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Building Science

Ventilation

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Build Tight - Ventilate Right

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How Tight?
What's Right?

Air Barrier Metrics

Material 0.02 l/(s-m²) @ 75 Pa

Assembly 0.20 l/(s-m²) @ 75 Pa

Enclosure 2.00 l/(s-m²) @ 75 Pa

0.35 cfm/ft² @ 50 Pa

0.25 cfm/ft² @ 50 Pa

0.15 cfm/ft² @ 50 Pa

Getting rid of big holes	3 ach@50
Getting rid of smaller holes	1.5 ach@50
Getting German	0.6 ach@50

Best

As Tight as Possible - with -

Balanced Ventilation

Energy Recovery

Distribution

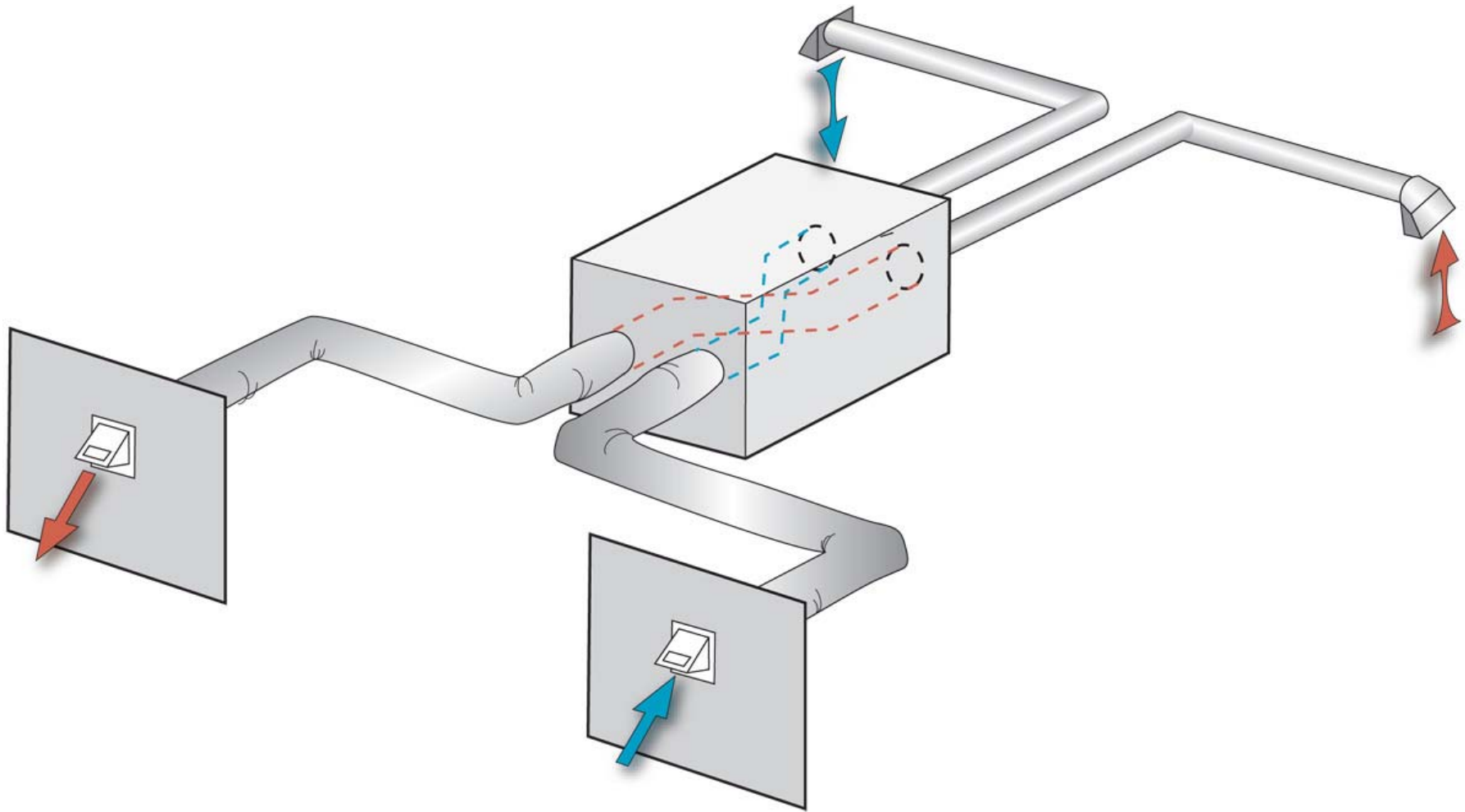
Source Control - Spot exhaust ventilation

