Moisture Buffering And Ventilation Strategies To Control Indoor Humidity in a Marine Environment

A Field Experimental Study

Shahrzad Pedram, MASc, P.Eng. – RDH Building Science Inc.

Fitsum Tariku, PhD – BCIT Building Science Centre of Excellence

Outline

Introduction

- What is moisture buffering?

Methodology

Experimental Set-up

- Indoor moisture and CO_2 load
- Ventilation strategies

Results

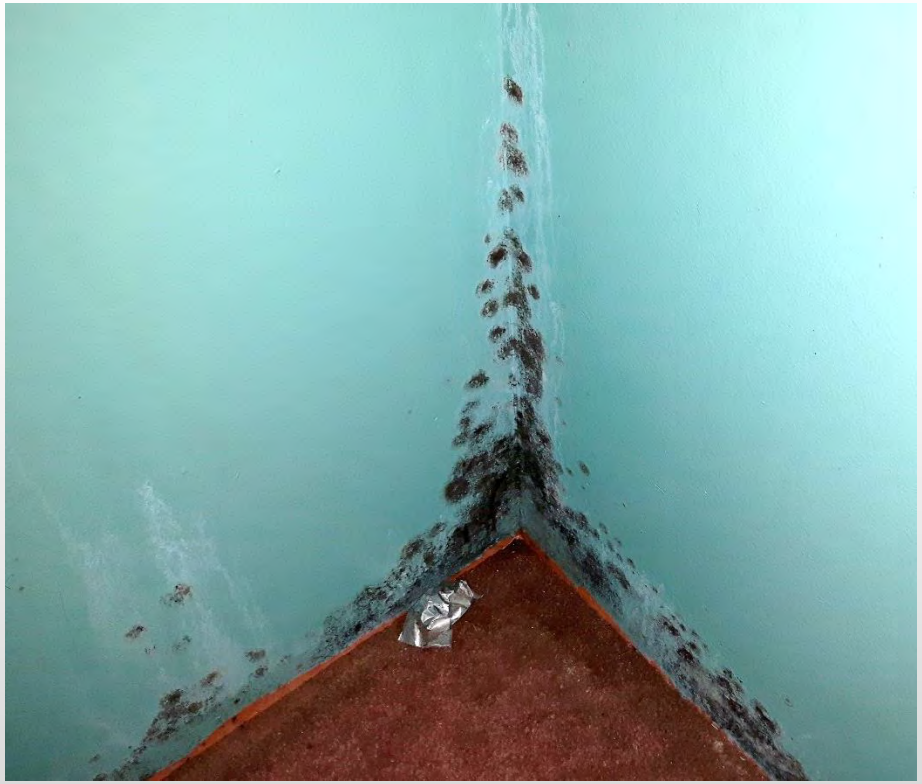
- Indoor humidity, CO2 levels, and ventilation heat loss

Conclusions and future works

indoor humidity

HVAC

High Indoor Humidity



High Indoor Humidity

Building air leakage rate

Ventilation systems

Occupants' lifestyle

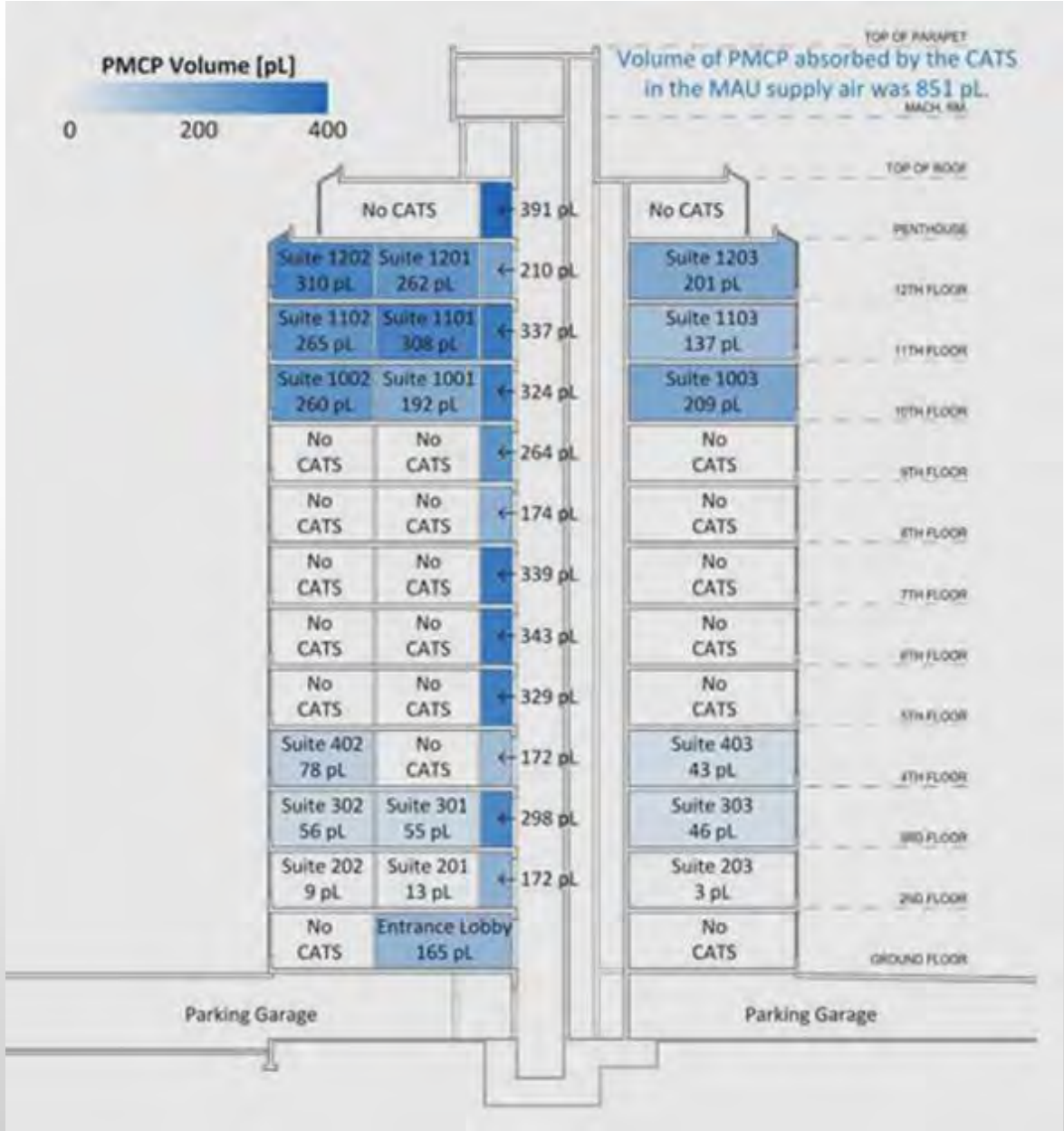
Building Airtightness

Source: http://en.wikipedia.org/wiki/Blower_door

Building Airtightness

Source: http://www.nanaimo-info-blog.com/2010/05/nanaimo-leaky-condo-townsite-raod.html

Ventilation Systems



Source: Ricketts & Straube (2014)

