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# **Simplified Space Conditioning in Low Load Homes**

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IBACOS, Inc.  
BA Webinar  
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# Overview

- Define the problem
- Define thermal comfort
- Discuss solutions
- Case Studies
  - Cold Climate Unoccupied Lab House
  - Hot Climate Occupied Test House

# Smaller Loads, same size home

Benchmark



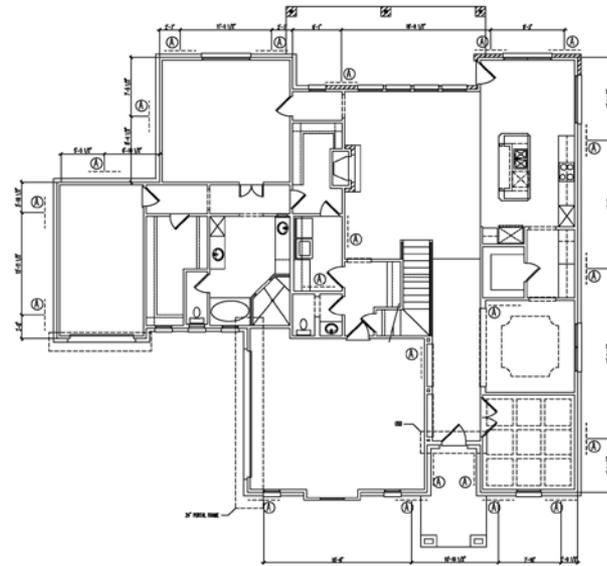
7 Tons  
2800 CFM  
3663 sq ft

ZERH



3 Tons  
1200 CFM  
3663 sq ft

# Here is the problem



- Though loads are smaller, same floor plan and geometry makes it difficult to condition space with less CFM.
- Traditional air handlers and duct systems may not be the best solution.

# ASHRAE Standard 55

## “Thermal Environmental Conditions for Human Occupancy”

Definition:

- “comfort, thermal: that condition of mind which expresses satisfaction with the thermal environment *and is assessed by subjective evaluation.*”

# ACCA 1997. Manual RS

- Establishes recommendations for thermostat-to-room temperatures to be within 2.0°F (3.0°F Cooling)

# System Design

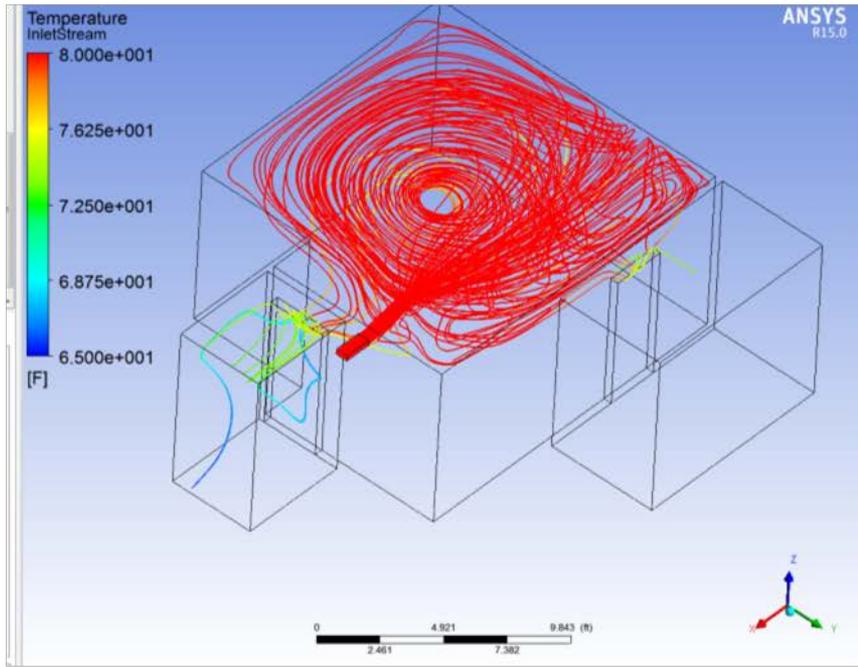
# Cold Climate House

## Peak Airflow (cfm)

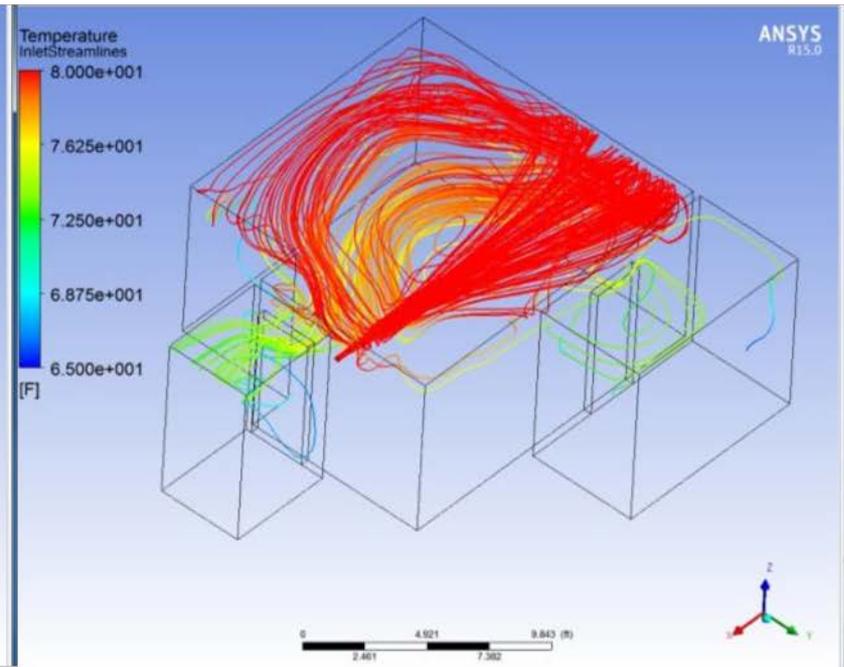
**Outdoor Design Temps: -3°F & 93°F,  
Indoor Design Temps 71 & 76**

		ZERH				Energy Star v.2		
	Area (ft <sup>2</sup> )	Htg AVF (cfm)	Clg AVF (cfm)	% Diff		Htg AVF (cfm)	Clg AVF (cfm)	% Diff
Entry	212	31	25	21%		54	44	20%
Dining	168	70	100	-35%		100	153	-42%
Pantry	36	8	3	91%		14	5	95%
Powder	36	0	2	-200%		0	2	-200%
Master Bathroom	174	35	58	-49%		52	79	-41%
Master Bedroom	306	130	223	-53%		170	301	-56%
Kitchen / Nook	300	71	127	-57%		102	175	-53%
Laundry	68	32	19	51%		40	28	35%
Family	304	84	145	-53%		111	178	-46%
Bedroom	225	83	80	4%		127	102	22%