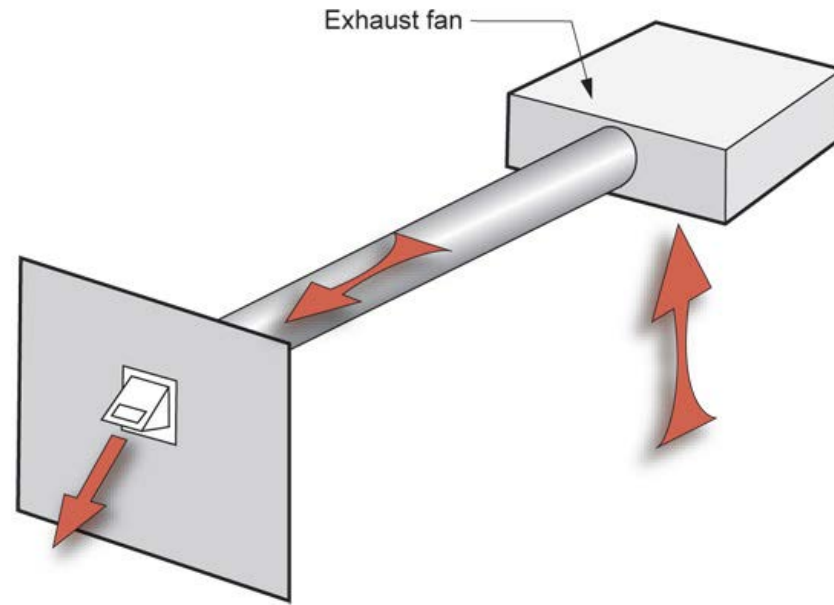
Filtration

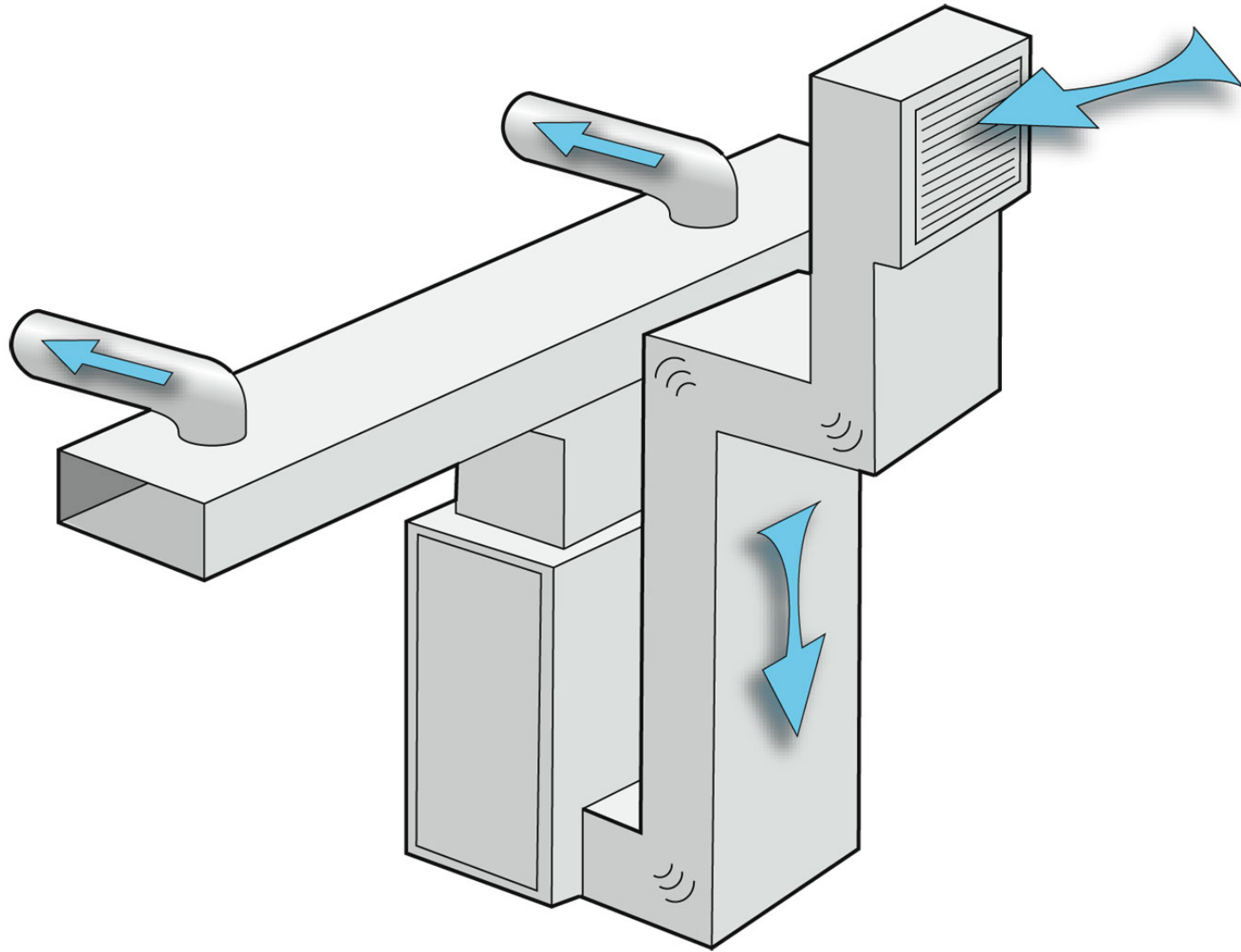
Material selection

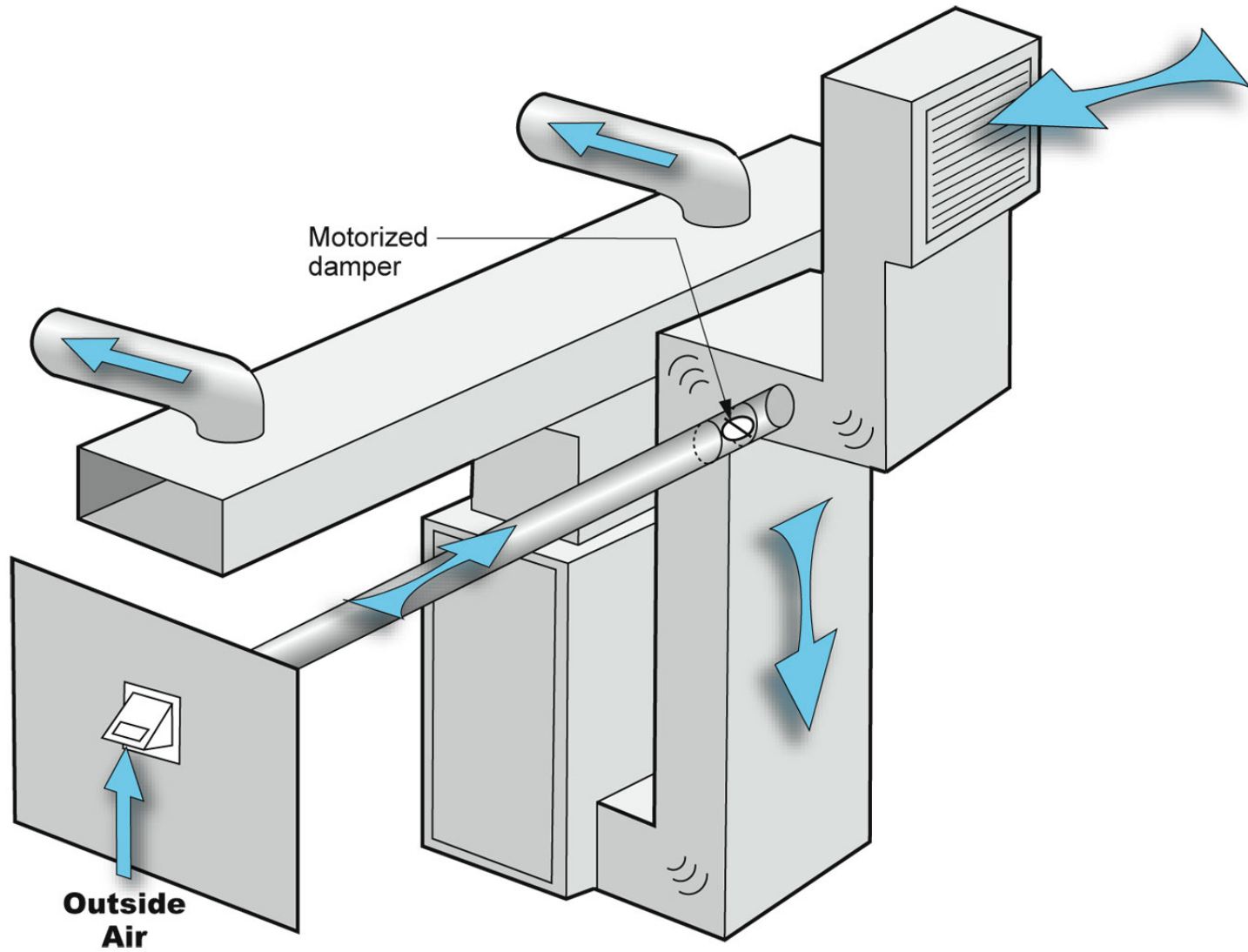
Worst

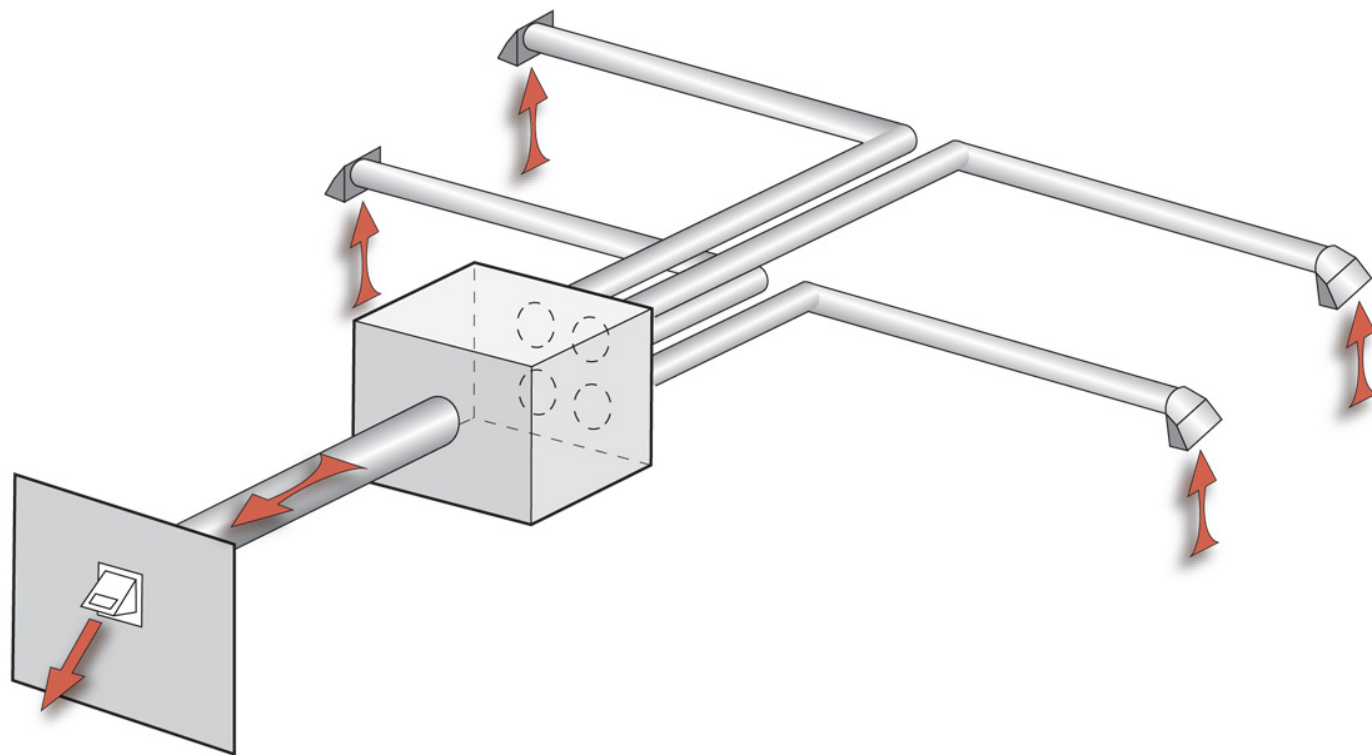
Leaky - with –
Exhaust ventilation
No Distribution