Occupants' Behaviour

indoor humidity

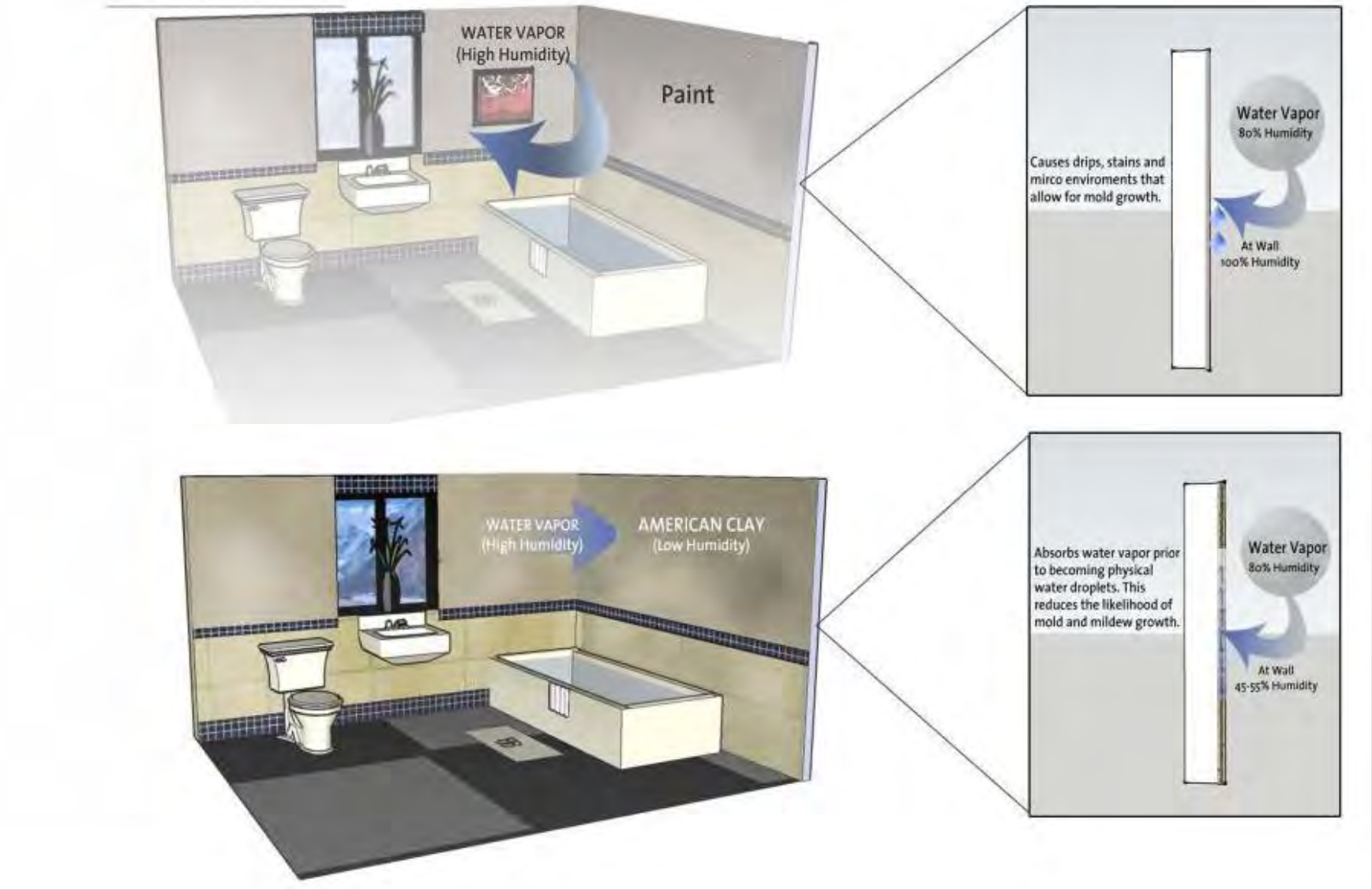
Moisture buffering

Hygric inertia

Humidity buffering

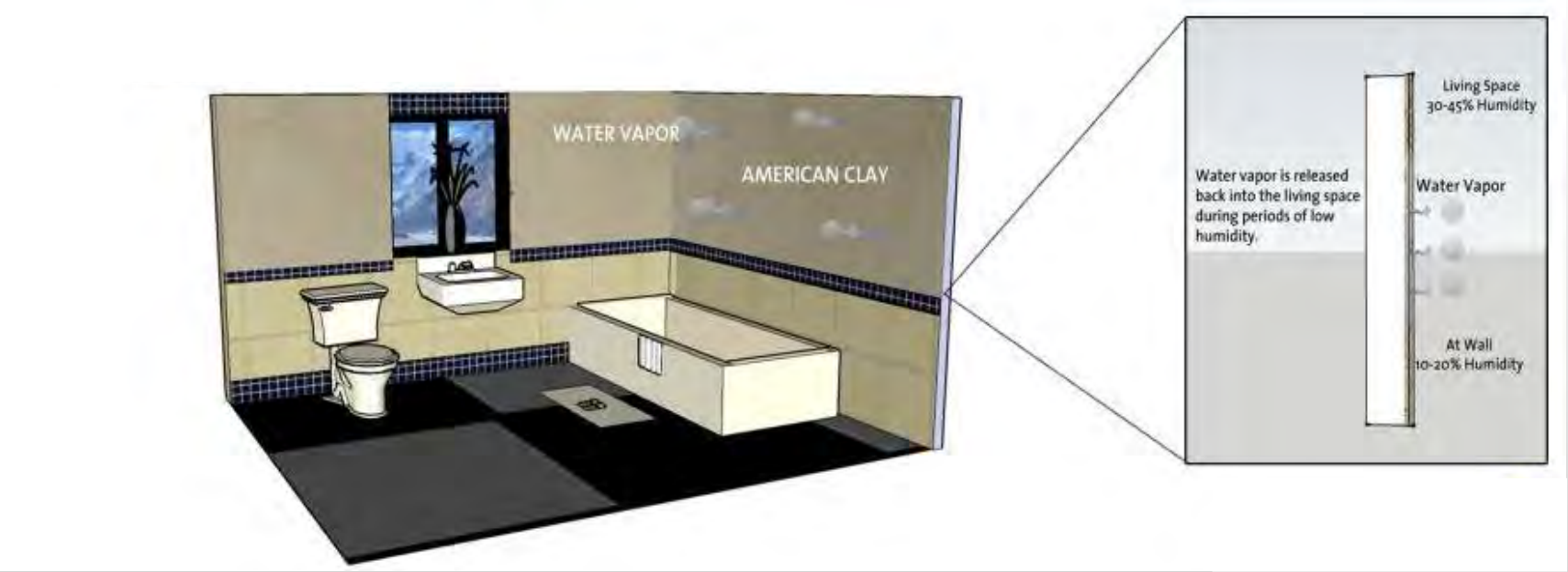
What is moisture buffering?