# Air mixing - high sidewall interior register heating



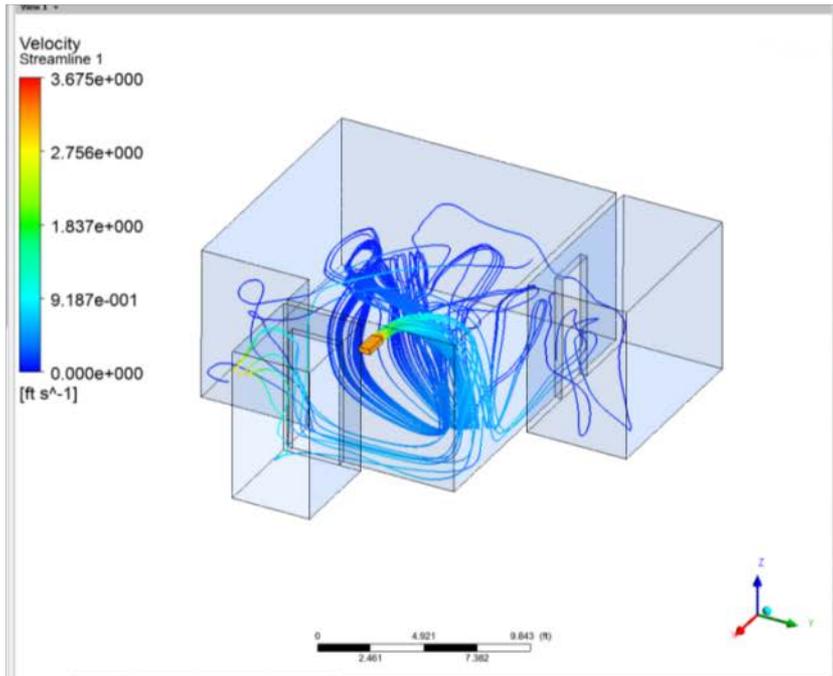
Standard register



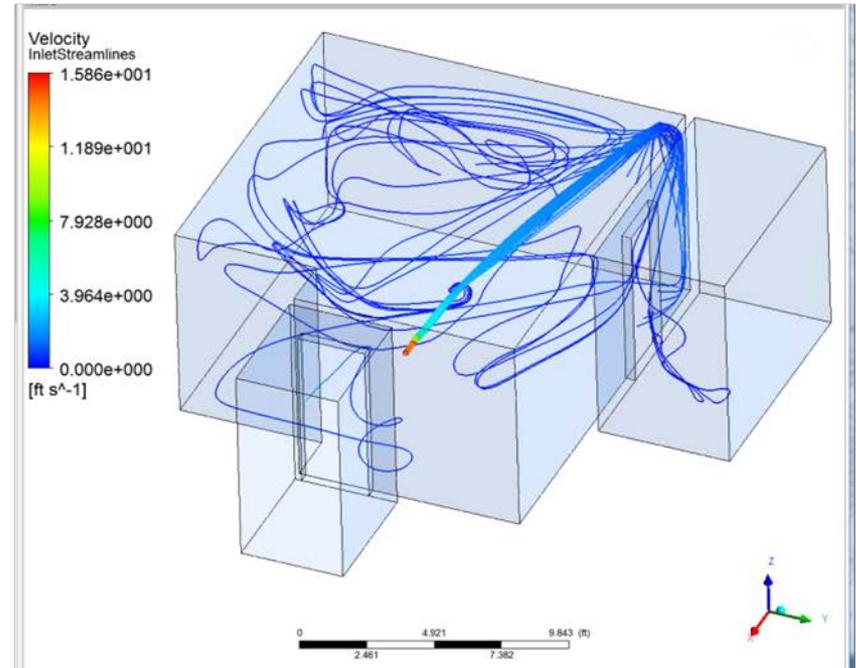
3 inch diameter diffuser

# Air mixing - high sidewall interior register cooling

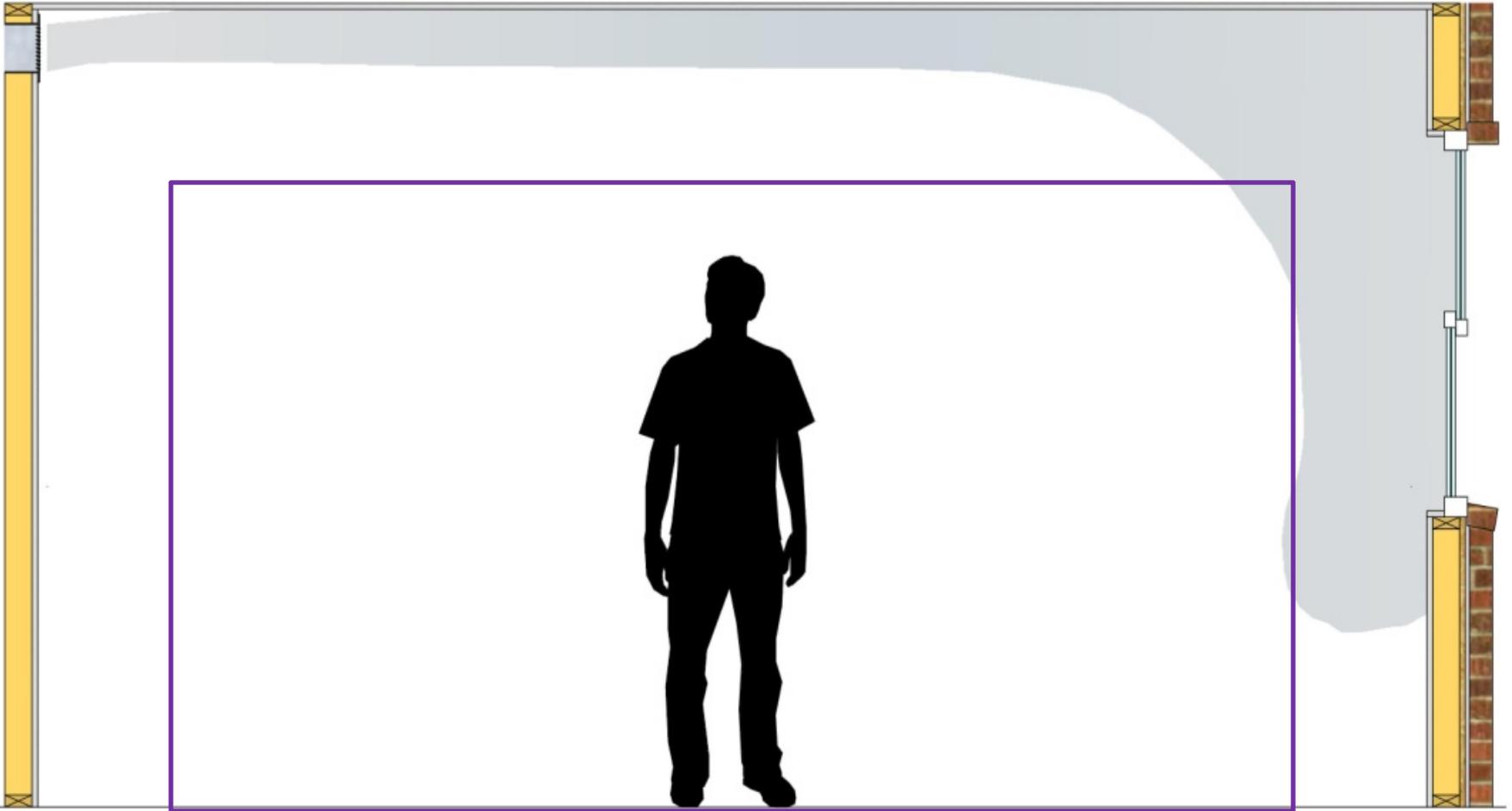
## Standard register



## 3 inch diameter diffuser



# Diffuser Placement – Occupied Zone



# Challenges

- Lower and lower loads = lower CFM and lower system runtime
- Less CFM means less velocity and throw
- Less velocity and throw results in less mixing
- Load disparities require better mixing and longer system runtime
- Load disparities require significantly different CFM in summer vs winter

# So what do you do?

- Equipment selection is critical
  - Total CFM is also critical
- If using ducts, do a duct design, verify it is installed per the design
- Consider designing with higher velocities
- Select supply outlets, don't just use what's on the truck

# Lets throw simplified systems into the mix...

Simple ducts? No ducts? Simple controls? Simple Air Handler Unit?

- Single point distribution with passive transfer
- Single point distribution with active transfer fans
- Limited ducts and air distribution
- Minisplit heat pumps

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# **Single Point Space Conditioning Case Studies**

With Data...