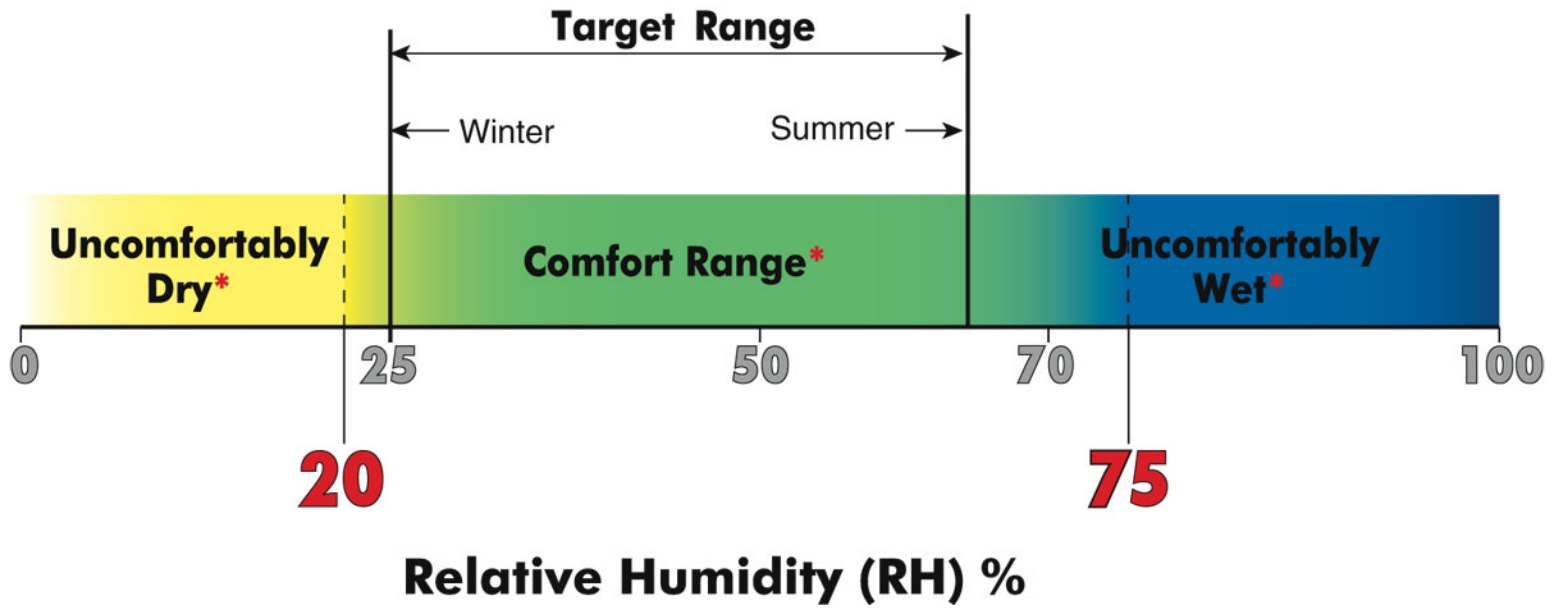










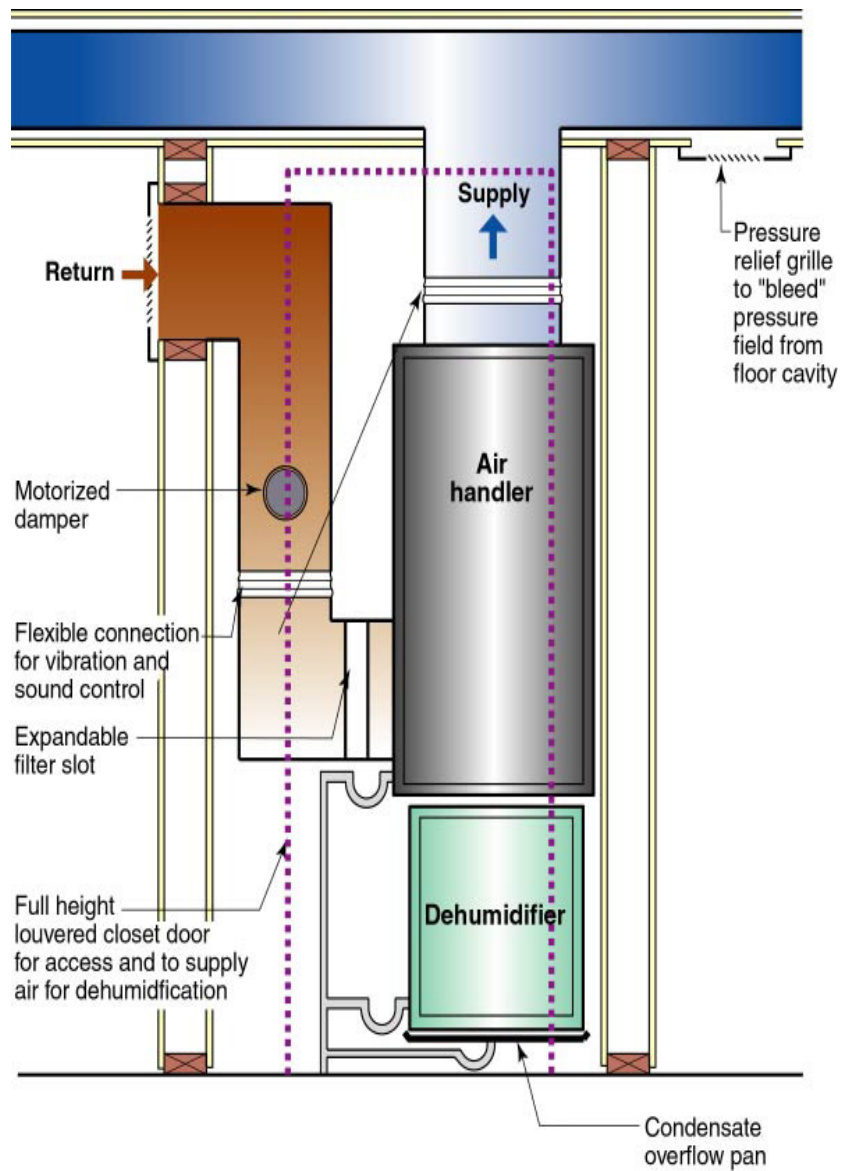


Recommended Range of Relative Humidity

Above 25 percent during winter

Below 70 percent during summer







Barriers – Technology Dehumidification

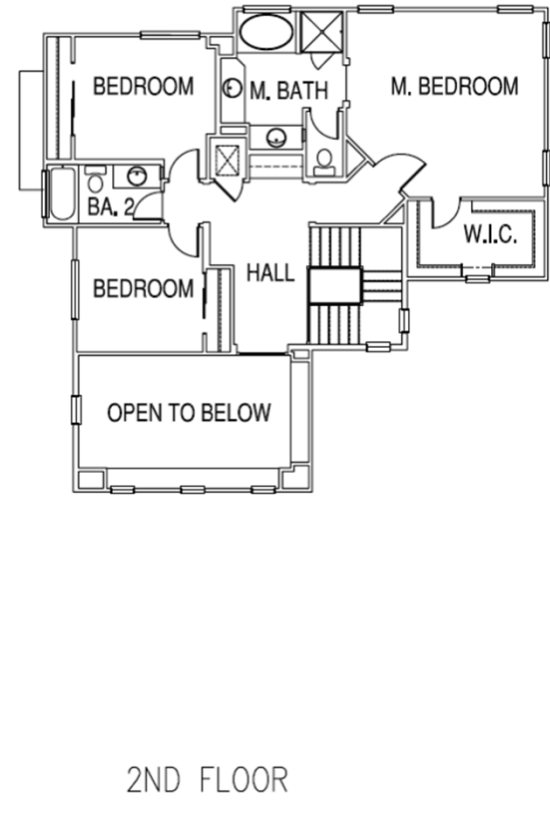
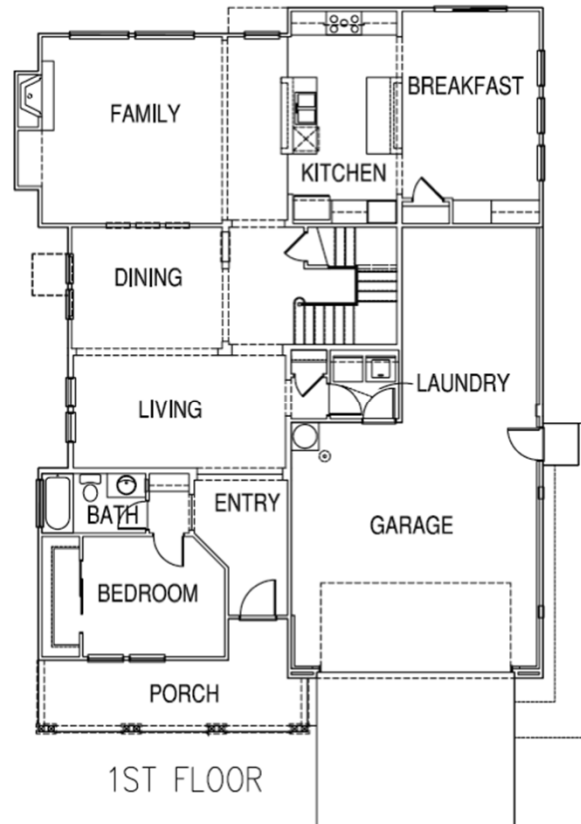
Barriers – Cost Exhaust \$150
Exhaust + Dist \$200