High Humidity

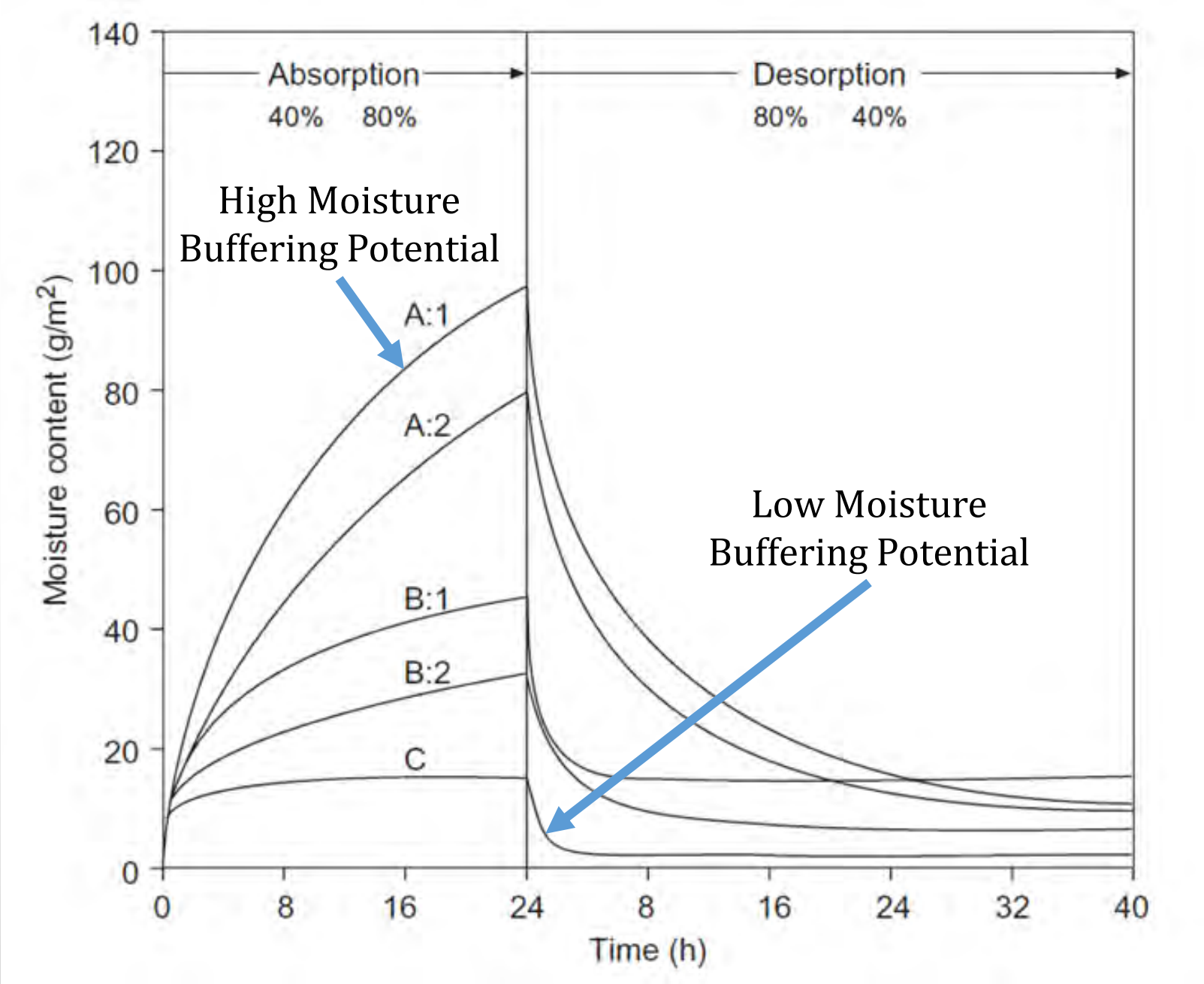


Source: American Clay

Low Humidity

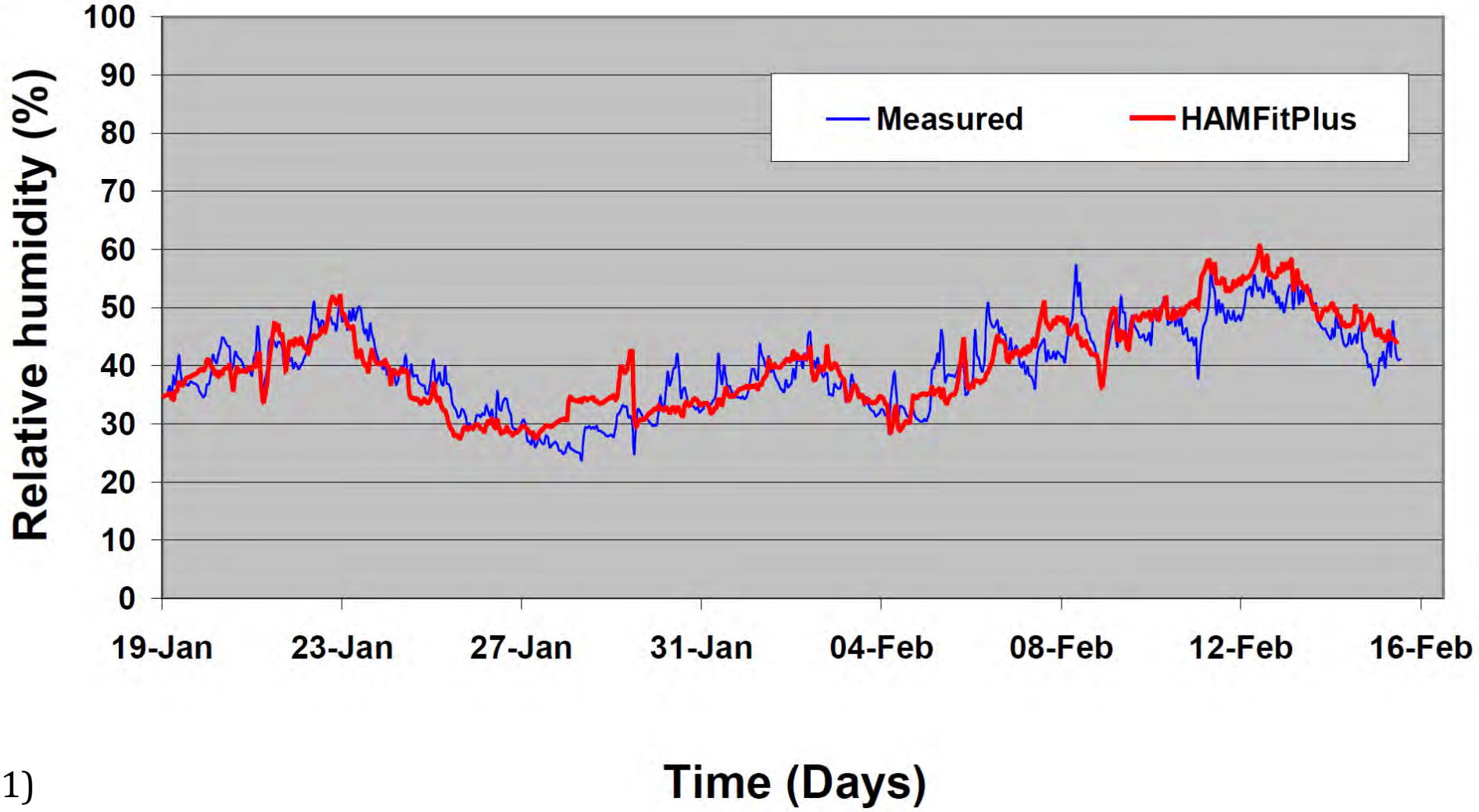


Source: American Clay



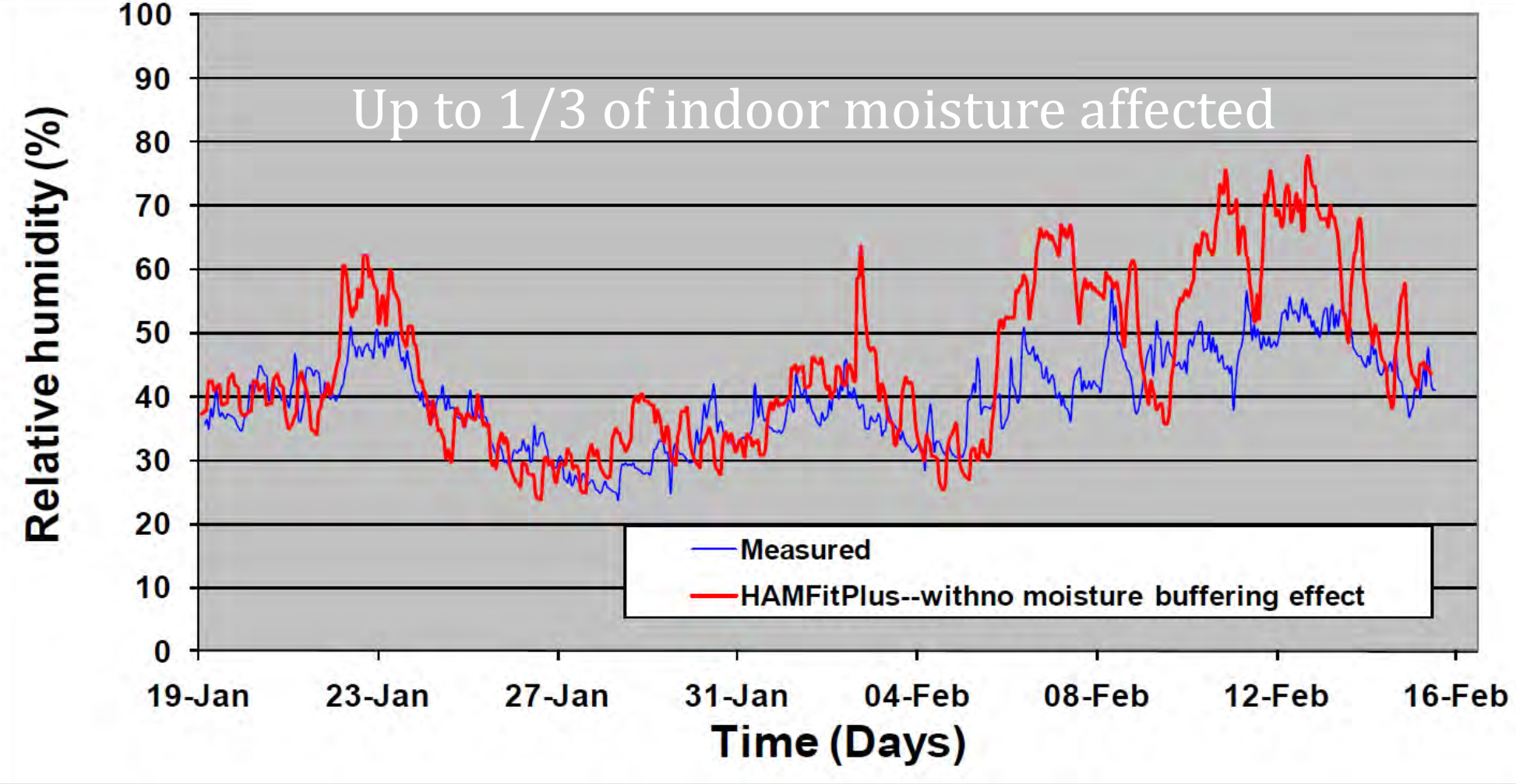
Svennberg, et al. (2007)

Previous research has shown that **moisture buffering** can greatly affect indoor relative humidity.



Tariku (2011)

Previous research has shown that **moisture buffering** can greatly affect indoor relative humidity.

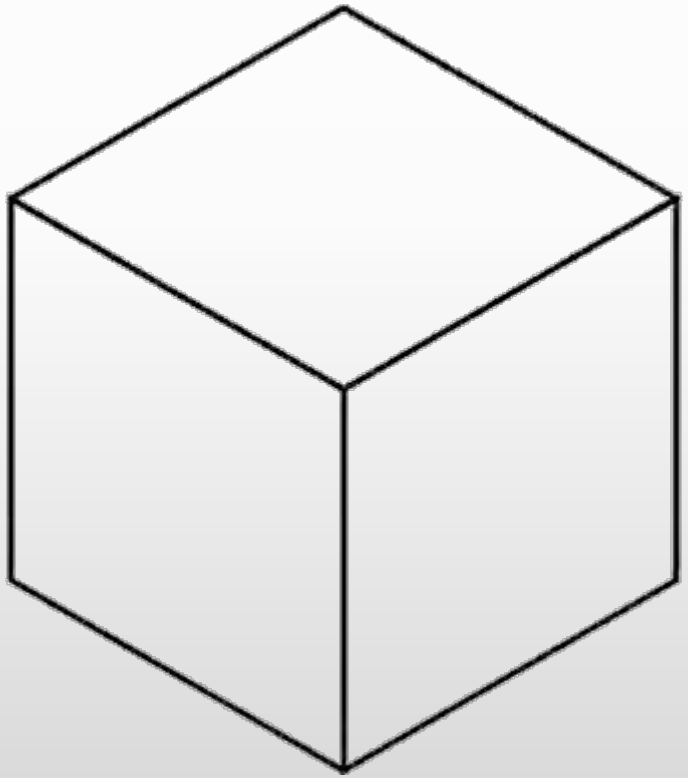


Tariku (2011)

Can moisture buffering help manage indoor humidity in a marine climate under varying ventilation schemes?

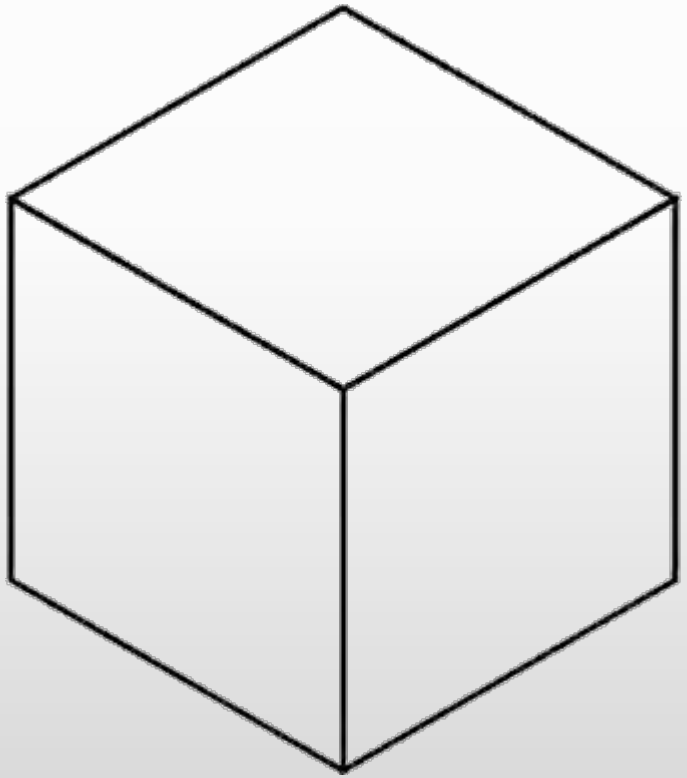
Field Testing

Control building



no moisture buffering

Test building



with moisture buffering

Why field testing?

Exposure to real climatic conditions

Can control interior operating conditions

Data can be used for verification of building simulation models

Why Vancouver's marine climate?

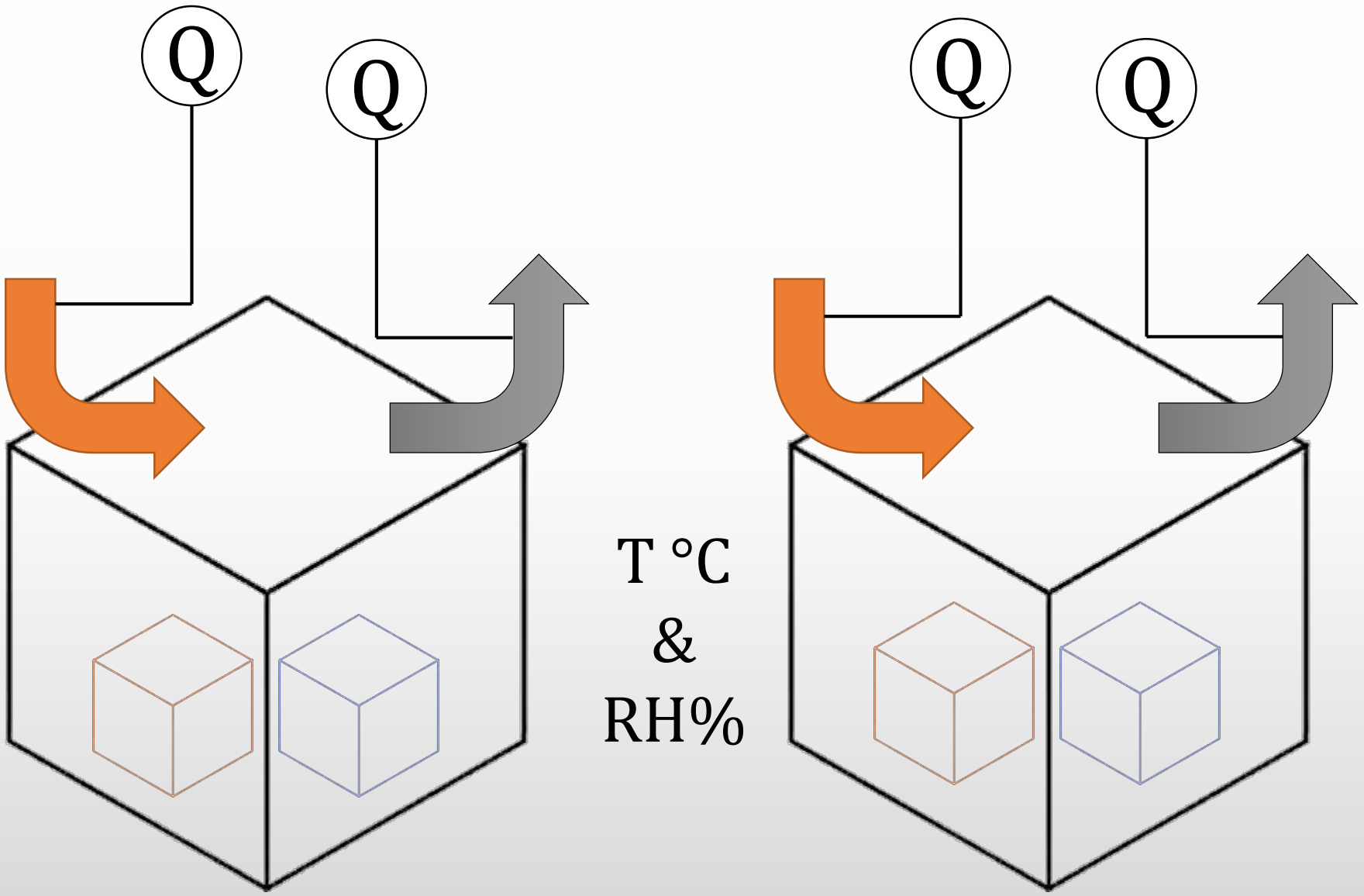
Field studies of moisture buffering have been undertaken in predominantly cold climates

- Sweden (Hameury, 2004)
- Denmark (Woloszyn et al, 2005)
- Germany (Kuenzel et al, 2004)