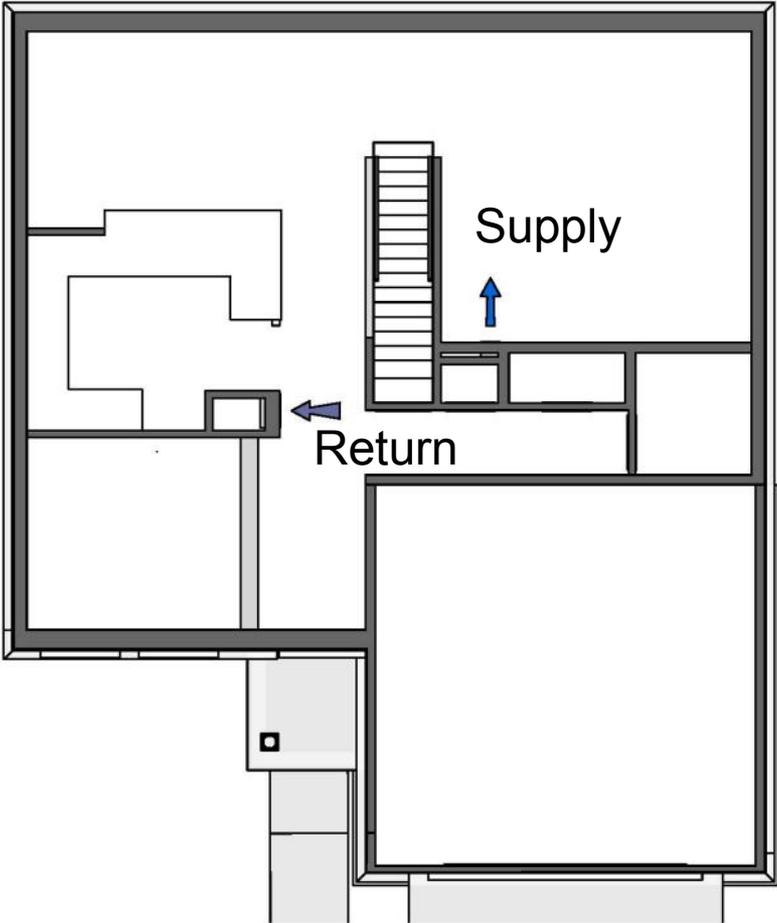
# One House Many Systems



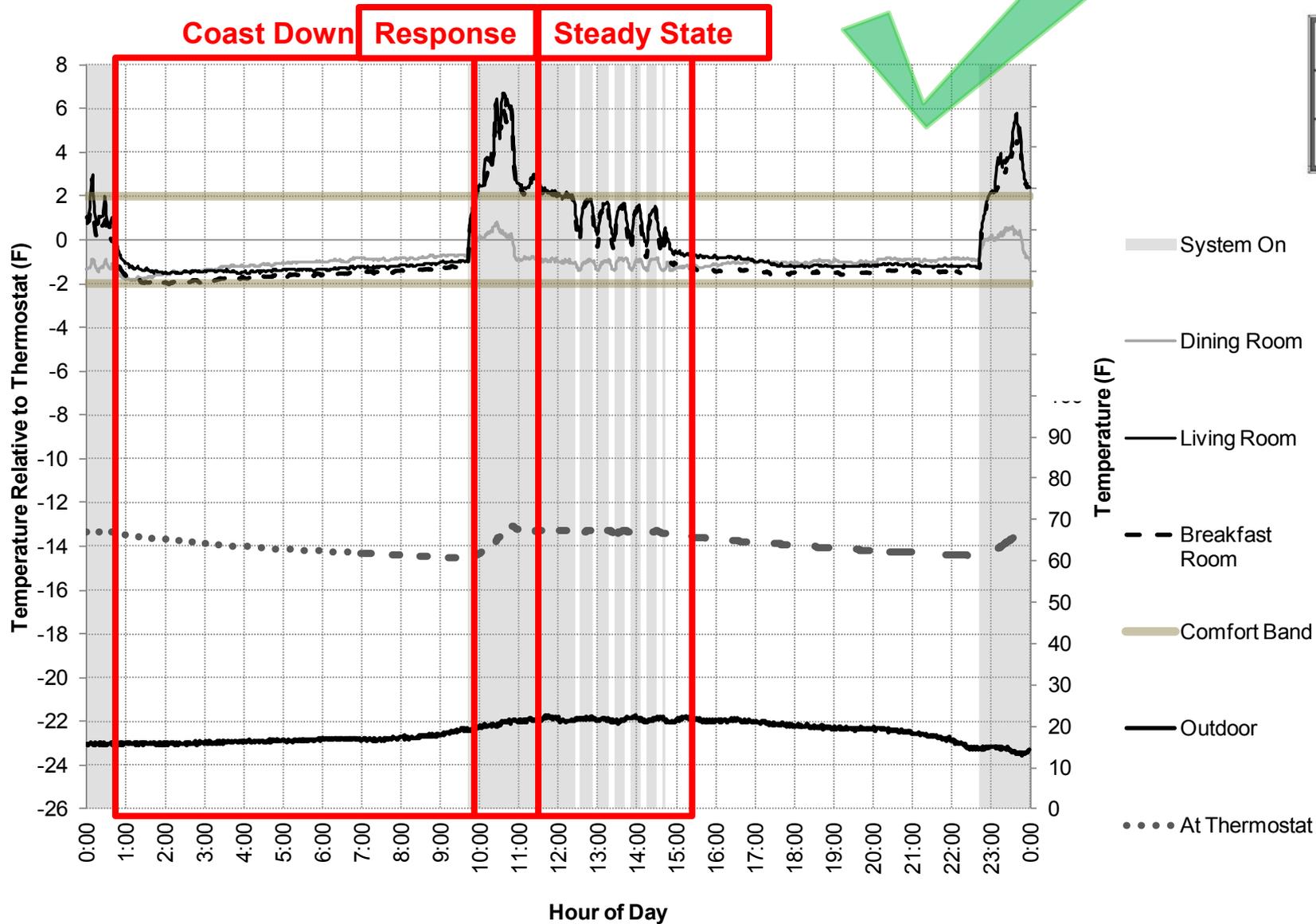
# Summary of strategies

- Single point distribution with passive transfer
- Single point distribution with active transfer fans
- Limited ducts and air distribution