Supply + Dist \$200
Spot + Ex/Sup + Dist \$500
Balanced/ER \$1,250
Dehumidification \$250 to \$1,250

Tracer Gas Testing
January 2006



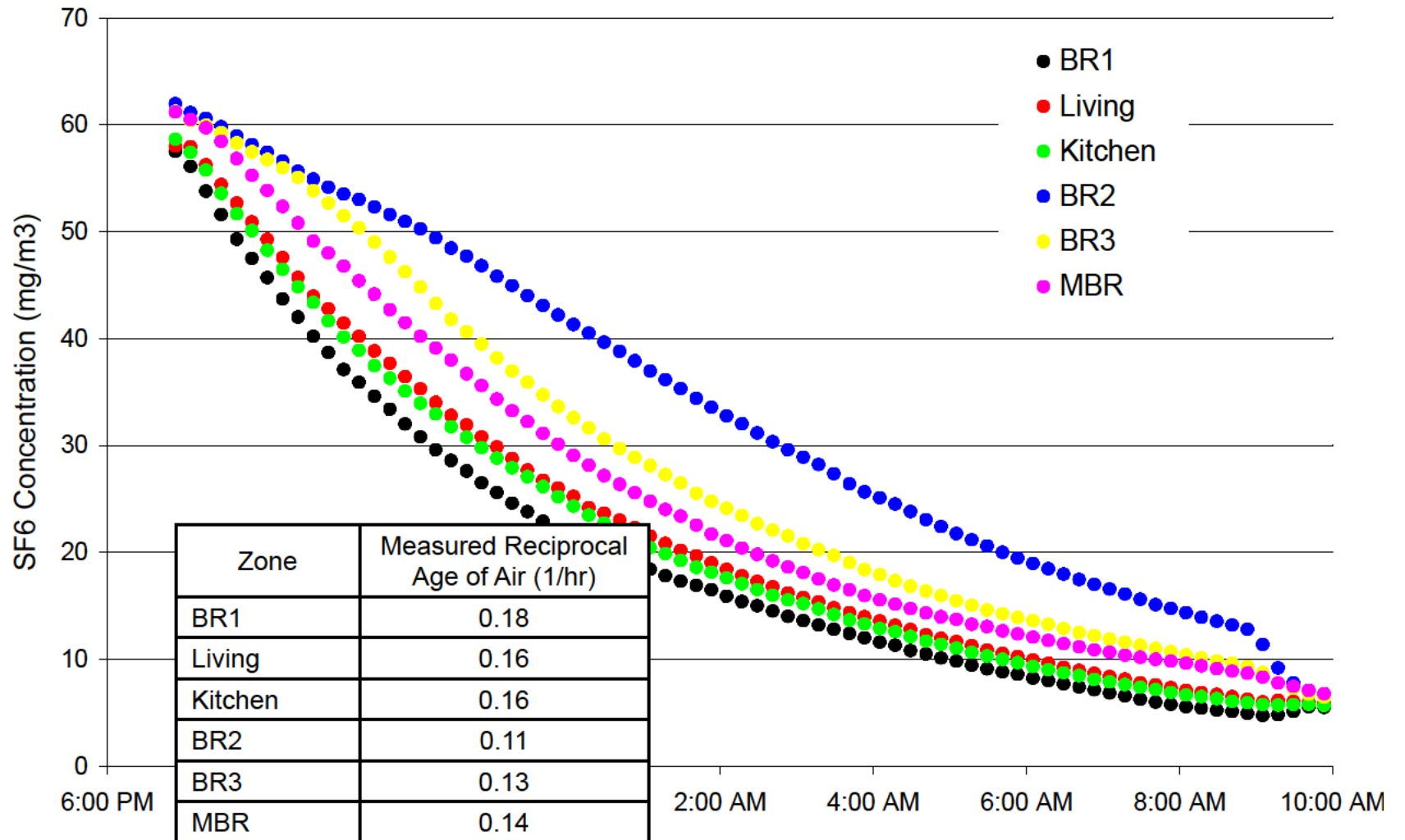
- Tracer gas test of a production house in Sacramento
- 2-story, 4 bedrooms, ~2500 square feet
- Ventilation systems tested: supply and exhaust ventilation, with and without mixing via central air handler