No field studies in a marine climate to date

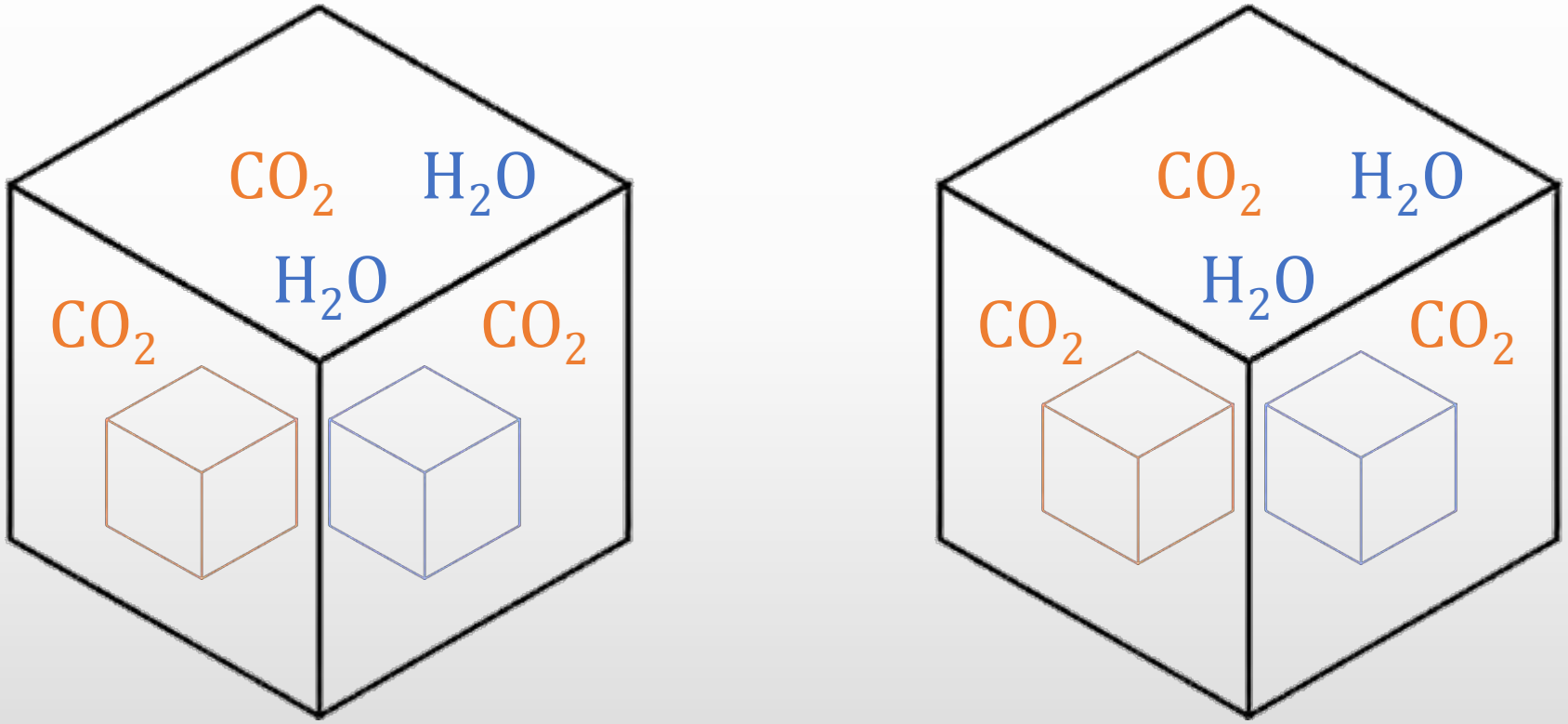
Whole-Building Performance Research Lab

Whole-Building Performance Research Lab



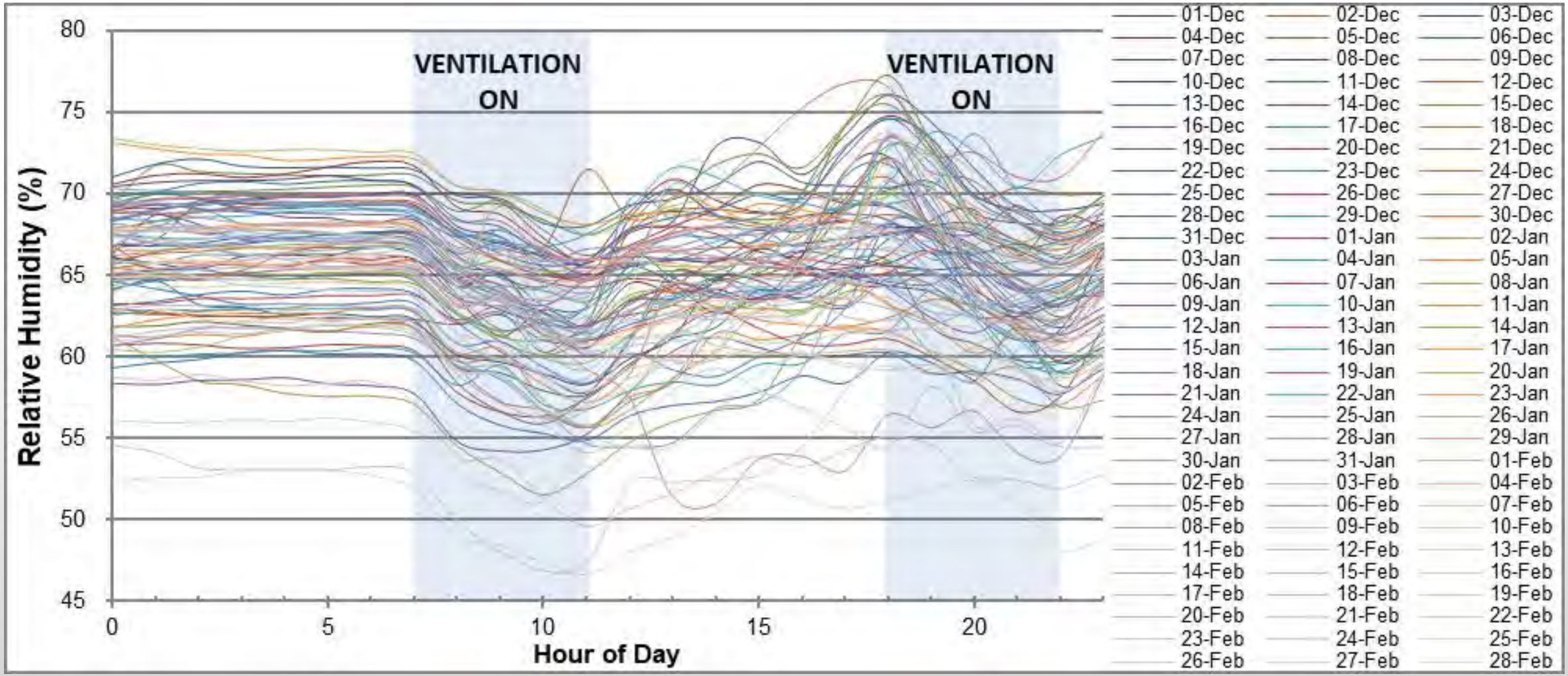
Varying ventilation strategies

Occupancy

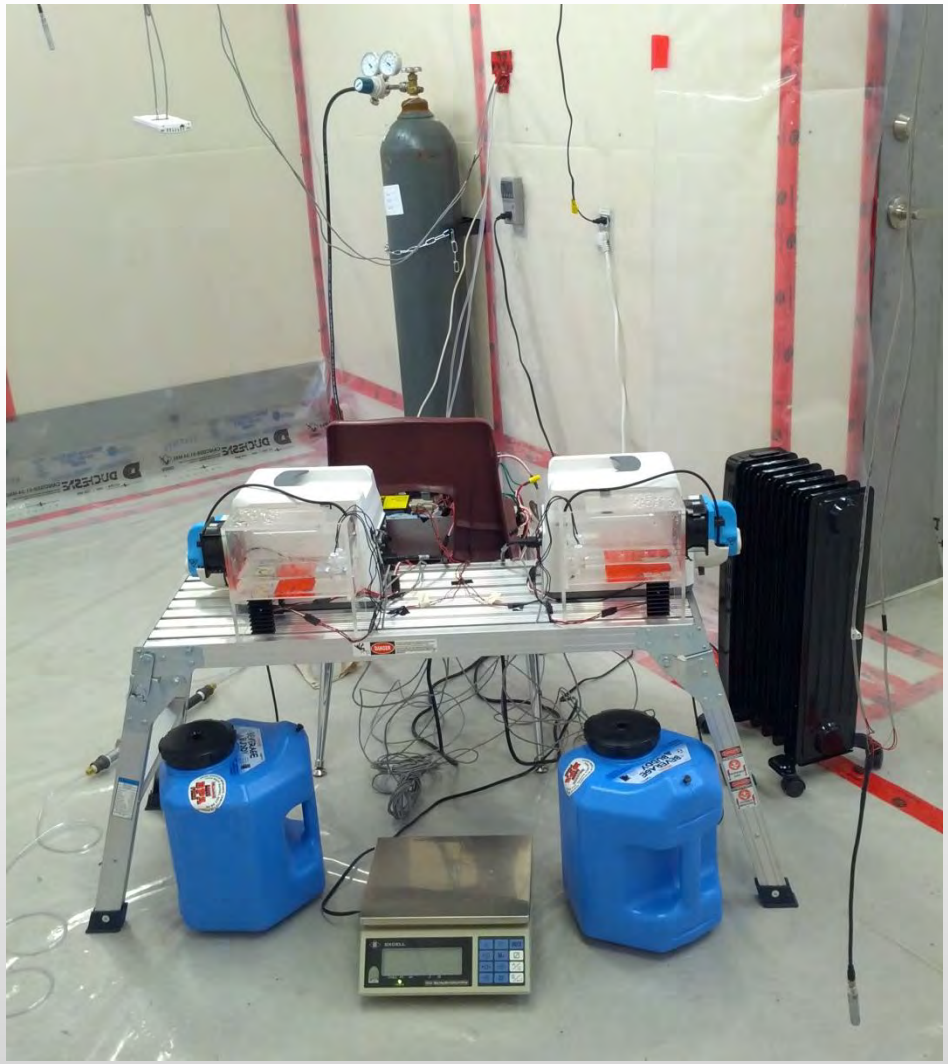


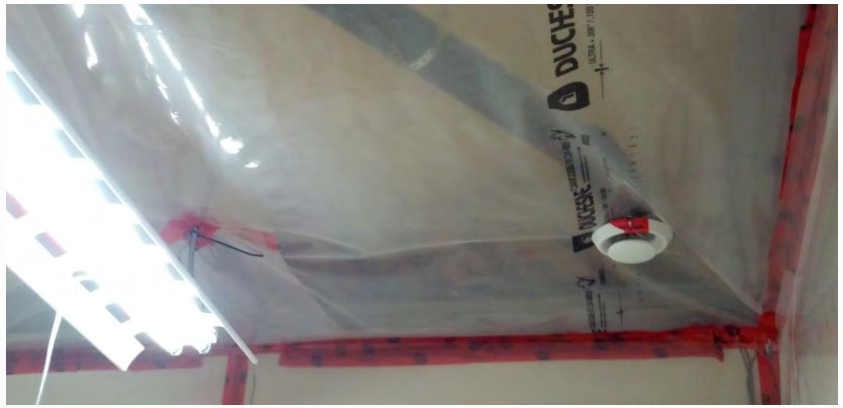
Simulated occupant loading

Actual indoor humidity data from a real suite



Occupancy simulators





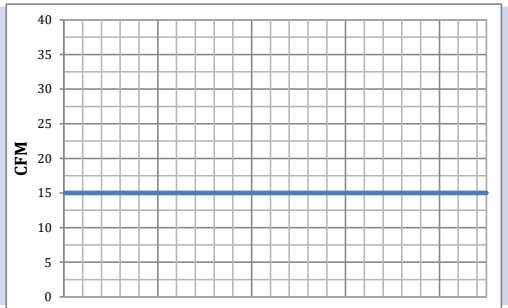
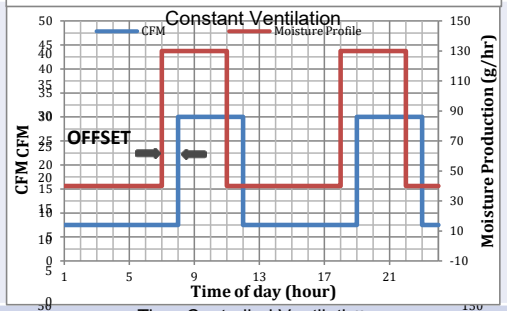
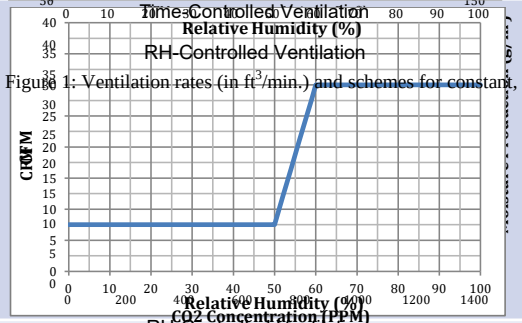
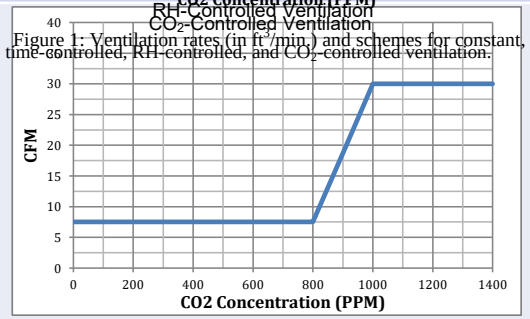
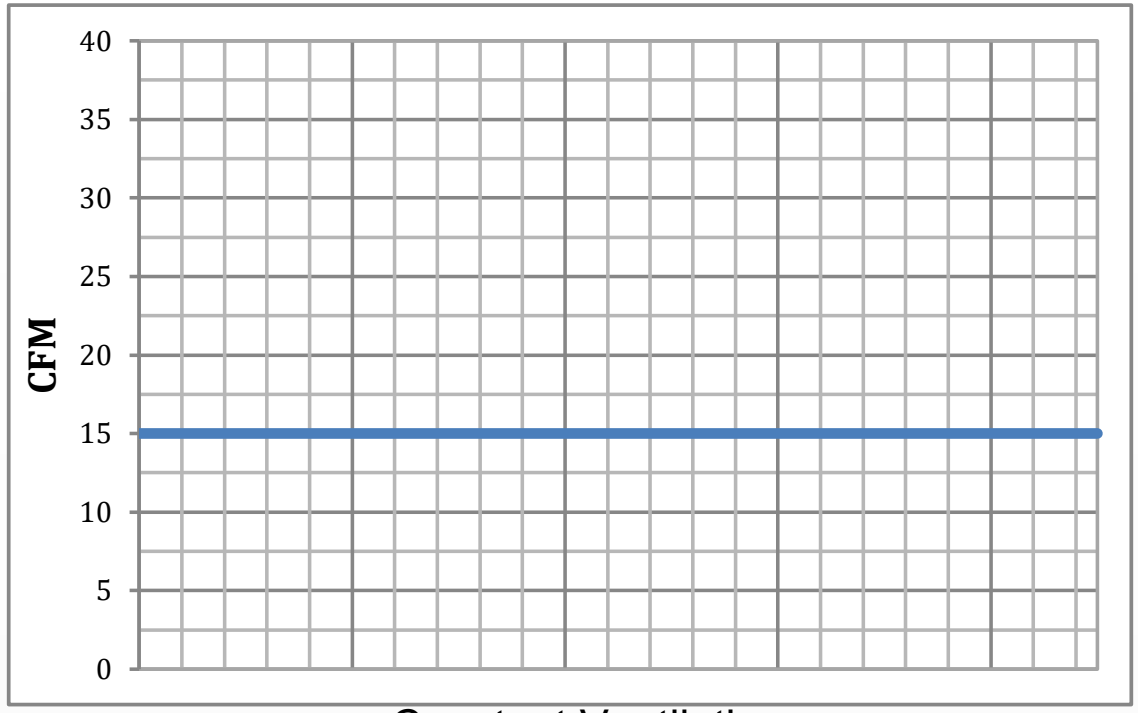
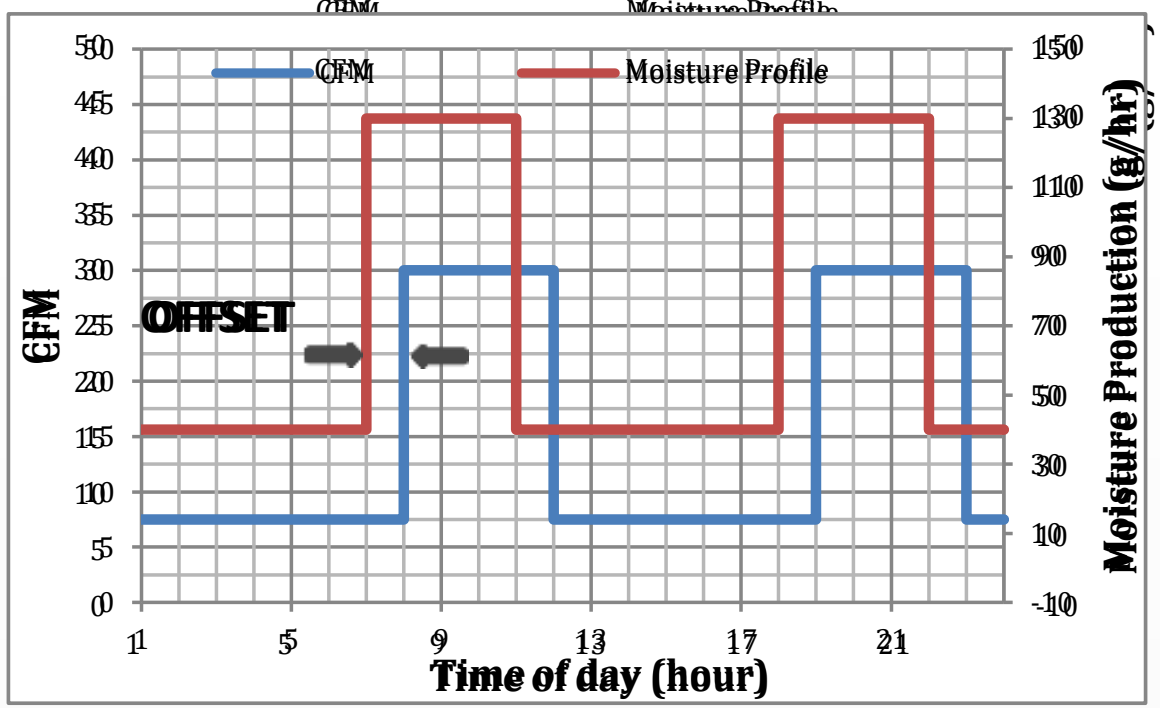