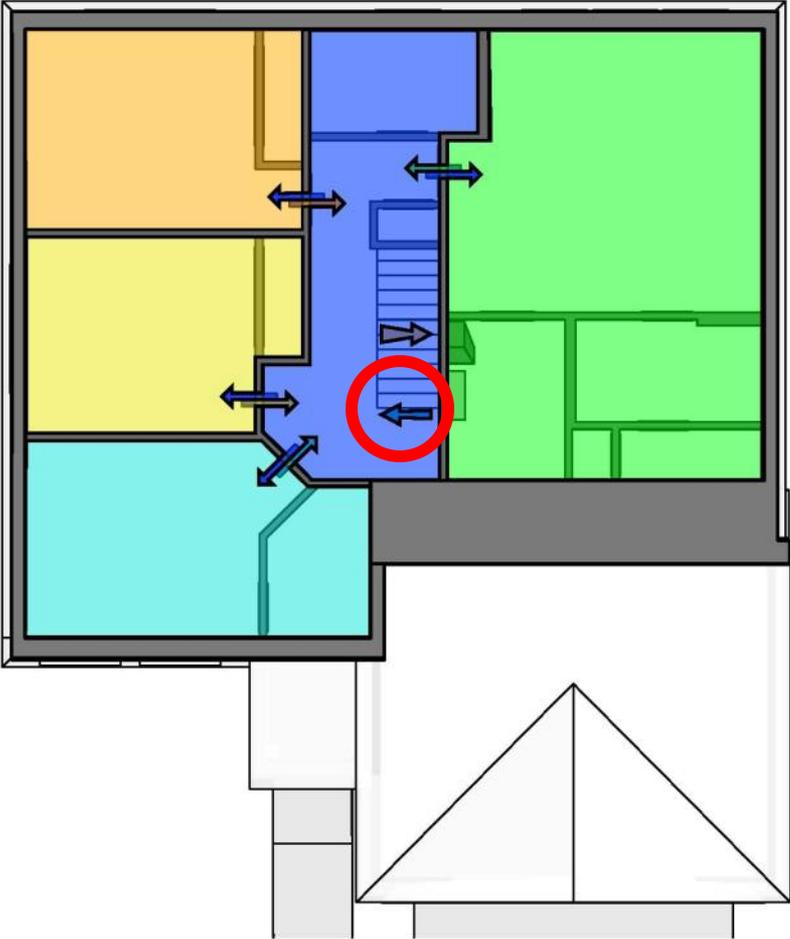
# Single Point on 1<sup>st</sup> Floor



# Single Point on 1<sup>st</sup> Floor – Winter Cloudy Day

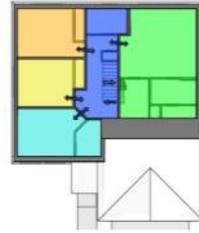


# Single Point on 2<sup>nd</sup> Floor

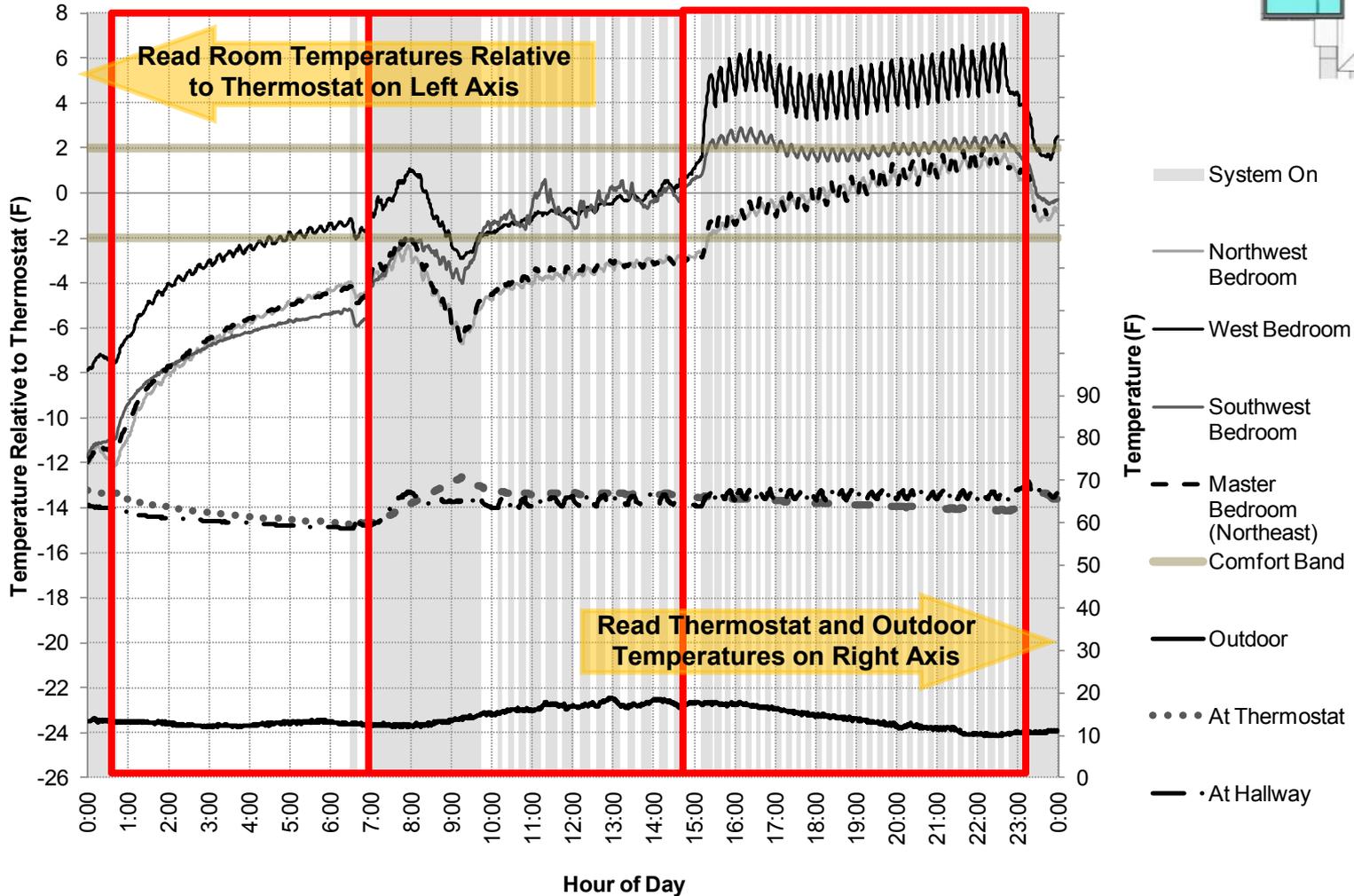


# Single Point on 2<sup>nd</sup> Floor – Doors Open

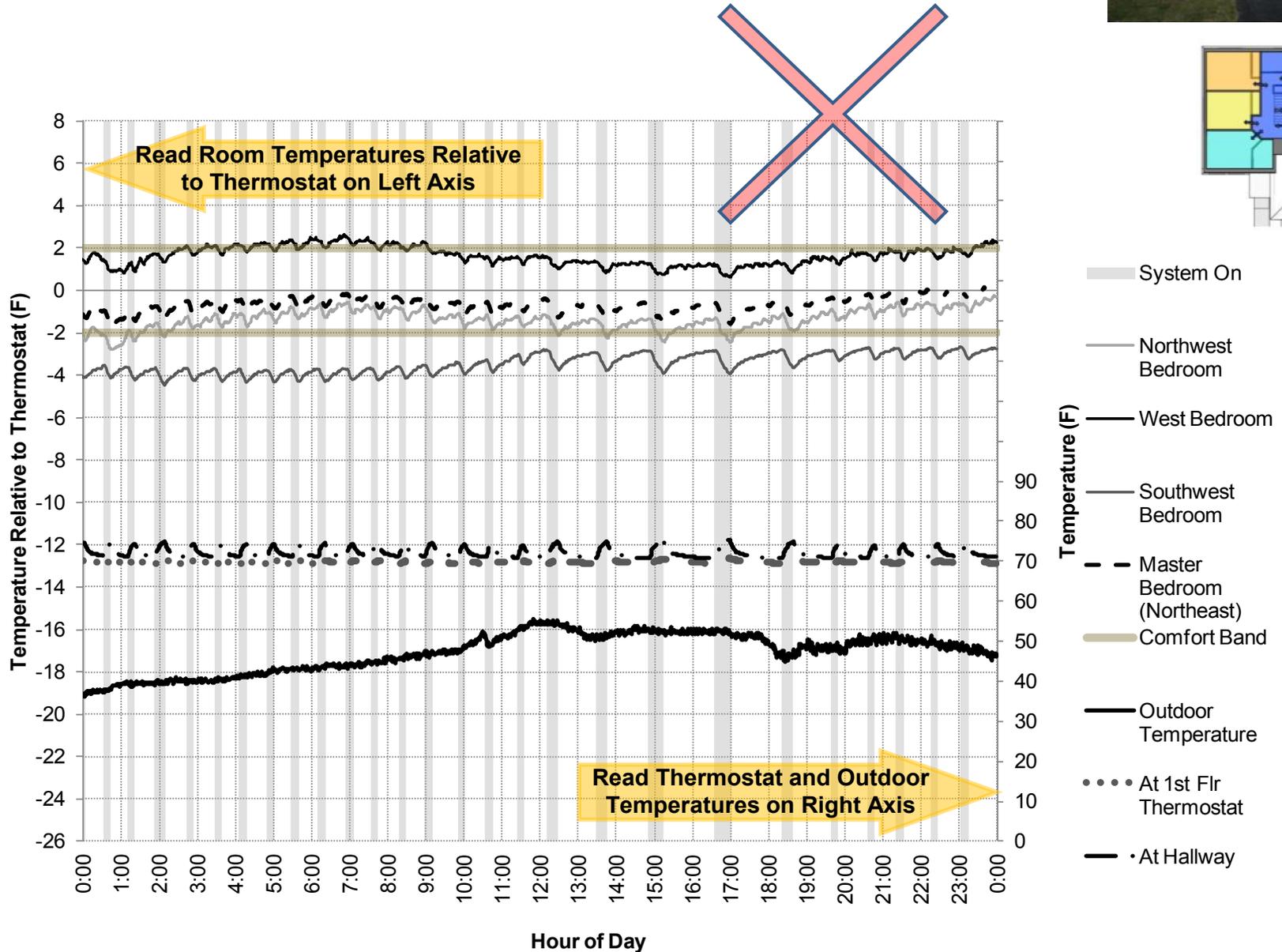
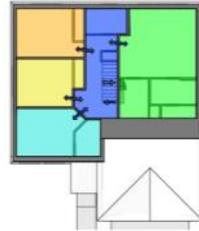
## Sunny Day



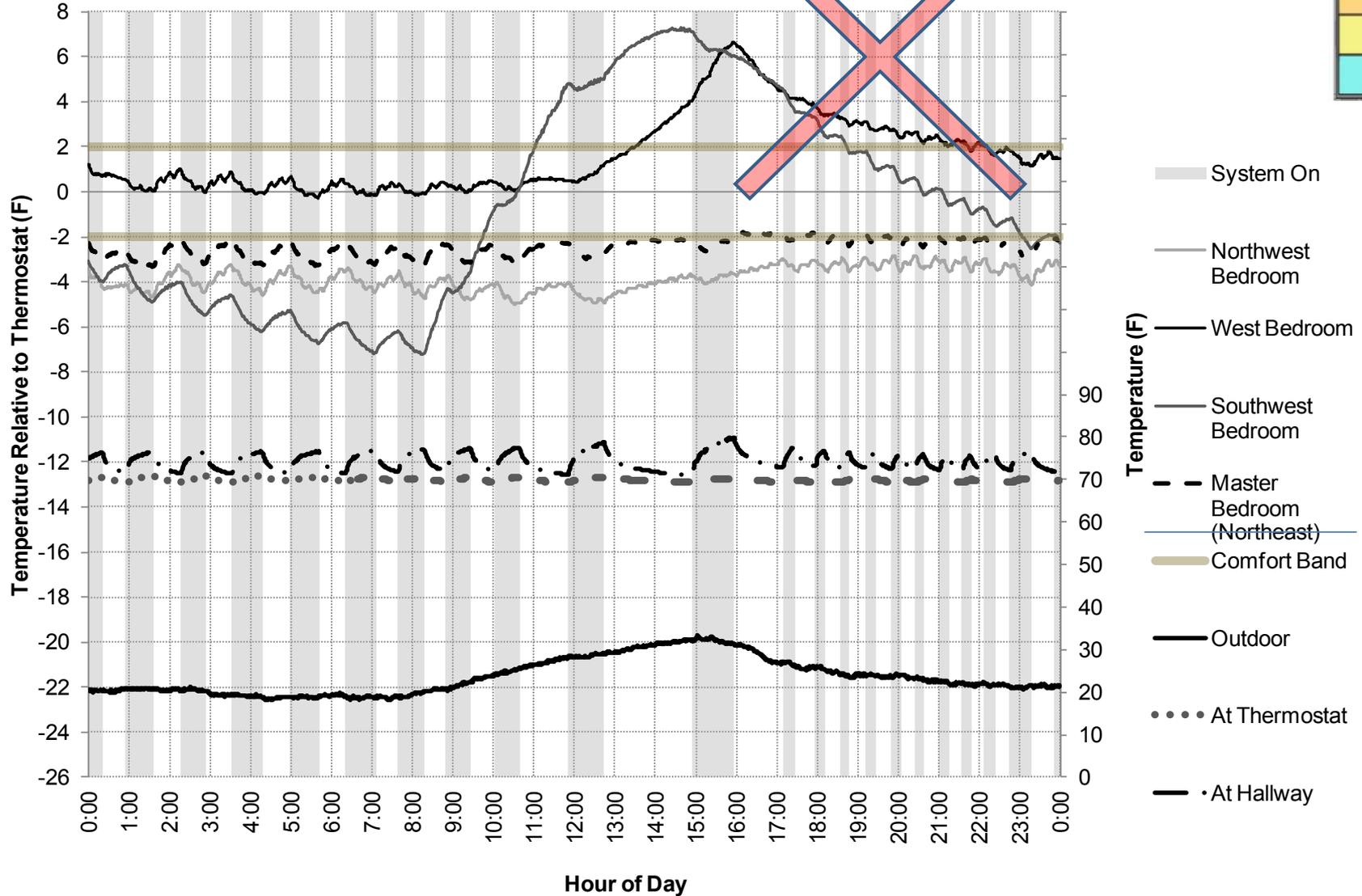
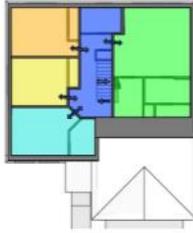
Doors Closed      Doors Open System Off      Doors Open 1<sup>st</sup> Floor System On      Doors Open 2<sup>nd</sup> Floor System On



# Single Point on 2<sup>nd</sup> Floor – Doors Closed, Transfer Fans, Cold Cloudy Day



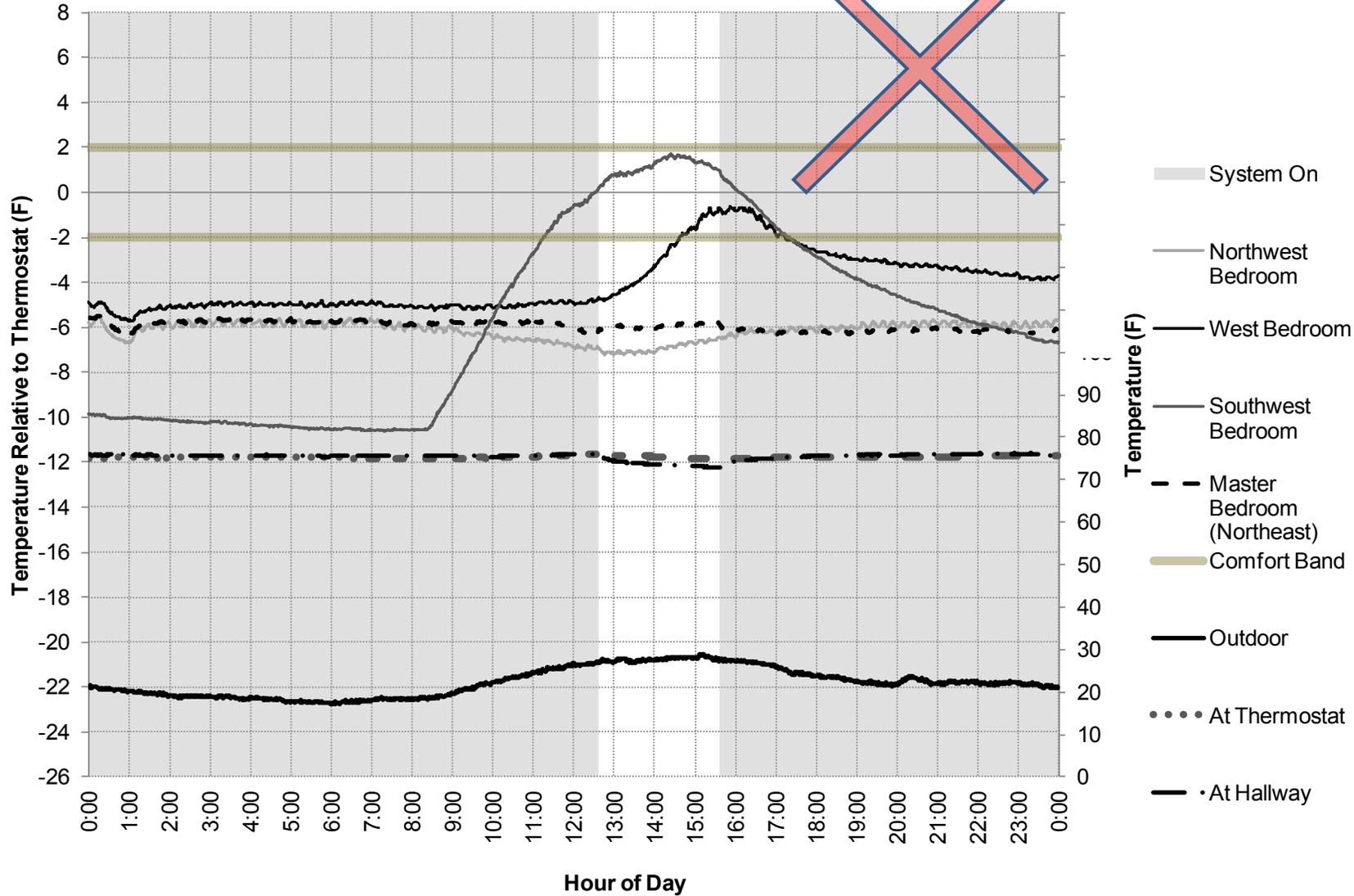
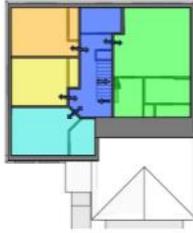
# Single Point on 2<sup>nd</sup> Floor - Doors Closed & Transfer Fans, Cold Sunny Day