Floor Plan - 2 Story House



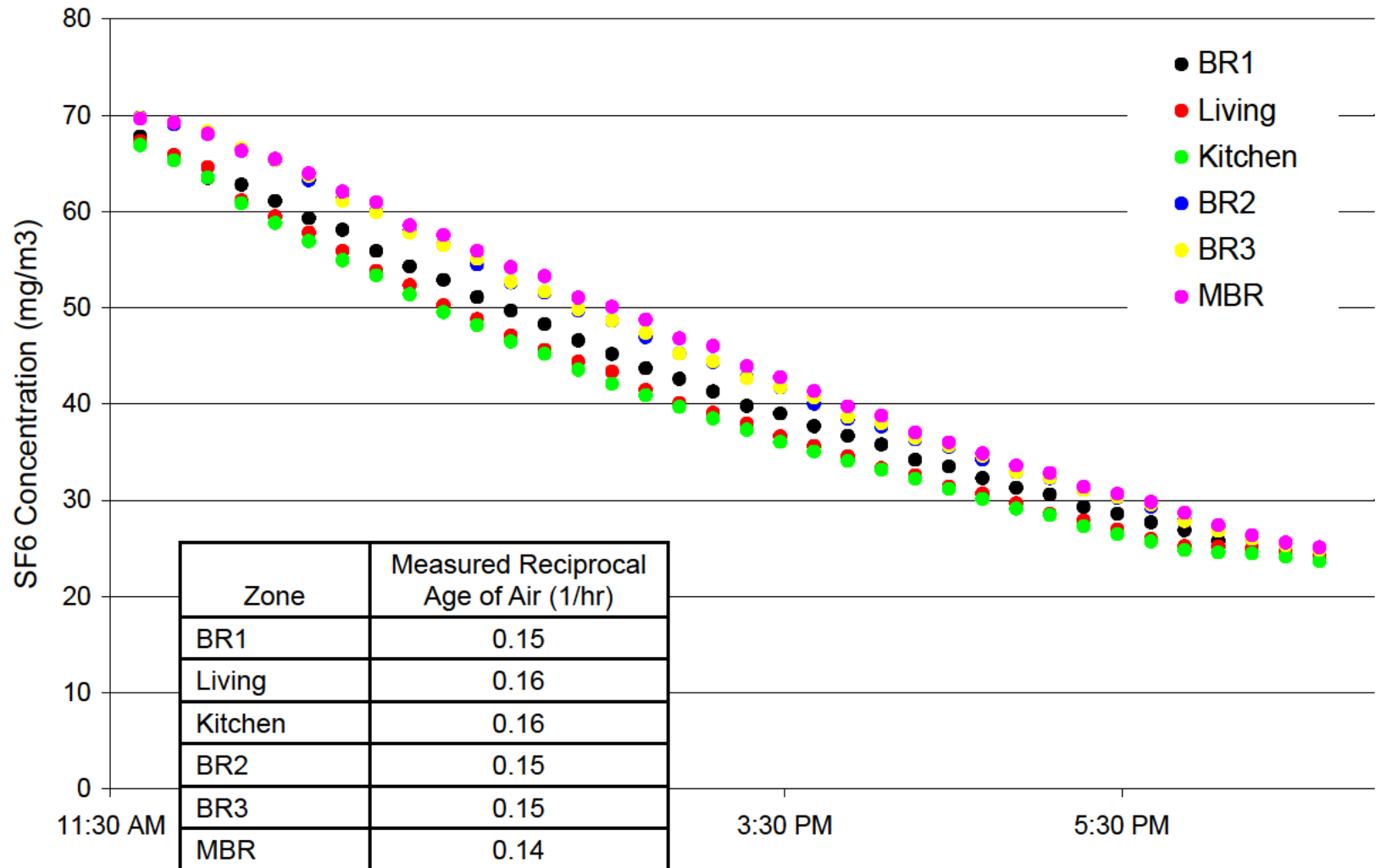
Example Results of Tracer Gas Testing

Laundry Exhaust, 100% of 62.2 Rate, Doors Closed, No Mixing



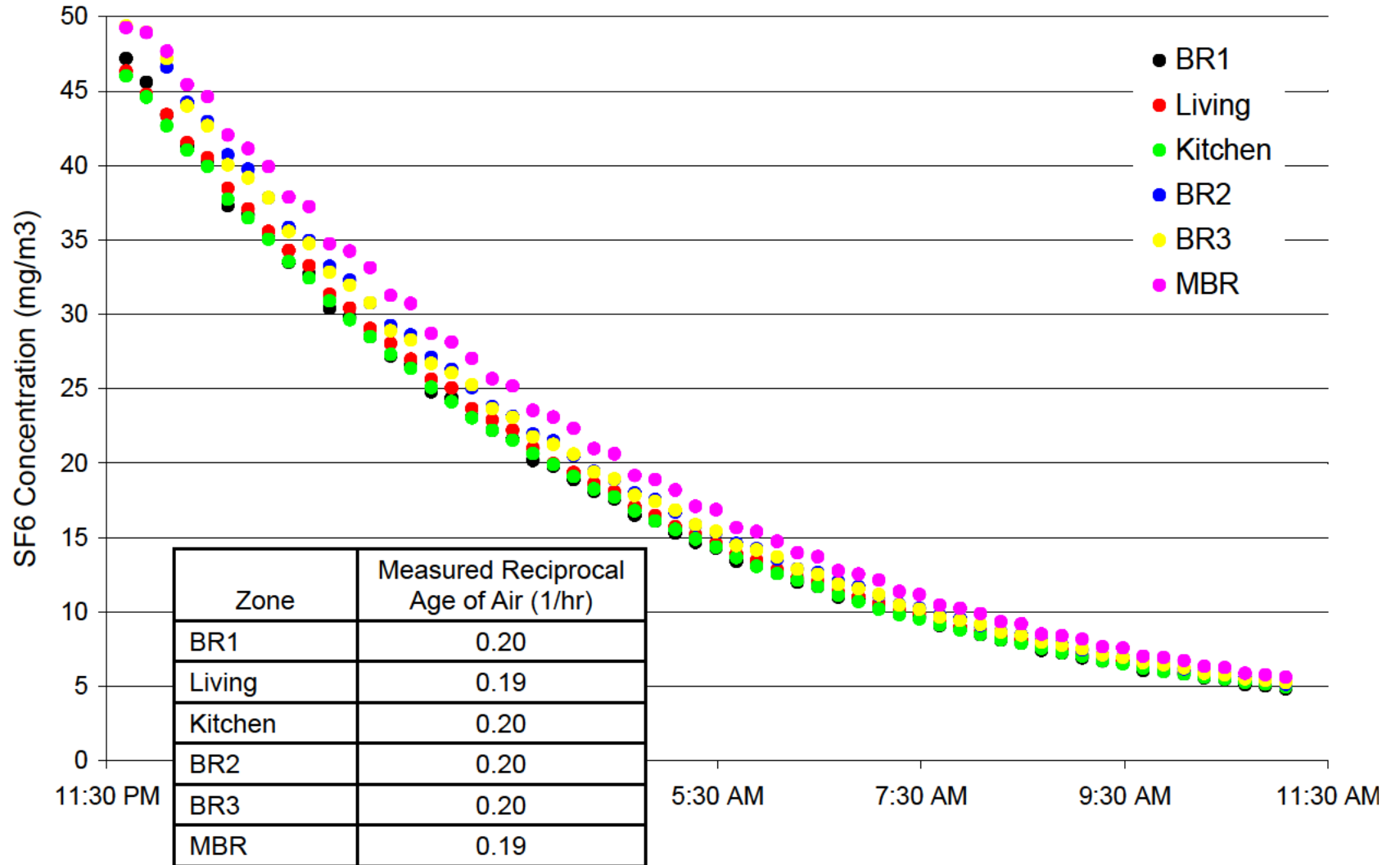
Example Results of Tracer Gas Testing