Test #	Test Period	Ventilation Scheme	Ventilation Strategy	
1	April 2014	Constant	15 CFM	
2	April 2014	Time Controlled	30 CFM at 8am - 12pm and 7pm - 11pm, 7.5 CFM all other times	
3	June 2014	RH Controlled	7.5 CFM at 50% RH or less, 30 CFM at 60% RH or more, between 50-60% RH linearly increasing CFM between 7.5 and 30 CFM	
4	July 2014	CO_2 Controlled	7.5 CFM at 800ppm or less, 30 CFM at 1000ppm or more, between 800-1000ppm linearly increasing CFM between 7.5 and 30 CFM	

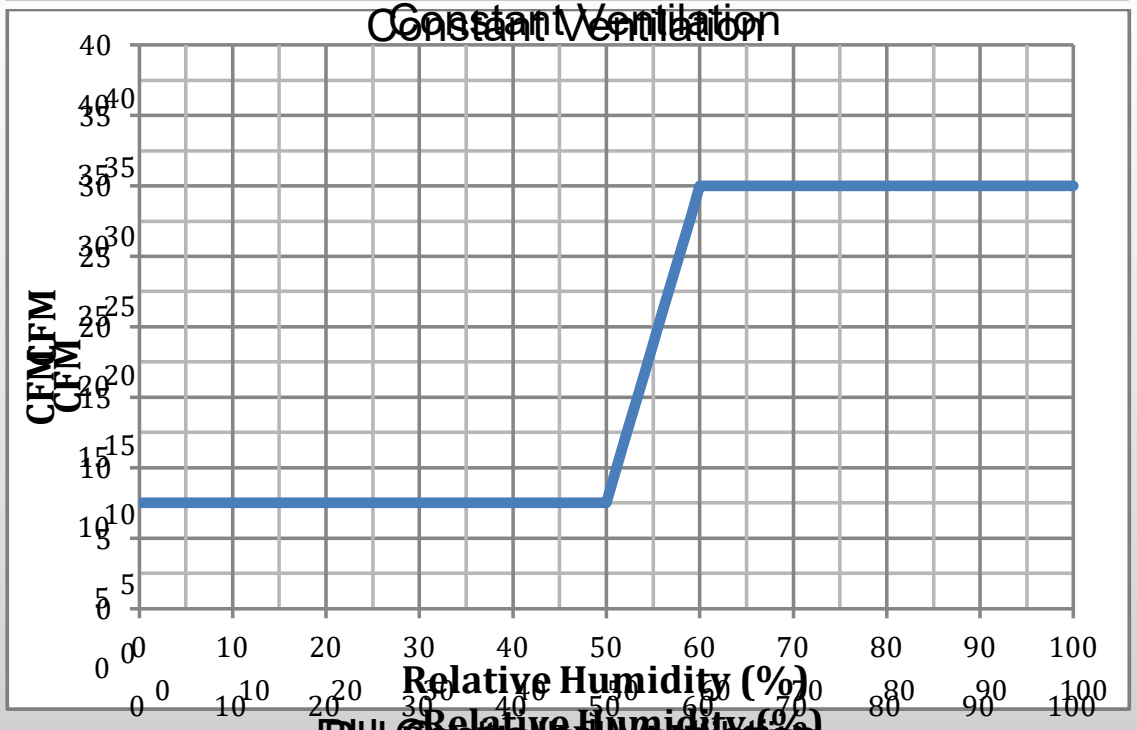
Figure 1: Ventilation rates (in ft^3/min.) and schemes for constant, time-controlled, RH-controlled, and CO_2-controlled ventilation.