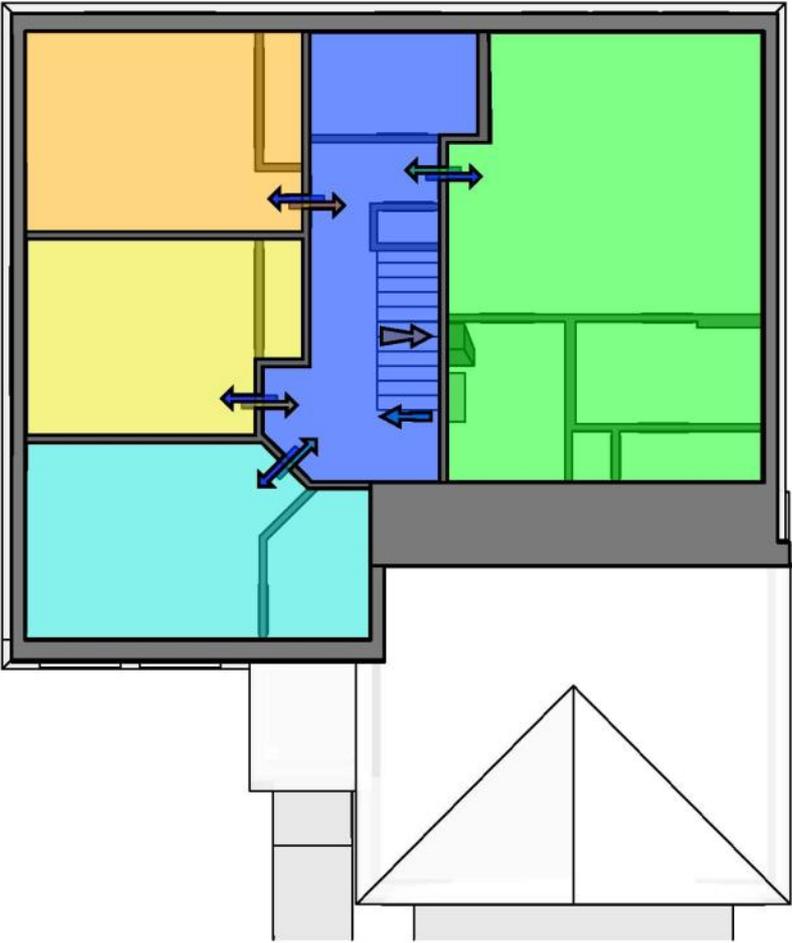
# Multi point 2<sup>nd</sup> Floor Doors Closed 15 CFM/Room



# Multi point 2<sup>nd</sup> Floor - Doors Closed , Cold Sunny Day

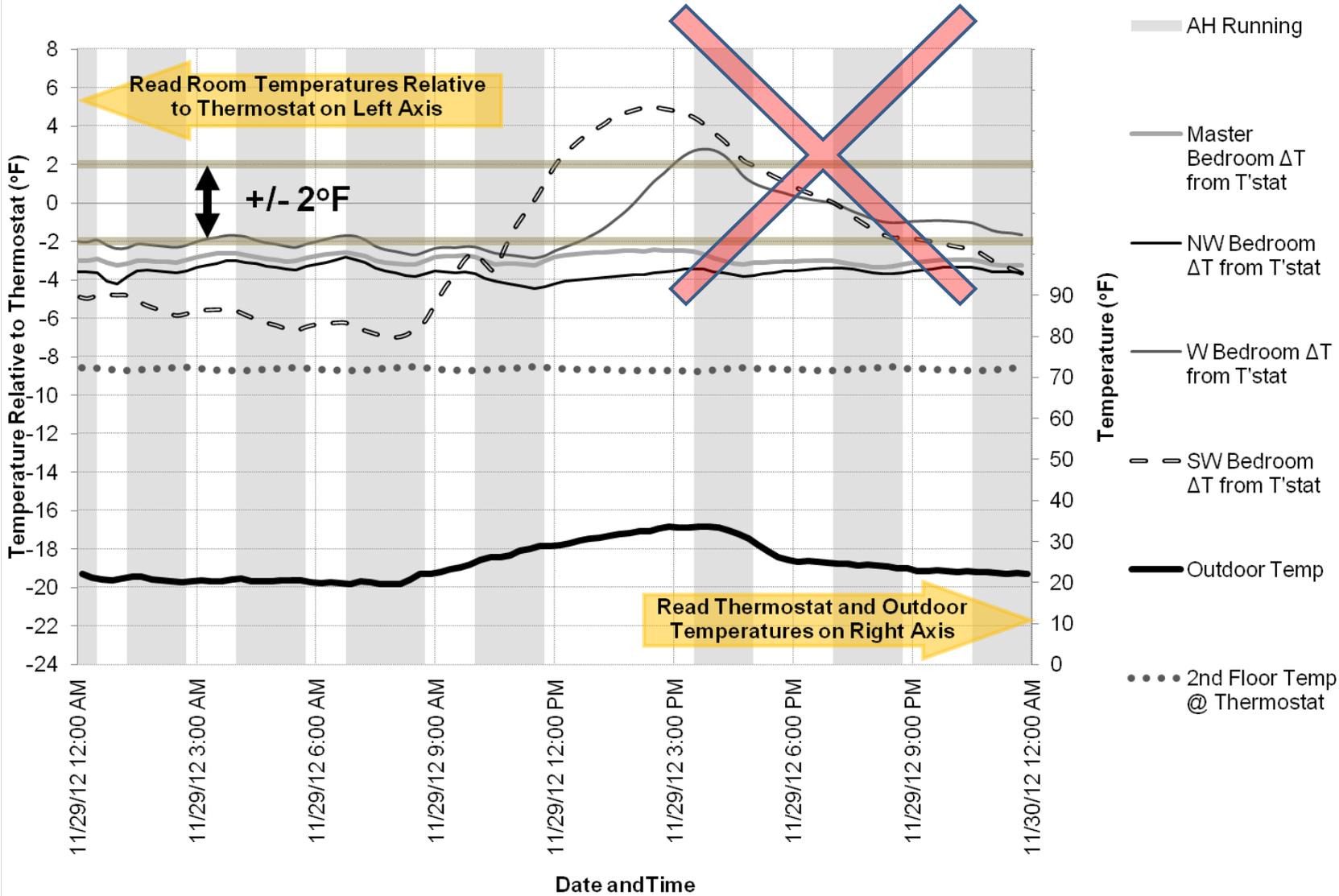
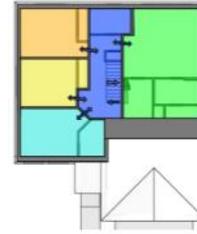