Laundry Exhaust, 100% of 62.2 Rate, Doors Closed, 33% Mixing



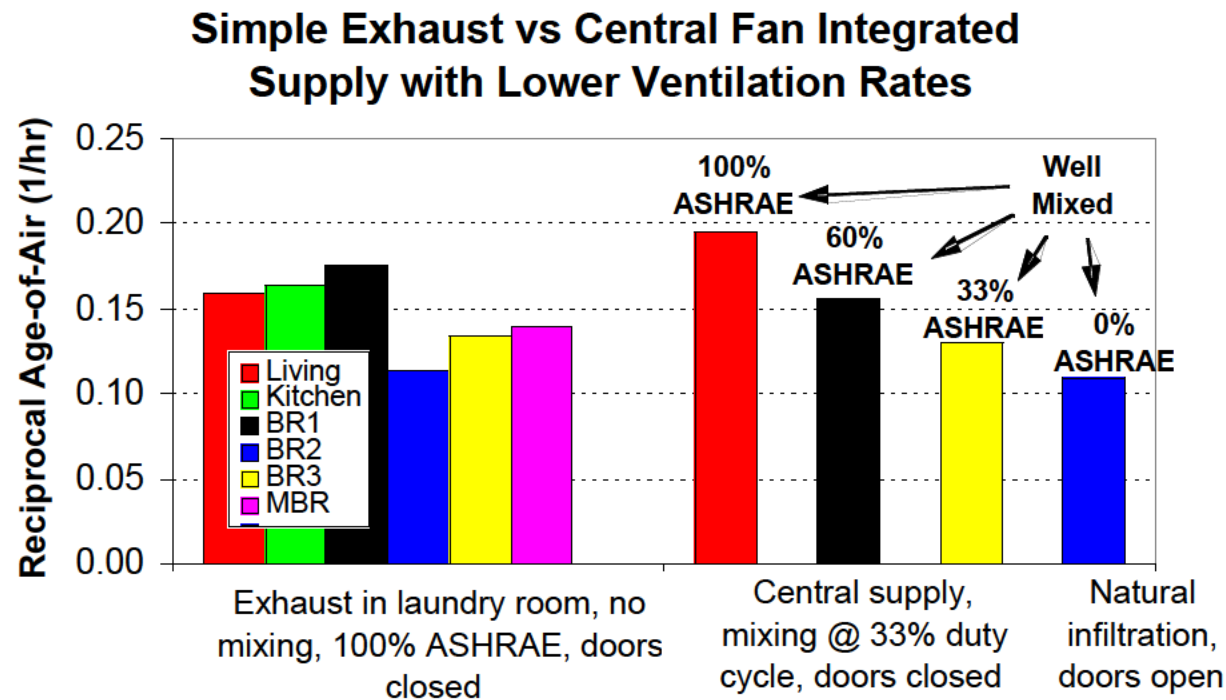
Example Results of Tracer Gas Testing

CFI, 100% of 62.2 Rate, Doors Closed, 33% Mixing

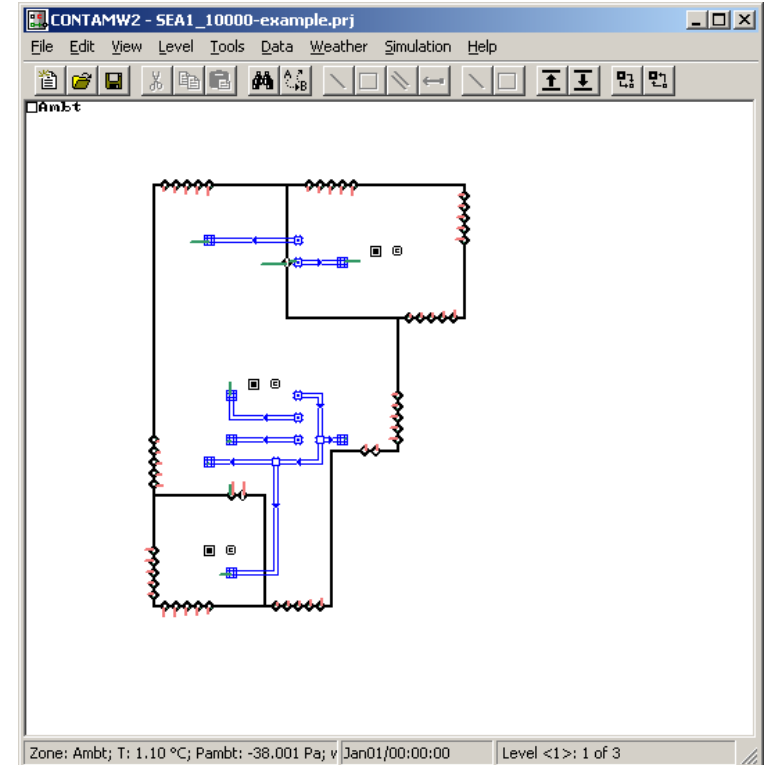
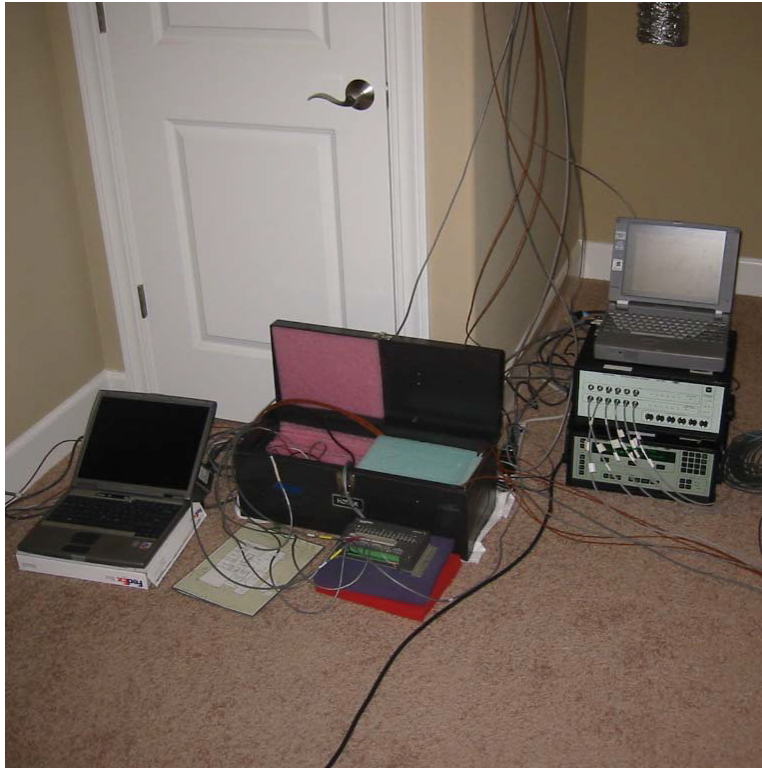


