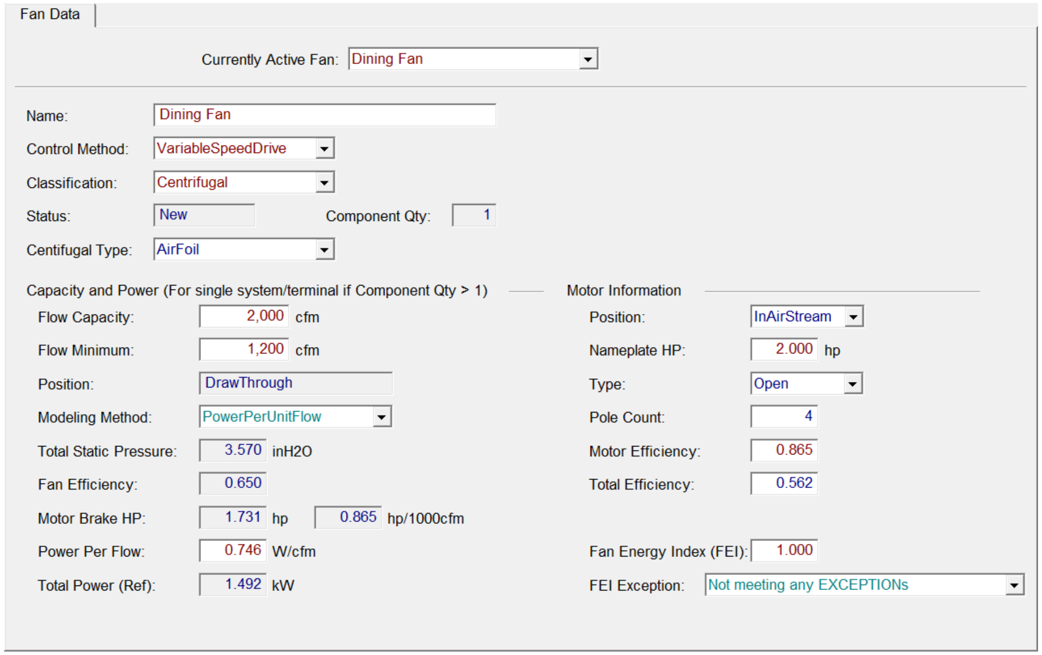
Air System Fan Component

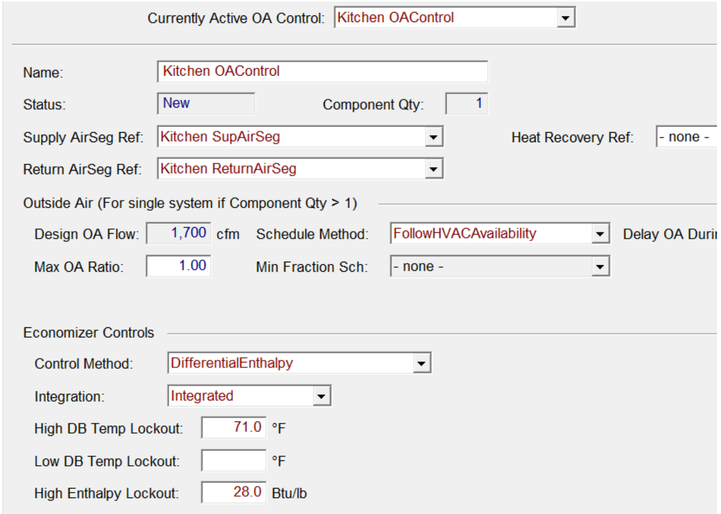
The fan airflow for each RTU was configured as a variablespeeddrive fan based on the design.

Zone	Supply Fan (cfm)	Outdoor Air (cfm)	Fan Eff. (W/cfm)	Economizer
Dining	2,000	1,200	0.746	Diff. Enthalpy
Kitchen	4,500	1,700	0.820	Diff. Enthalpy

Outdoor Air Controller

Each unit includes an economizer controlled based on enthalpy as shown below.