# “Right Sized 2<sup>nd</sup> Floor – Supply in every room



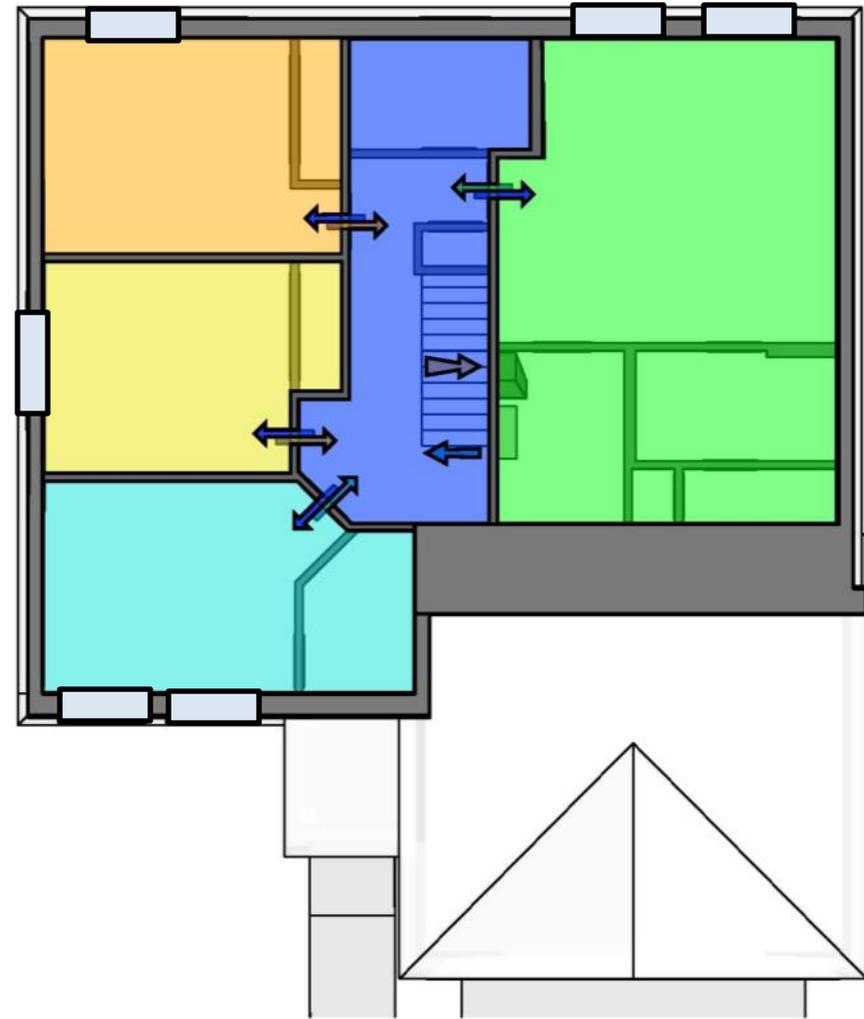
# “Right Sized 2<sup>nd</sup> Floor - Doors Closed

## T'Stat in Hall, Cold Sunny Day



# Why?

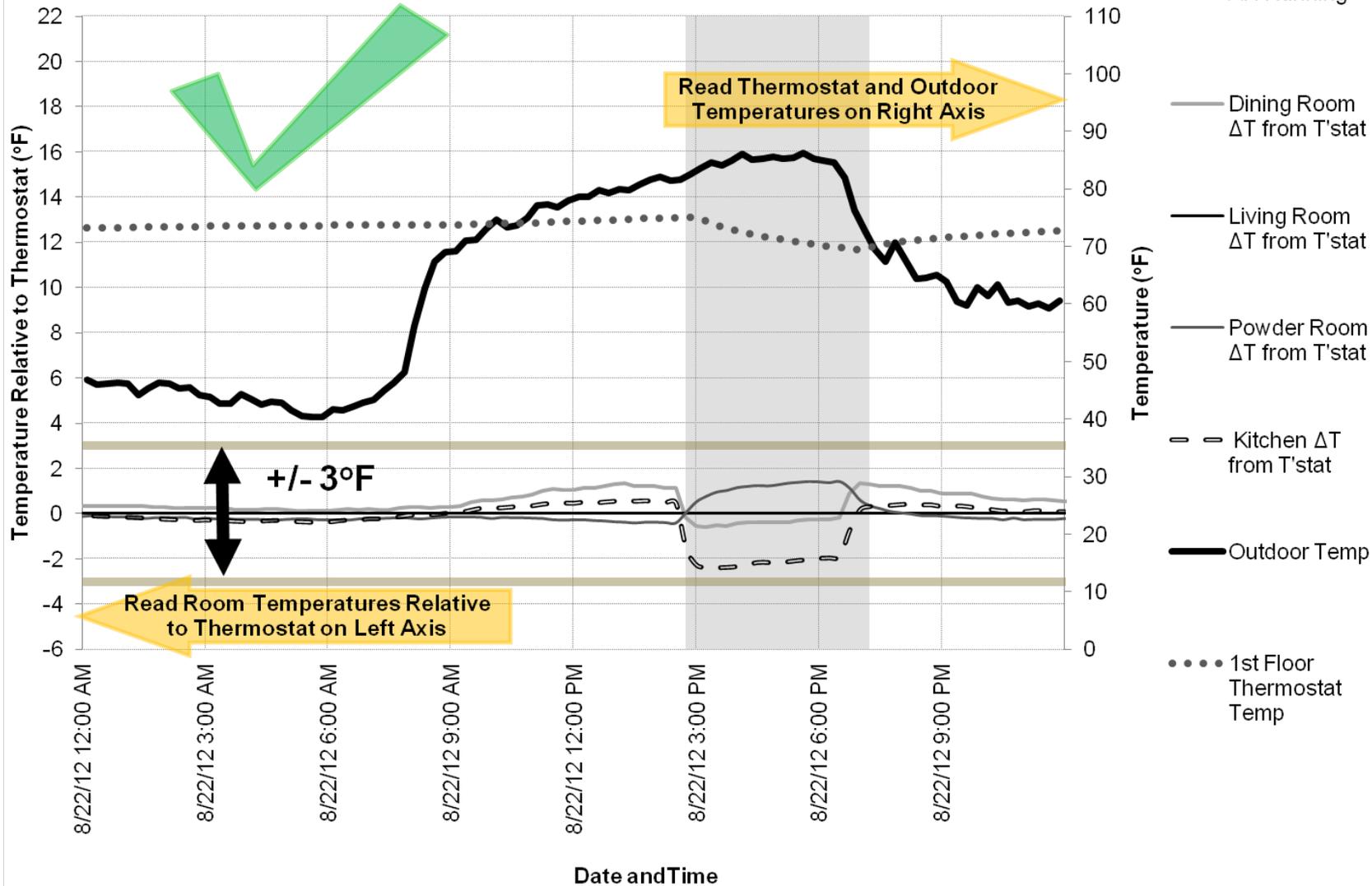
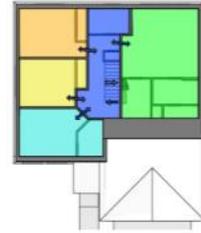
- Room to wall area ratio
  - “Panel Heating”
  - Need Highly Conductive Walls?
- Location of Single Point supply relative to transfer fan / door locations
- Solar gains not equal



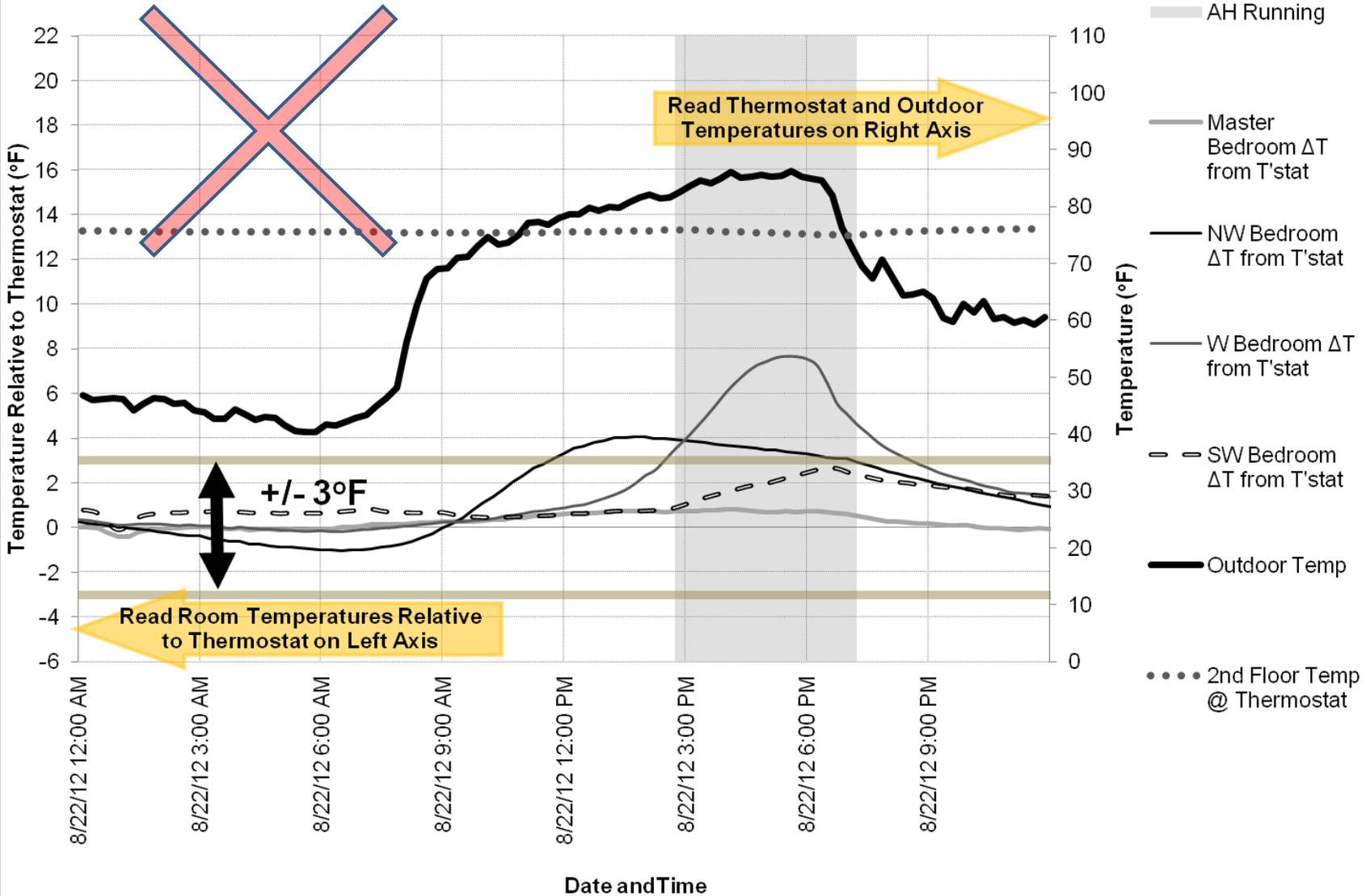
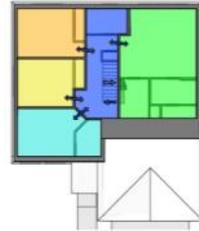
# Summer 2012 – Hot, Sunny Days