Conclusions From Tracer Gas Testing

- Mixing is very important to whole-house and individual zone pollutant decay rate
- Supply ventilation is slightly more effective than exhaust ventilation, even with mixing
- The location of a single-point ventilation system affects the performance



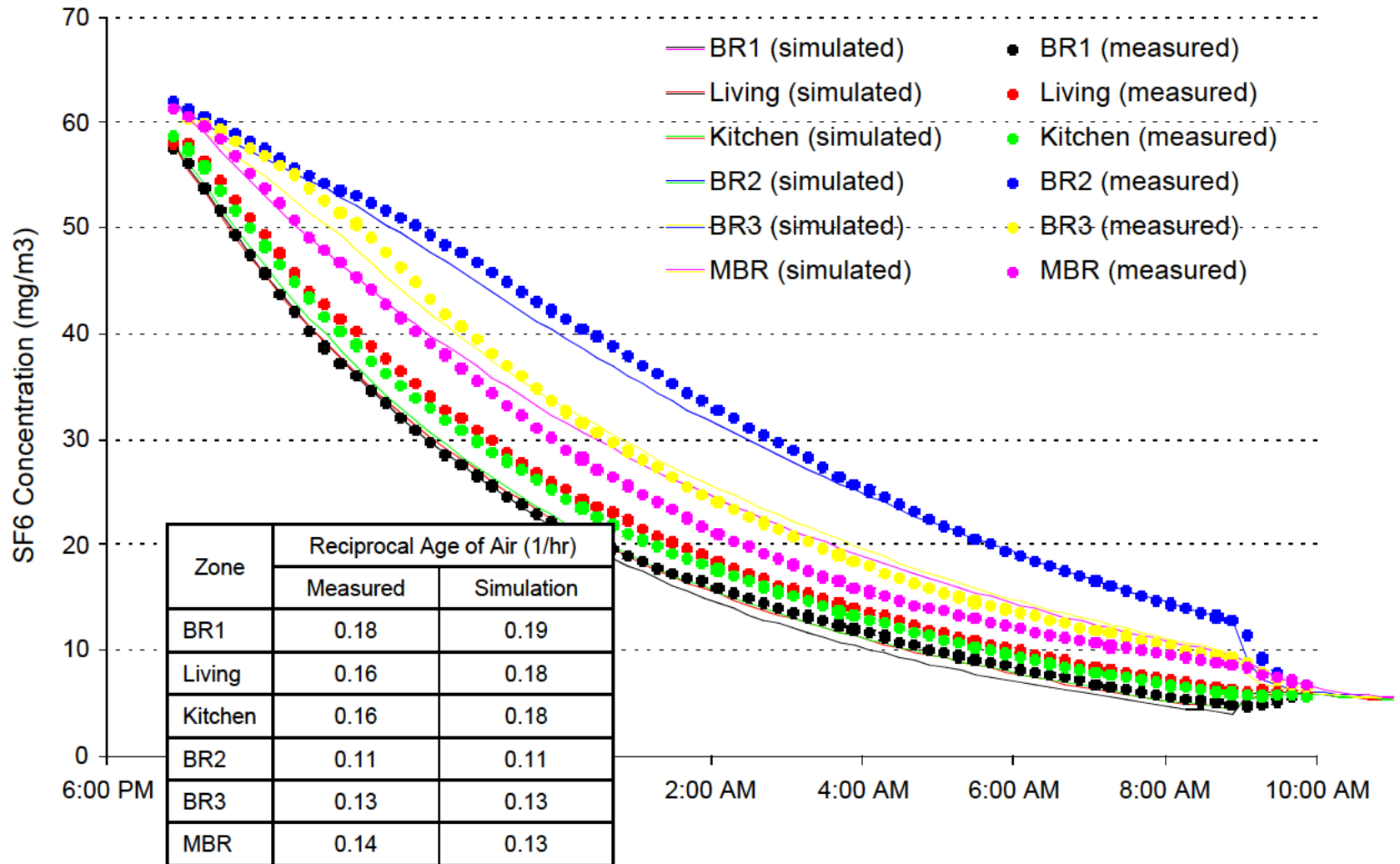
Tuned CONTAM Model



Computer modeling used to replicate field testing (tune the model) and predict performance of systems not tested in the field