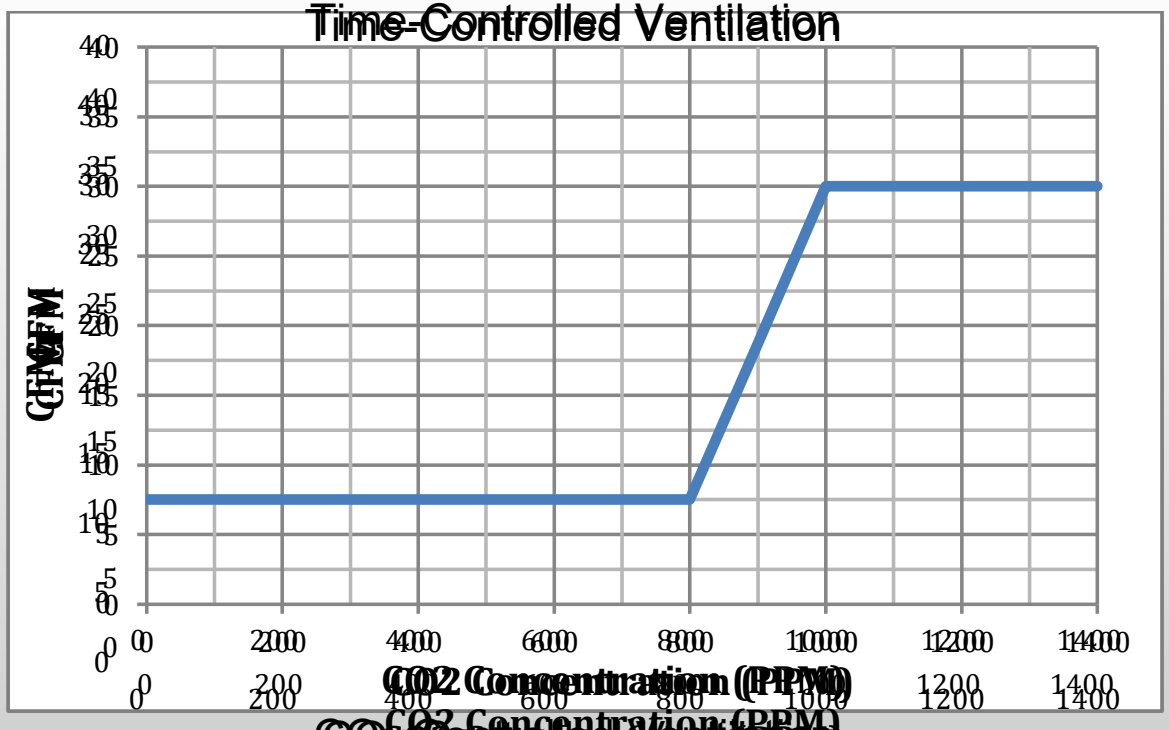


Constant Ventilation

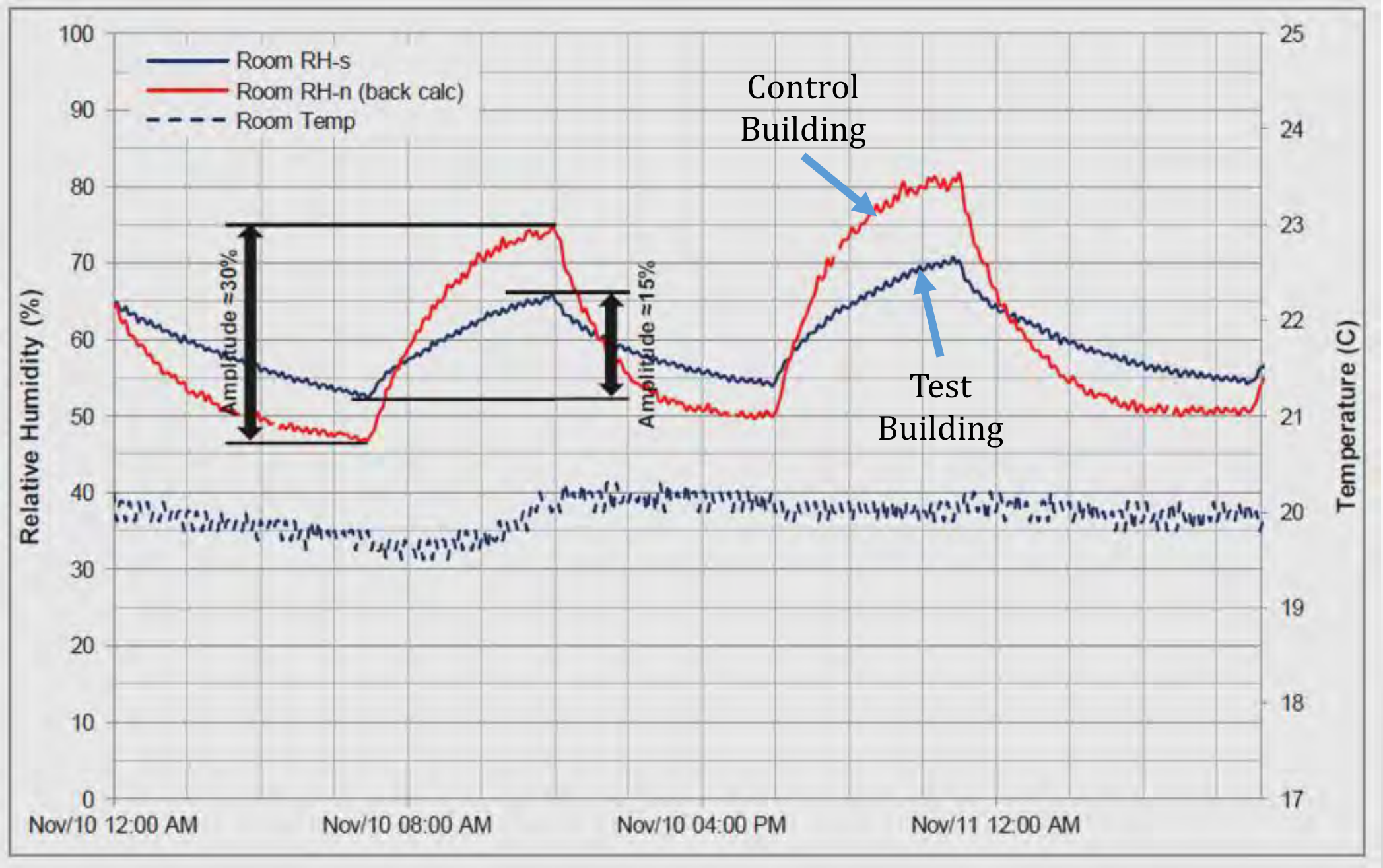


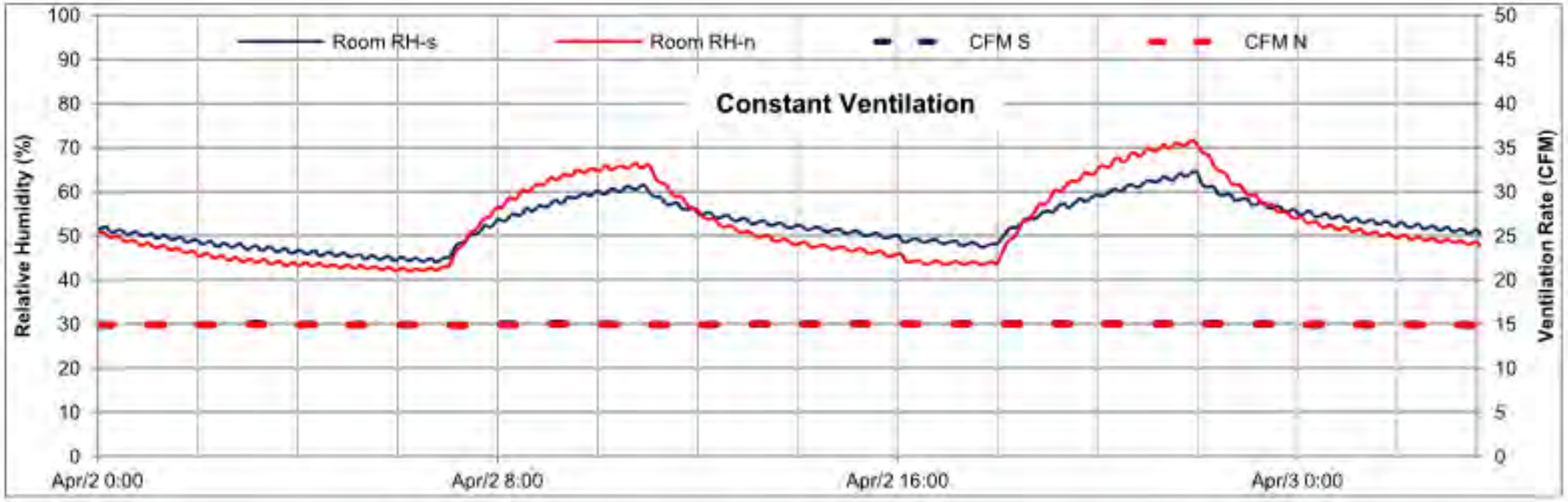
Time-Controlled Ventilation

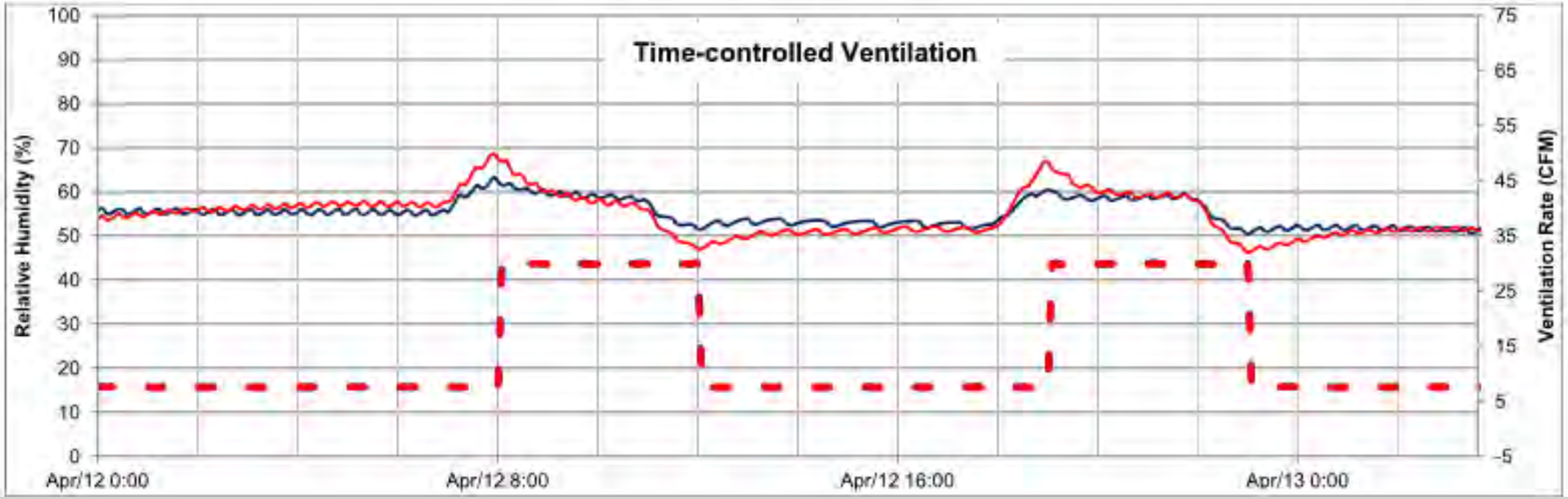


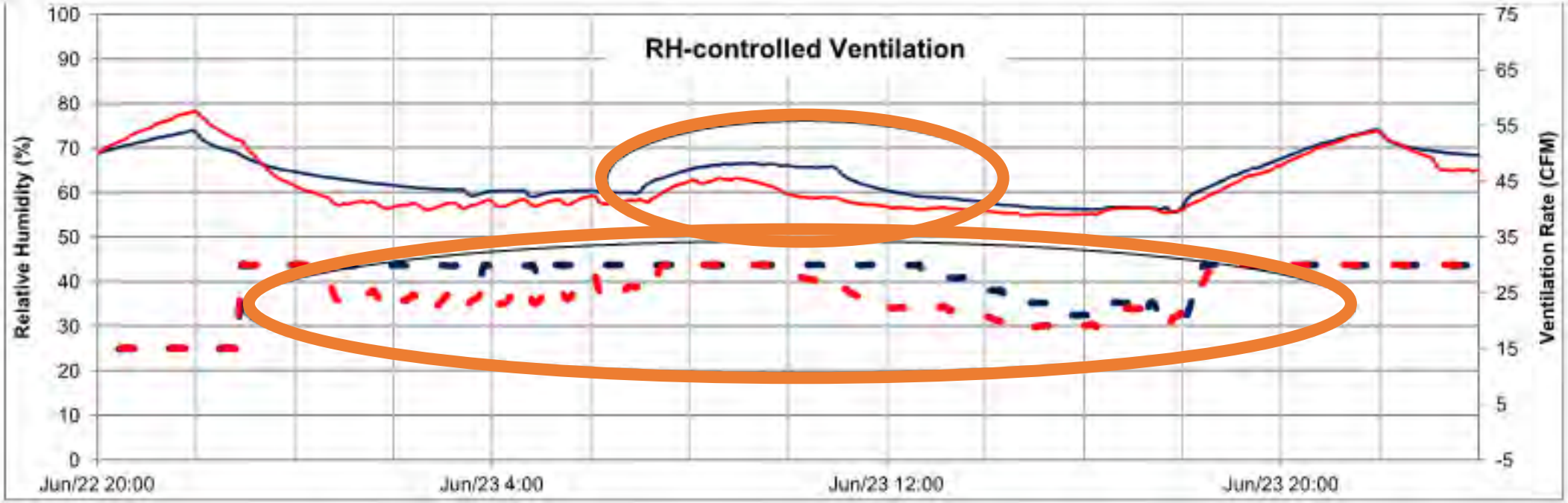


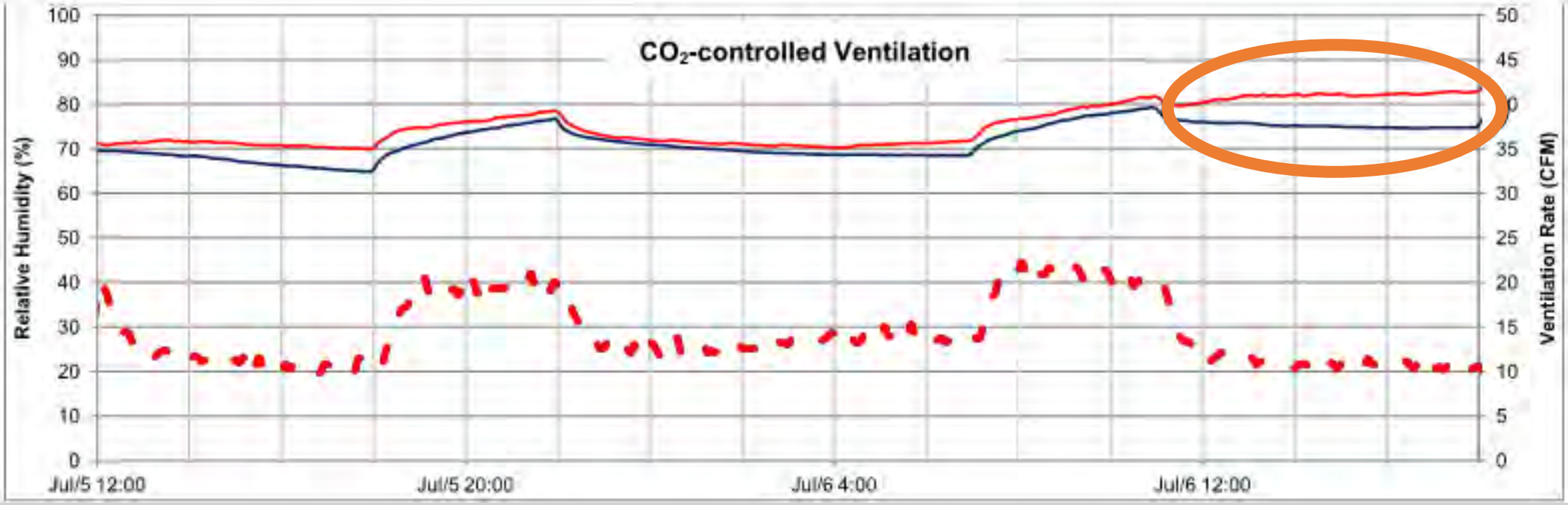
Results


Room RH-s
Room RH-n (back calc)
Room Temp
Control Building
Test Building
Amplitude ≈30%
Amplitude ≈15%
Relative Humidity (%)
Temperature (C)
100
90
80
70
60
50
40
30
20
10
0
25
24
23
22
21
20
19
18
17
Nov/10 12:00 AM
Nov/10 08:00 AM
Nov/10 04:00 PM
Nov/11 12:00 AM

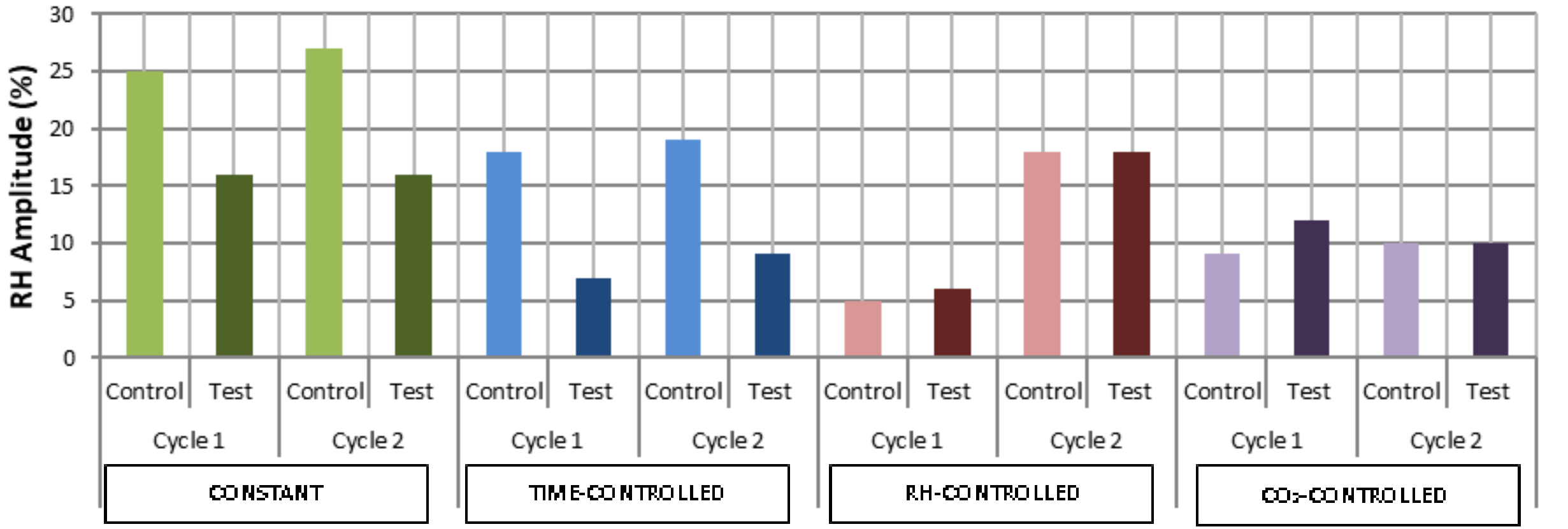