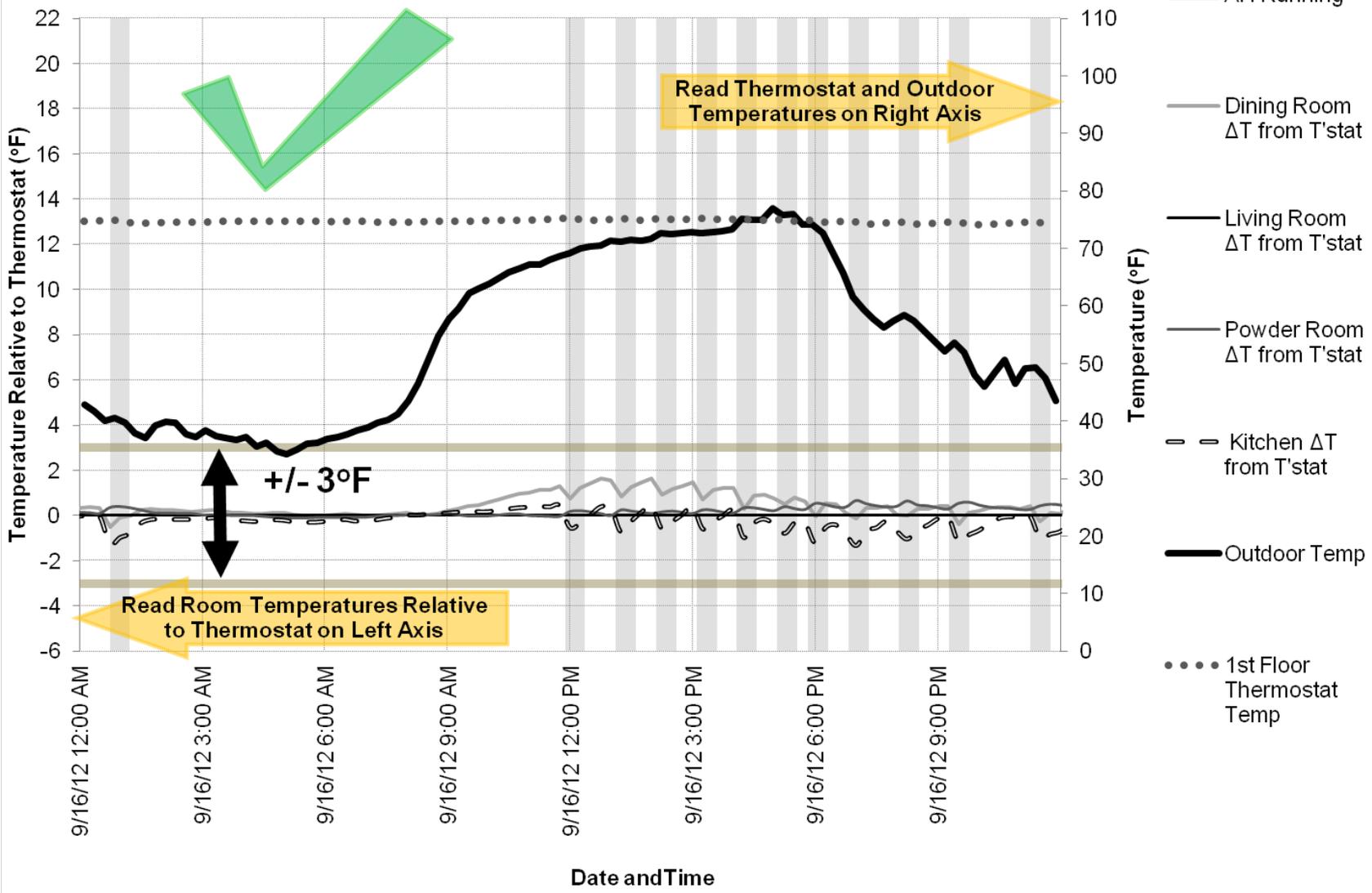
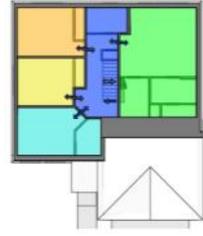
# Single Point , 1st Floor – Transfer Fans Sunny Hot Summer Day



# Single Point on 2<sup>nd</sup> Floor – Transfer Fans, Hot Sunny day



# “Right Sized” 1<sup>st</sup> Floor – Distribution to Each Room, Sunny Hot Day

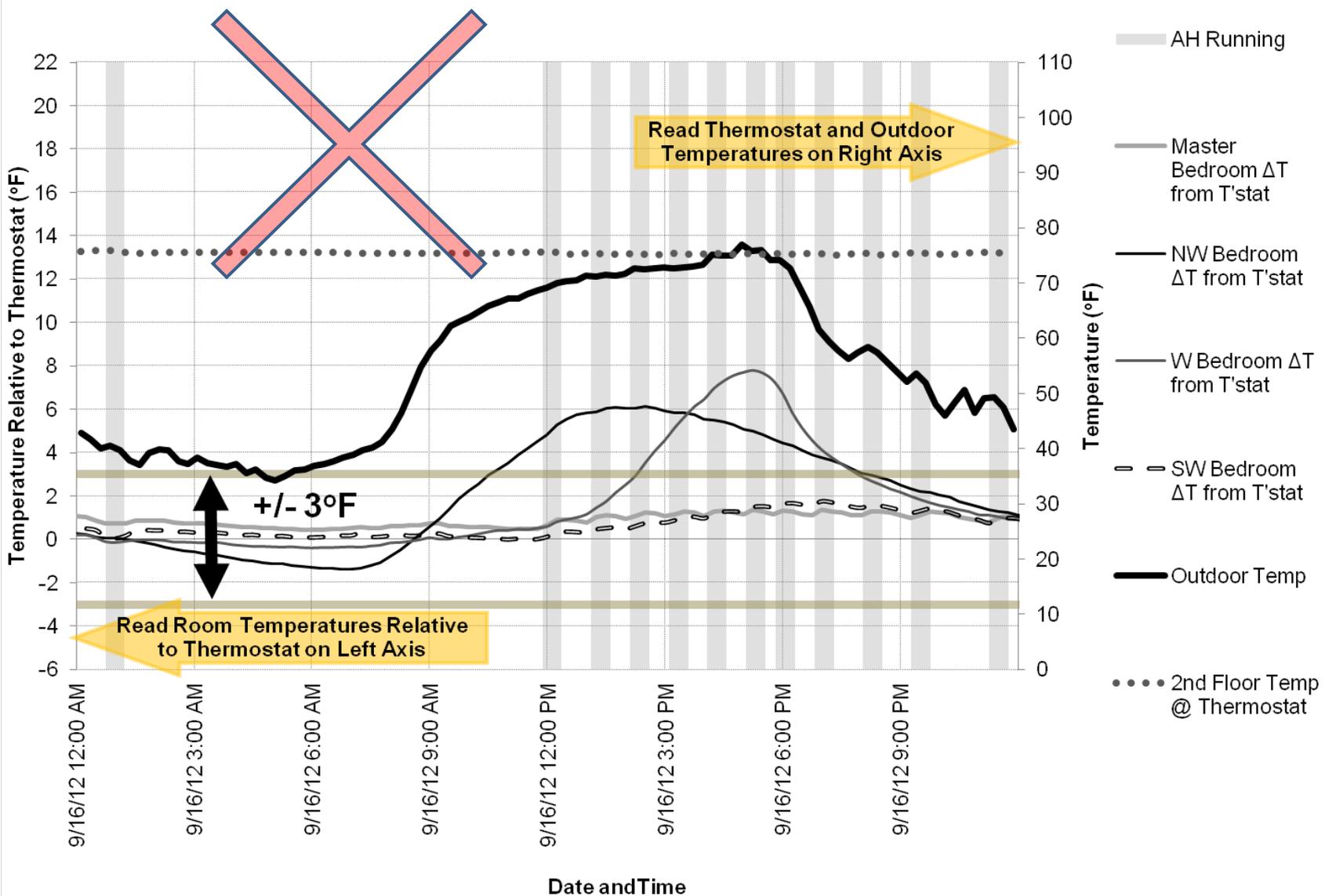
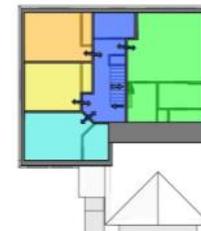


Read Thermostat and Outdoor Temperatures on Right Axis

Read Room Temperatures Relative to Thermostat on Left Axis

+/- 3°F

# “Right Sized” 2<sup>nd</sup> Floor – Distribution to Each Room, Sunny Hot Day



# MSHP – Preliminary Data: Hot Humid Climate Occupied Test House





MODEL #: SEZ-KD09NA4  
 COOLING OUTPUT: 8,100 BTU/HR  
 HEATING OUTPUT: 10,900 BTU/HR AT 47°  
 AIRFLOW: 222 CFM (MEDIUM)

TRANSFER GRILLES,  
 SEE TYP. DETAIL

MODEL #: MSZ-FE09NA  
 COOLING OUTPUT: 9,000 BTU/HR  
 HEATING OUTPUT: 10,900 BTU/HR AT 47°  
 AIRFLOW: 202 CFM (MEDIUM)

ALL DUCTWORK IN BULKHEAD

TRANSFER GRILLE,  
 SEE TYP. DETAIL

MODEL #: MSZ-GE06NA  
 COOLING OUTPUT: 6,000 BTU/HR  
 HEATING OUTPUT: 7,200 BTU/HR AT 47°  
 AIRFLOW: 201 CFM (MEDIUM)