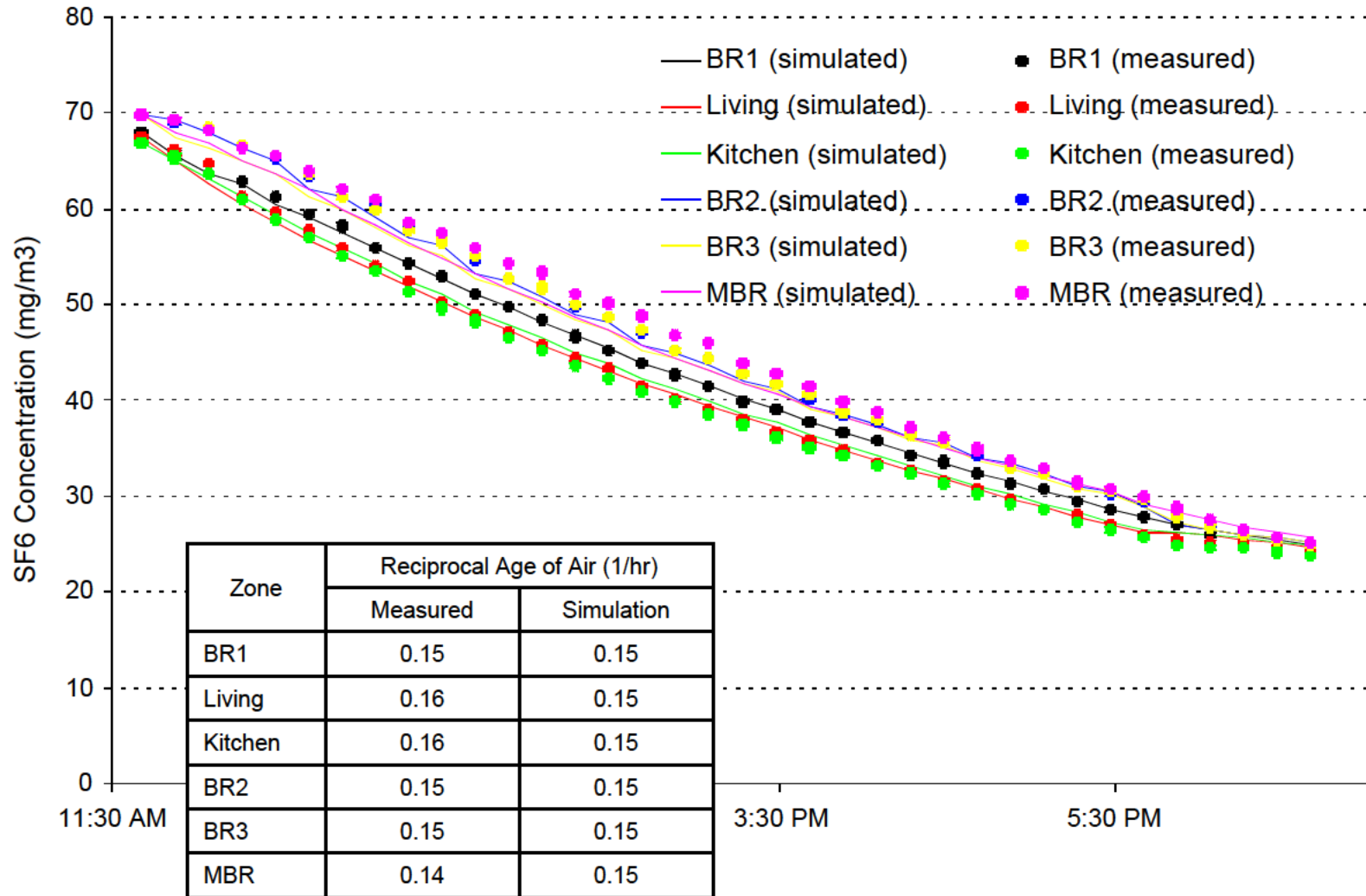
Example Results of Tuned CONTAM Model

Laundry Exhaust, 100% of 62.2 Rate, Doors Closed, No Mixing



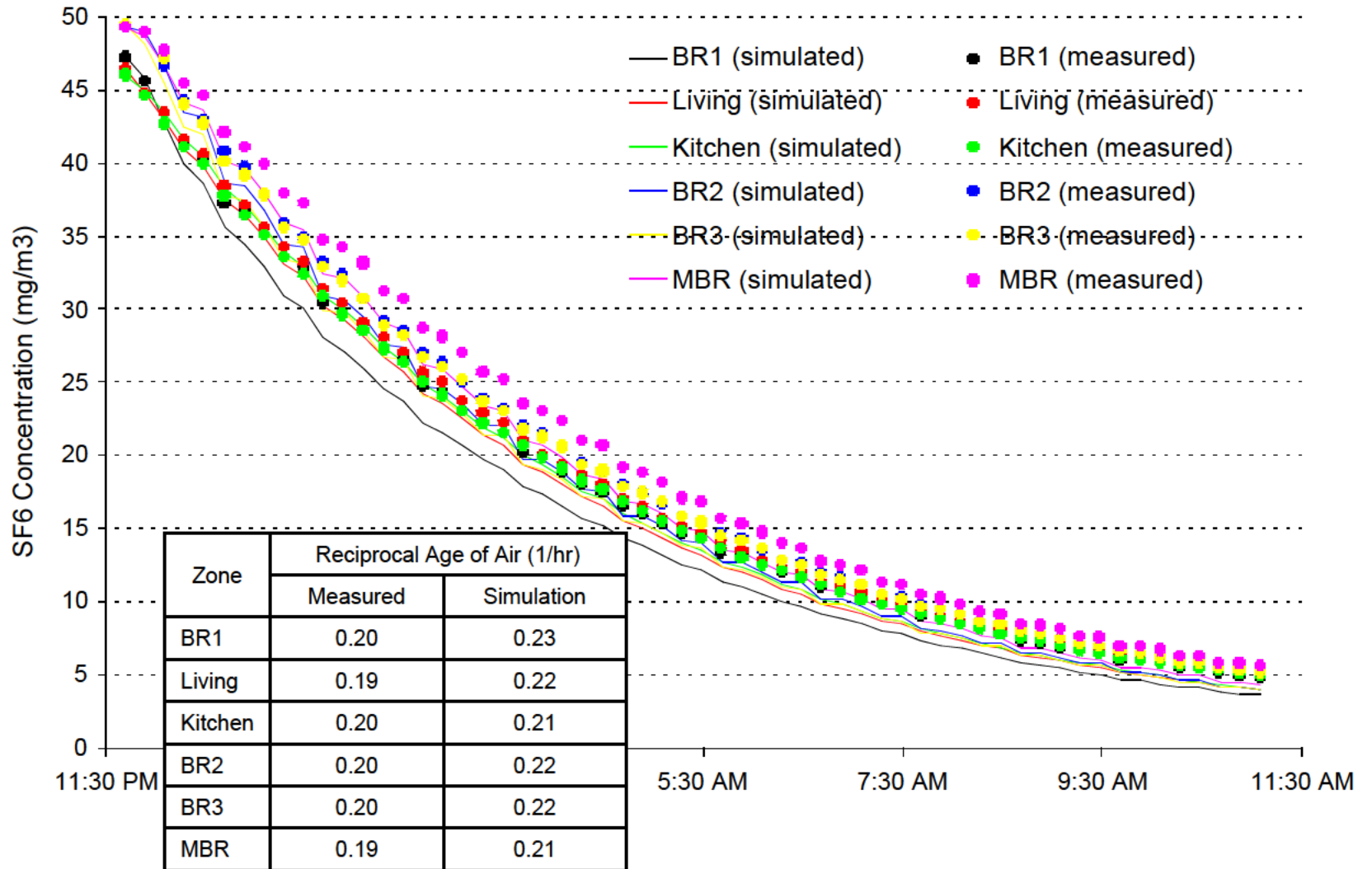
Example Results of Tuned CONTAM Model

Laundry Exhaust, 100% of 62.2 Rate, Doors Closed, 33% Mixing



Example Results of Tuned CONTAM Model

CFI, 100% of 62.2 Rate, Doors Closed, 33% Mixing



Tuned CONTAM Model Applied to Other Systems

Systems Evaluated & Compared:

1. Exhaust ventilation, without central duct system
2. Supply ventilation, without central duct system
3. Exhaust ventilation, with central ducts, standard Tstat
4. Exhaust ventilation, with central ducts, Tstat with timer
5. Supply ventilation, with central ducts, Tstat with timer
6. Fully ducted balanced ventilation system, without central duct system

$Q(v)$ = Ventilation Rate

$Q(\text{fan})$ = $Q(v) \cdot C(s)$

$C(s)$ = System Coefficient

Airflow Ratios—All Simulations

System Type	Range	Approximate Median
Fully ducted balanced ventilation system, with or without central duct system	1.0	1.0
Non-fully ducted balanced ventilation, with central duct system, and central air handler unit controlled to a minimum runtime of at least 10 minutes per hour	0.9 to 1.1	1.0
Supply ventilation, with central duct system, and central air handler unit controlled to a minimum runtime of at least 10 minutes per hour	1.1 to 1.7	1.25
Exhaust ventilation, with central duct system, and central air handler unit controlled to a minimum runtime of at least 10 minutes per hour	1.1 to 1.9	1.25
Exhaust ventilation, with central duct system, and central air handler unit not controlled to a minimum runtime of at least 10 minutes per hour	1.0 to 1.8	1.5
Supply ventilation, without central duct system	1.4 to 1.9	1.75
Exhaust ventilation, without central duct system	1.3 to 2.6	2.0

ASHRAE Standard 62.2 calls for 7.5 cfm per person plus 0.03 cfm per square foot of conditioned area

Occupancy is deemed to be the number of bedrooms plus one