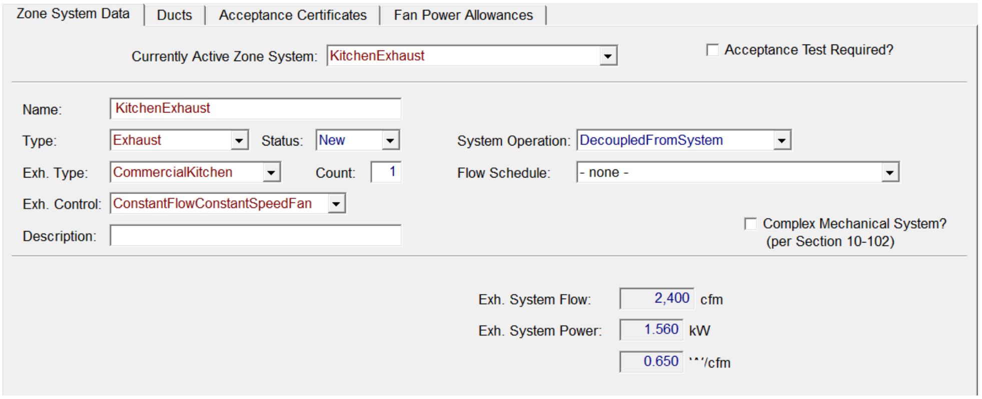




Zone System, Kitchen Exhaust

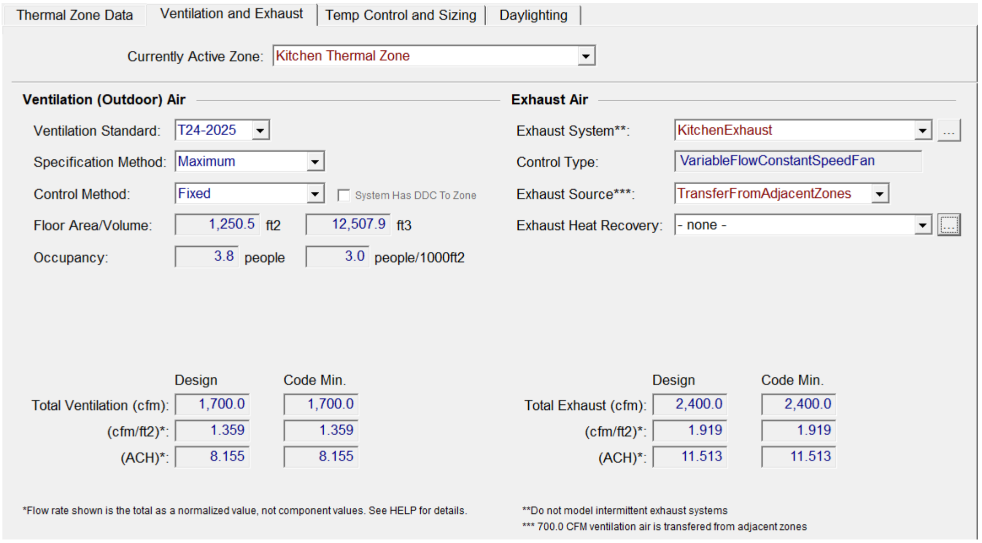
Zone kitchen exhaust was configured with a zone system set to CommercialKitchen as the fan type.

The control type was assumed to be a constant flow control with a constant speed fan.



Thermal Zone Exhaust Control

The thermal zone component for the kitchen sets the link to the kitchen exhaust fan, as well as defines the source of makeup air. In this configuration the makeup air is taken from the adjacent zones in the building, the dining area.