Room RH-s
Room RH-n
CFM S
CFM N
Constant Ventilation
Relative Humidity (%)
Ventilation Rate (CFM)
100
90
80
70
60
50
40
30
20
10
0
50
45
40
35
30
25
20
15
10
5
0
Apr/2 0:00
Apr/2 8:00
Apr/2 16:00
Apr/3 0:00


Time-controlled Ventilation
Relative Humidity (%)
Ventilation Rate (CFM)
100
90
80
70
60
50
40
30
20
10
0
75
65
55
45
35
25
15
5
-5
Apr/12 0:00
Apr/12 8:00
Apr/12 16:00
Apr/13 0:00

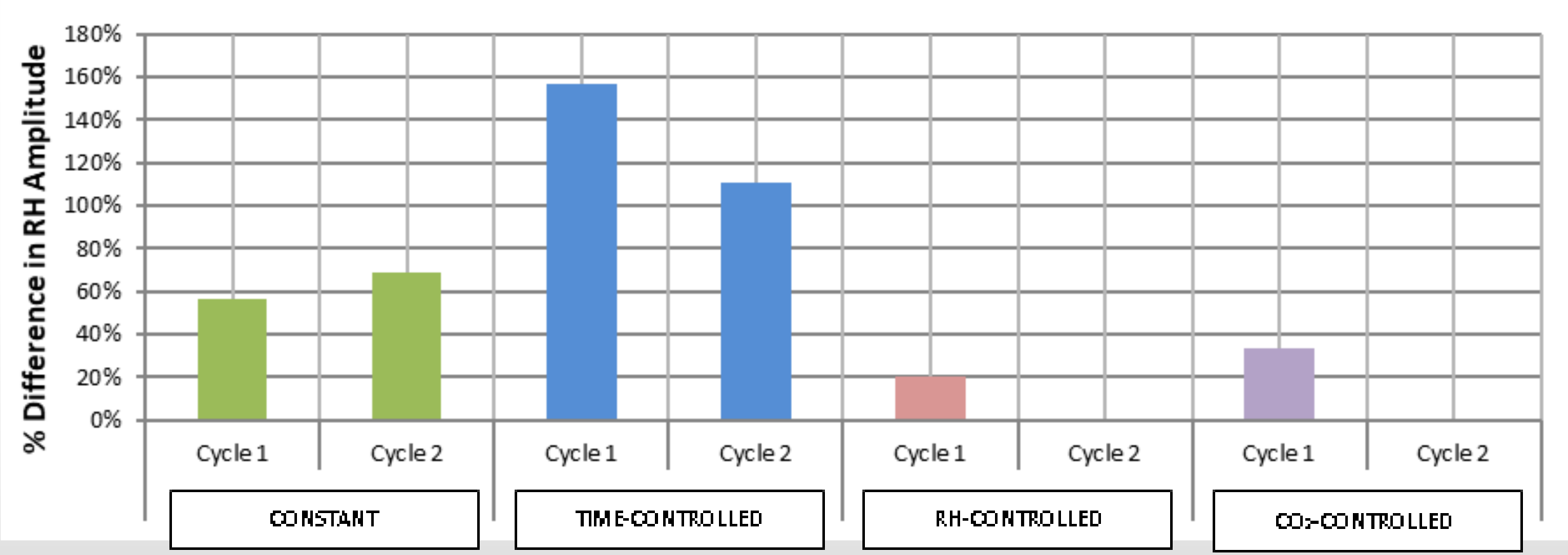

RH-controlled Ventilation
Relative Humidity (%)
Ventilation Rate (CFM)
100
90
80
70
60
50
40
30
20
10
0
75
65
55
45
35
25
15
5
-5
Jun/22 20:00
Jun/23 4:00
Jun/23 12:00
Jun/23 20:00