SECOND FLOOR  
 SEE W-104

MODEL #: MSZ-FE12NA  
 COOLING OUTPUT: 12,000 BTU/HR  
 HEATING OUTPUT: 13,600 BTU/HR AT 47°  
 AIRFLOW: 226 CFM (MEDIUM)

TRANSFER GRILLE,  
 SEE TYP. DETAIL

147 CFM

10X4 HIGH SIDEWALL REGISTER

ALL DUCTWORK IN BULKHEAD

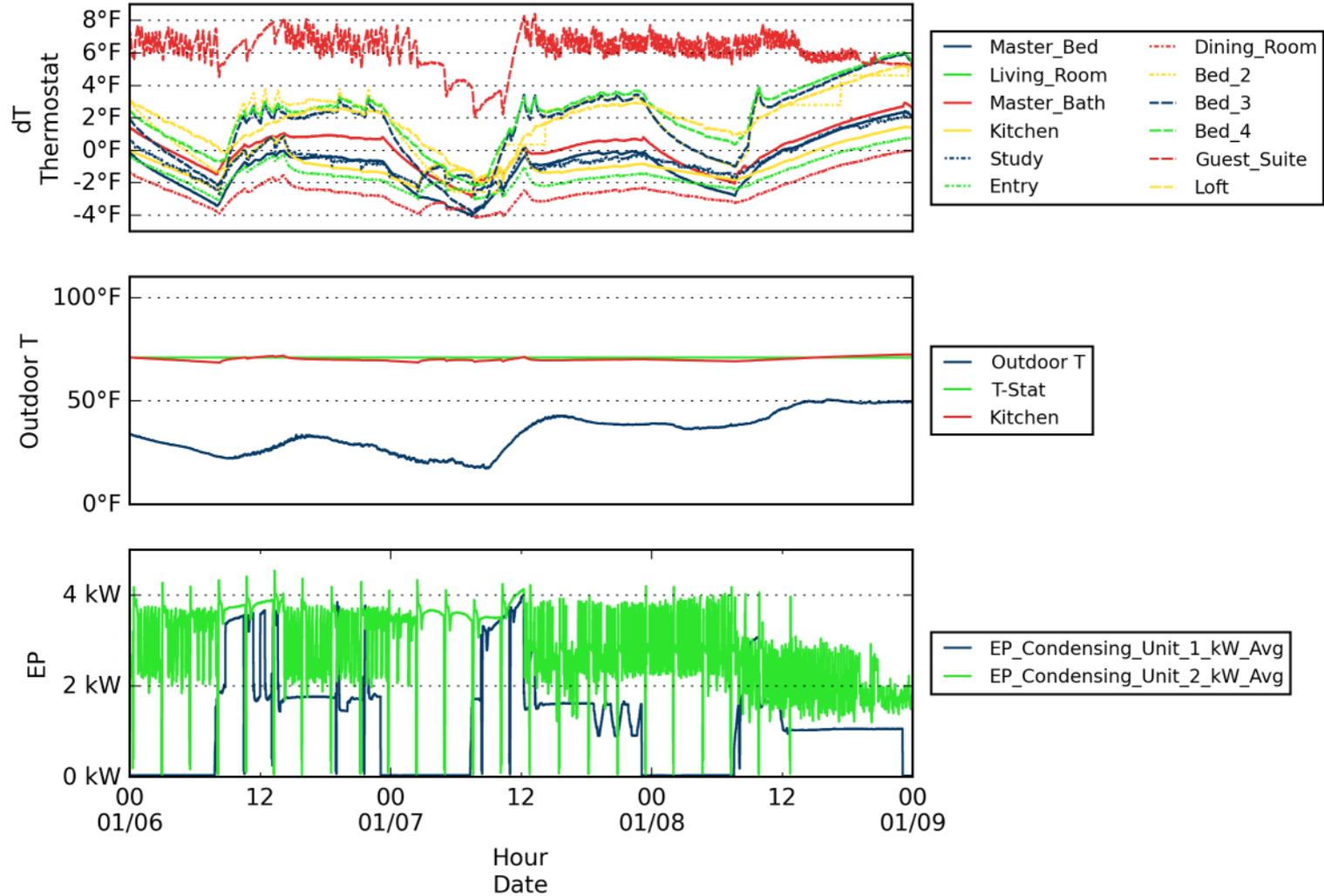
MODEL #: SEZ-KD09NA4  
 COOLING OUTPUT: 8,100 BTU/HR  
 HEATING OUTPUT: 10,900 BTU/HR AT 47°  
 AIRFLOW: 247 CFM (MEDIUM)

40 CFM  
 8X4 HIGH SIDEWALL REGISTER

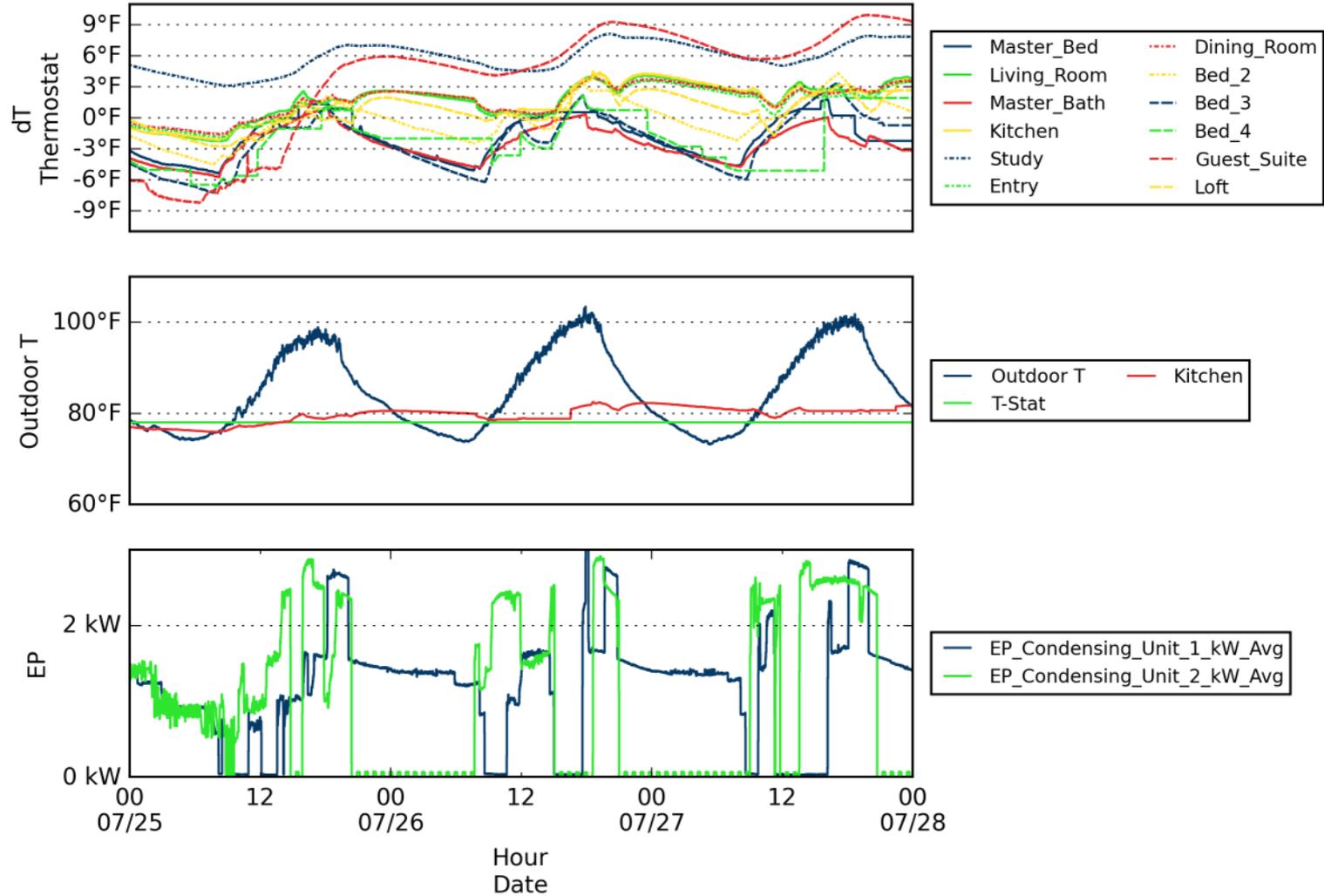
60 CFM  
 8X4 HIGH SIDEWALL REGISTER

MODEL #: MSZ-GE06NA  
 COOLING OUTPUT: 6,000 BTU/HR  
 HEATING OUTPUT: 7,200 BTU/HR AT 47°  
 AIRFLOW: 201 CFM (MEDIUM)

# Winter - Unoccupied



# Summer - Occupied



# Conclusions

- Large open spaces can be effectively conditioned from one point
  - Proper location in house, register selection / throw pattern critical
- Set up / Set back is hard to do uniformly
- Difficult to condition furthest rooms, still need direct conditioning air
- Minisplit heat pumps offer a compelling alternative

# Thank You

- Questions?
- apoerschke@ibacos.com
  
- Acknowledgements:
  - US DOE Building America Program
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  - S&A Homes
  - Imagine Homes
  
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  - Cold Climate
  - [http://apps1.eere.energy.gov/buildings/publications/pdfs/building\\_america/space\\_cond\\_lowload\\_pittsburgh.pdf%20](http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/space_cond_lowload_pittsburgh.pdf%20)
  - Hot Dry Climate
  - [http://apps1.eere.energy.gov/buildings/publications/pdfs/building\\_america/space\\_conditioning\\_lowload\\_homes.pdf](http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/space_conditioning_lowload_homes.pdf)