System Efficiency Tables

Category	Proposed Design	vs. Standard Baseline
System Type	Package SZVAVAC (both zones), VSD fan, partial-recirculation RTU configured with return air ductwork.	Standard assigns CV/SZ AC to Dining and SZ VAV AC to Kitchen; proposed uses VSD VAV on both zones.
Cooling	RTU-1 Dining: EER 11.0, single-stage DX. RTU-2 Kitchen: EER 10.8, two-stage DX.	Same DX equipment type per Table 140.4-A. Proposed entered at code-min EER rather than drawing-rated IEER.
Heating	Natural-gas furnace, AFUE 81%, at each RTU. No supplemental heat.	Same fuel and AFUE. NRCC C2 shows proposed loses 3.76 LSC on space heating vs. standard.
Supply Fan	VSD centrifugal: 0.75 W/cfm (Dining RTU), 0.82 W/cfm (Kitchen RTU).	Standard Dining: ConstantVolume fan. Kitchen: VSD. Proposed VSD on Dining saves 8.23 LSC on indoor fans.
VAV Terminal	VAVNoReheatBox at both zones. Dining modulates 1,200–2,000 cfm under CO2 DCV. Kitchen fixed at 1,700 cfm.	Standard Dining: ConstantVolume, no DCV. Kitchen terminal type same in both designs.
Economizer	Differential enthalpy, integrated with mechanical cooling, on both RTUs.	Standard uses FixedDryBulb 71°F. Differential enthalpy performs better on cool, humid CZ9 coastal mornings.
Photovoltaics	24.3 kWdc rooftop PV array.	NRCC C2 shows proposed gains 1.29 LSC vs. baseline.

Note: Heat recovery — neither RTU crosses the 70% outdoor air fraction threshold; kitchen hood exhaust (2,400 cfm Type I) is exempt from heat recovery requirements. Domestic hot water — 30-gallon natural-gas storage water heater, UEF 0.65; same equipment type and fuel in both proposed and standard designs.

Relevant Energy Code Citations

Required Demand Control Ventilation

401.2.1.2.3 [Section 120.1(d)3]

The Dining zone exceeds the occupancy density limit for cafeteria / fast-food dining, requiring CO_2-based modulating ventilation airflow. The VAV terminal on RTU-1 carries minimum and maximum airflow setpoints and is controlled by a zone CO_2 sensor. The Kitchen zone is not subject to DCV — kitchen ventilation rates are driven by the hood makeup-air requirement and held constant.

Fan Power Budget, Packaged VAV Units

401.3.3.3 [Section 140.4(a)3D]

Each Package SZ VAV AC supply fan must meet the prescriptive fan-power limit for VAV systems in its capacity range. The modeled supply fan power (0.75 W/cfm on RTU-1 and 0.82 W/cfm on RTU-2) is consistent with the prescriptive limit for packaged VAV systems at design airflow.

Air-Side Economizer, Packaged Units

401.3.7 [Section 140.4(e)]

Each rooftop unit exceeds the 33,000 Btu/hr cooling-capacity threshold that triggers the economizer requirement. Both units are configured with differential enthalpy economizers integrated with mechanical cooling, satisfying the prescriptive requirement in Climate Zone 9. Differential enthalpy was selected over fixed dry-bulb to improve free-cooling availability during the cool, humid morning hours typical of coastal Climate Zone 9 operation.

Exhaust Air Heat Recovery, Kitchen Hood Exemption

401.3.18 [Section 140.4(q)]

Outdoor air systems delivering 3,000 CFM or more at 70% or greater outdoor air fraction would typically require exhaust air heat recovery. Neither RTU exceeds the 70% outdoor air threshold (RTU-1 at 60%, RTU-2 at 38%), and the kitchen hood exhaust is independently exempt from heat recovery requirements as a Type I commercial kitchen hood exhaust stream. No heat recovery is required or provided.

Kitchen Hood Exhaust, Type I

Section 140.9(b)

The 2,400 cfm Wall-Mounted Canopy Type I hood is classified as heavy-duty. Hood airflow per linear foot meets the prescriptive maximum, and the hood is modeled with continuous occupied-hour operation. No demand-controlled kitchen ventilation is applied — the hood operates at constant volume.

Minimum DX Cooling and Furnace Efficiency

Table 401.3-A [Table 140.4-A]

The DX cooling coil and gas furnace heating coil at each rooftop unit must meet minimum EER, IEER, and AFUE thresholds for their capacity ranges. Both modeled units carry code-minimum cooling efficiency entries (see the modeling note above regarding the AHRI 920 vs. AHRI 340/360 rating-standard mismatch) and meet the 81% AFUE mandatory minimum on the gas furnace.

This example is one of eight developed as part of the *Addressing Complex HVAC Systems in Code Compliance* project. The full guide includes additional HVAC system types, alternative configurations, and working CBECC model files. All resources are available through the CalBEM working group and EnergyCodeAce platform.