CO₂-controlled Ventilation
Relative Humidity (%)
Ventilation Rate (CFM)
100
90
80
70
60
50
40
30
20
10
0
50
45
40
35
30
25
20
15
10
5
0
Jul/5 12:00
Jul/5 20:00
Jul/6 4:00
Jul/6 12:00

Relative Humidity Amplitudes

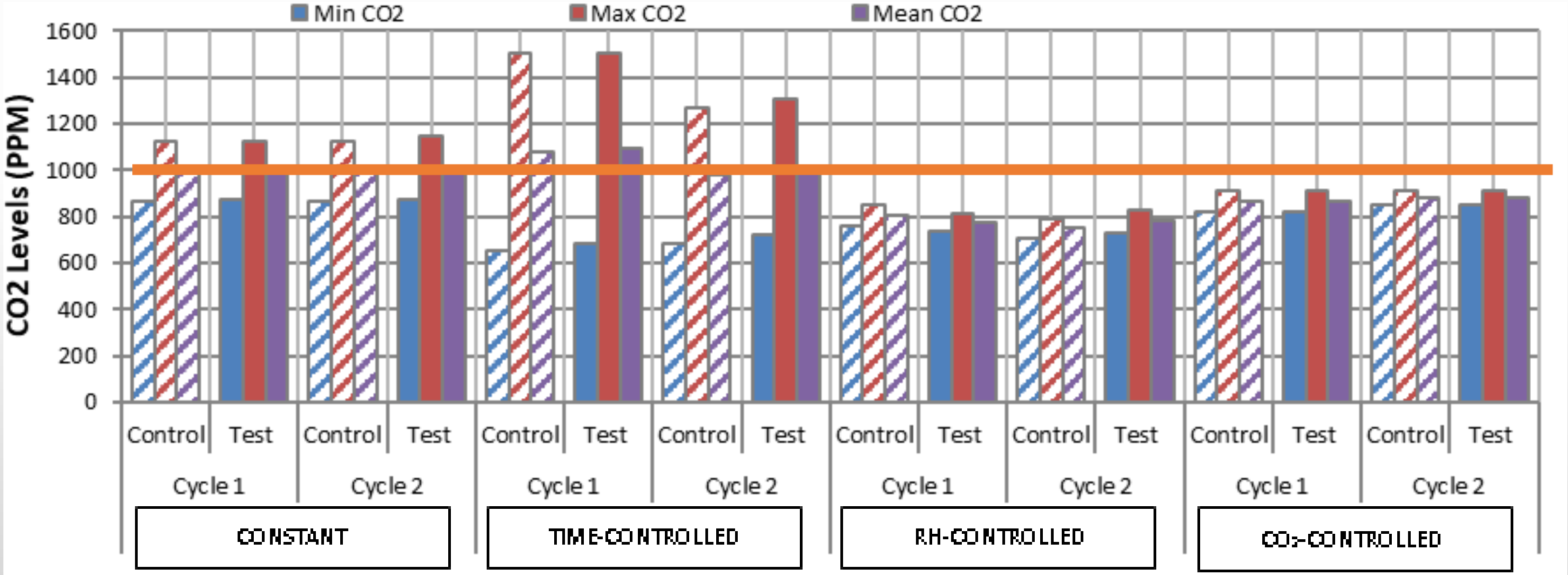


Δ in Relative Humidity Amplitudes

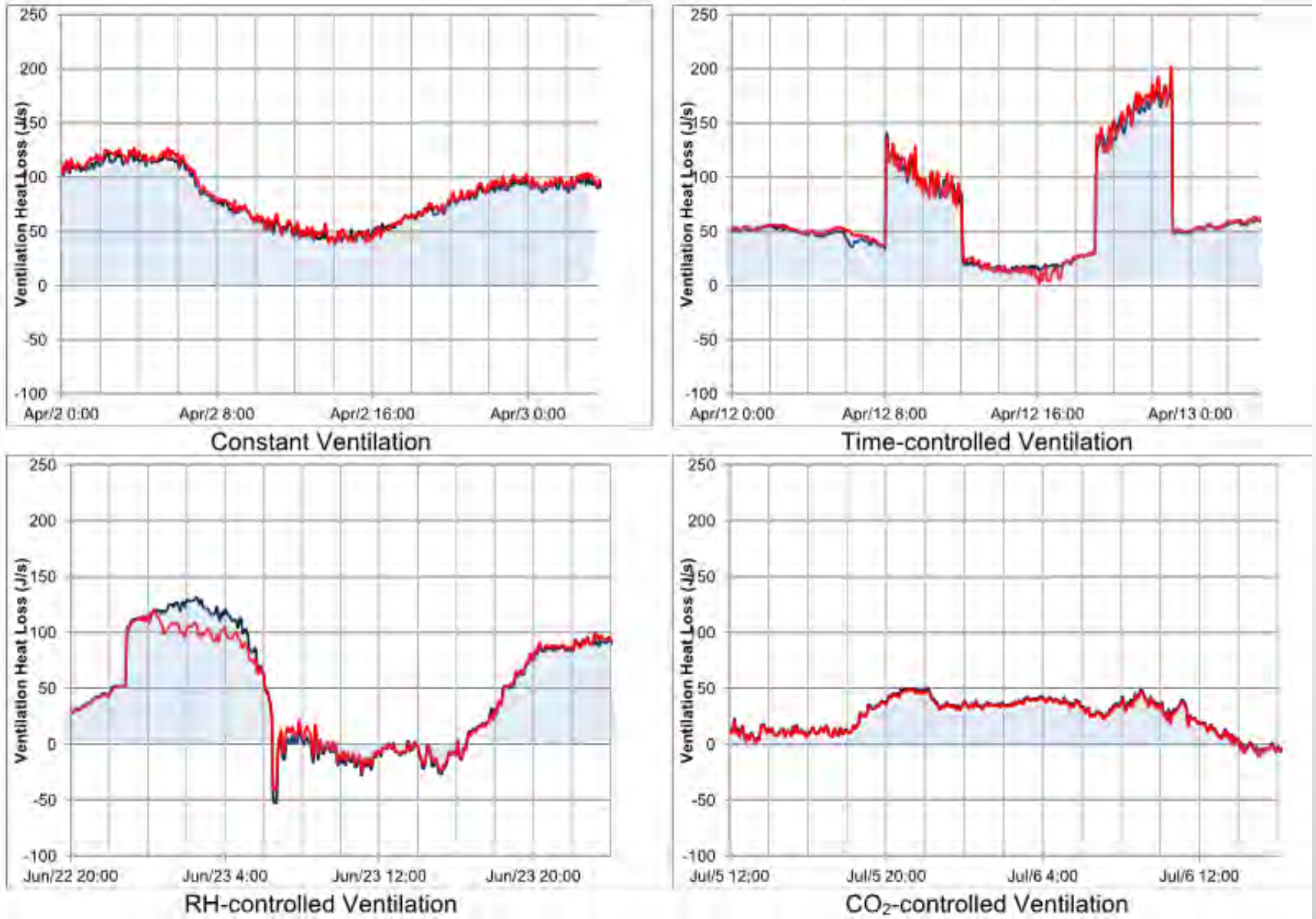


CO_2 Levels

Ventilation Scheme	Control Building	Test Building
Constant	40%	48%
Time-controlled	51%	55%
RH-controlled	0%	0%
CO_2-controlled	0%	0%

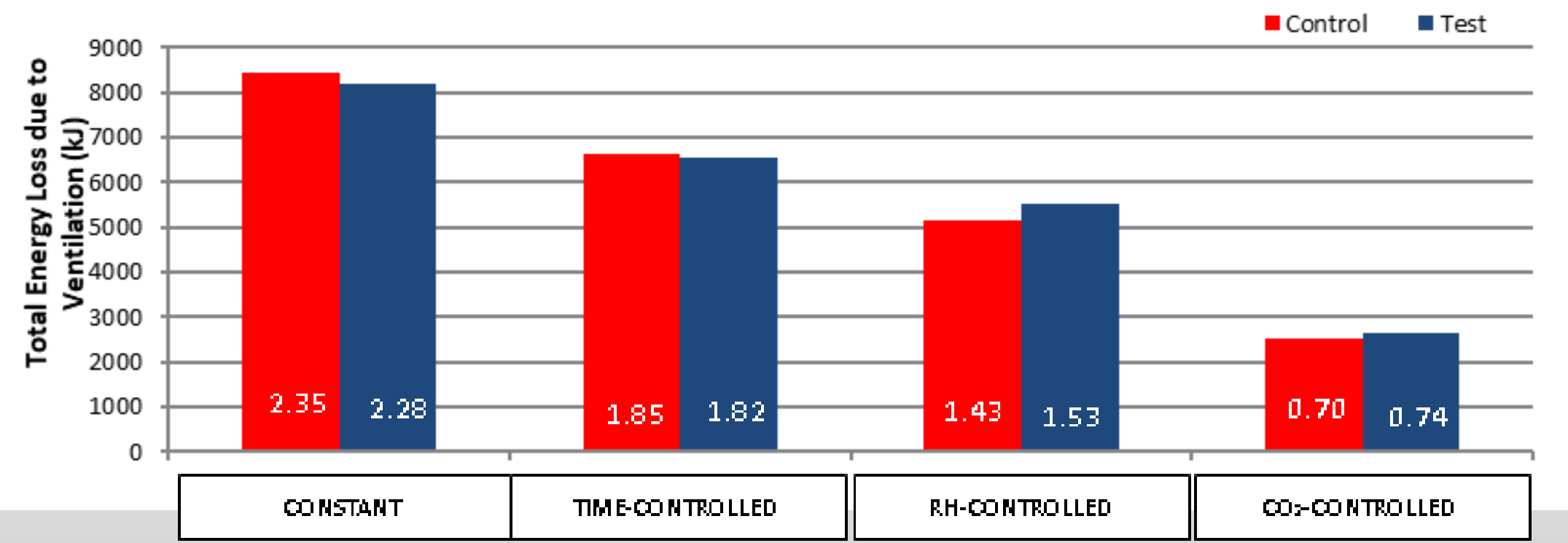


Ventilation Heat Loss



Ventilation Heat Loss

Total ventilation heat energy loss in kJ and kW-hr



Findings of Research

Moisture buffering works!

- Effective in regulating humidity levels as a passive measure when coupled with adequate ventilation
- Not a substitute for ventilation
- Effective under high moisture loading
- Different ventilation schemes provide competing interests between moisture management and IAQ
- Moisture buffering can increase ventilation demand

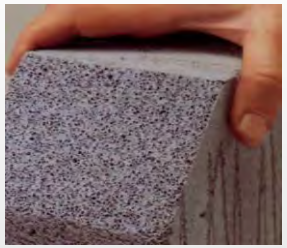
Findings of Research

Moisture buffering works!

- Time-controlled ventilation + moisture buffering achieved <u>20% energy</u> savings versus constant ventilation + moisture buffering without compromising indoor RH levels (CO_2 levels were comparable)
- Moisture buffering of unpainted gypsum board generally helped regulate indoor humidity in our climate

Future Research

- Optimization of ventilation strategy and moisture buffering properties
- Alternative finishing materials
- Design criteria for moisture buffering performance
- Seasonal changes in occupants' loading
- Optimized ventilation algorithms



Thank you for your attention!
Questions?