CSA F280-2012

Right Sizing & Optimizing Mechanical Systems

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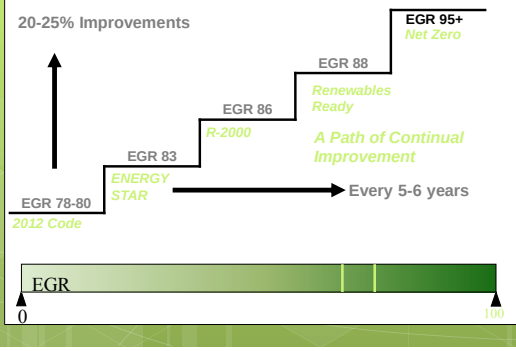

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National Building Code section 9.36

- The 1st time our National Code has explicitly identified the overall Efficiency target for homes.

Section 9.36. Energy Efficiency

9.36.1. General

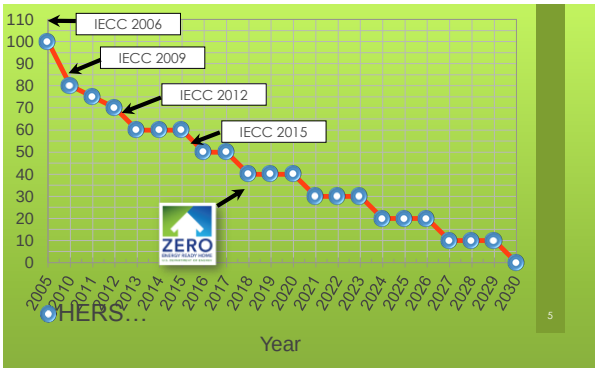
9.36.1.1. Scope

1) This Section is concerned with the energy used by *buildings* as a result of
a) the design and construction of the building envelope, and
b) the design and construction or specification of systems and equipment for
i) heating, ventilating or air-conditioning, and
ii) service water heating.

(See Appendix A.)

9.36 No small change. Lets place it in perspective;

It is interesting to note that just a decade ago this was approximately the baseline efficiency R2000 homes in Canada.



HERS…

South of the border

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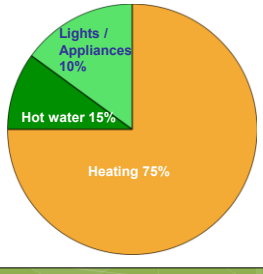
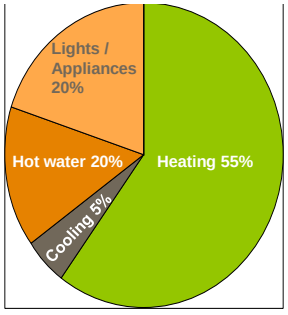
30 years ago….

- **Typical 1982 Household**
  - ERS 55 to 60
  - AC?



Typical 9.36 Zone 5 home (ERS 78-80)

Typical Canadian Household
Where does the $$$ go?



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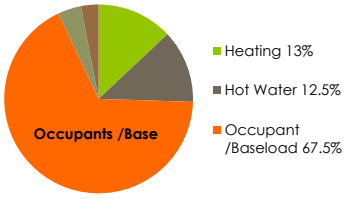
A NET ZERO HOUSEHOLD



The Status Quo

No accounting for Sensible Recovery of ventilation air through an HRV *(Application of HRV's in new Canadian Homes has increased substantially with the adoption of NBC 9.36)*

+

Average Air Change Rates of new homes are dropping: *e.g. NBC 9.36 Building code assumes homes start at 3.0+ACH50 and Attached homes at 3.5+ACH50*

+

Envelope R Value(s) have increased by nearly 40% since 2000.

What SHOULD we see happening to equipment and Air system designs?

We couldn't keep up with the unintended consequences of efficient housing…

1. Odd and unusual complaints from occupants
   - " My new energy efficient Home is uncomfortable"…
2. Shrinking loads
3. Smaller Fans
4. Lower CFM
5. ….

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When our shoes are to big we start to run sloppy!

1. **Short cycling furnace during Heating operation.**
   1. "Cold Spots" through out home. specifically longer runs to 2nd floor .
   2. Early equipment failure
   3. 2 stage /Multi stage furnaces never coming off low-fire.
   4. 2 stage /Multi stage furnaces dropping to low blower speed=less CFM.
2. **Short cycling of air conditioning during Cooling operation**
   1. Discomfort due inadequate run time
      1. 2 nd floor, long runs with inadequate volume to condition the space
      2. High relative humidity rates as latent loads remain high
      3. Early equipment failure

Story of a Zone 5 home…

- CHBA AWARD WINNING HOME
- "Short Cycling".
- Center of home was comfortable, extremities too hot / cold.
- Temperature "stratification" between floors.
- Complaints about comfort.
- **Could not balance the home**.

Decided to review the HVAC design:

- Review of existing F280-M90 heat loss vs. Hot 2K / F280-2012 heat loss.
- Installed furnace 126% oversize from Hot 2K / F280-2012
- Installed furnace within allowances for existing F280 (< 40% oversize).

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Story of a Zone 5 home…

HVAC Comparison Report — Jan 10th, 2012

Model	Sq. Ft.	H2K Btu	Current F280 Btu	Model % Over H2K/F280-2012	Furnace Output	Output % Over Model	Output % Over H2K/F280 -2012
Model 1	1442	25,365	44,073	73.76%	45,000	2.10%	77.41%
Model 2	1685	30,062	49,005	63.01%	68,000	38.76%	126.20%
Model 3	1872	30,784	35,149	14.18%	45,000	28.03%	46.18%
Model 4	1460	21,988	40,221	82.92%	45,000	11.88%	104.66%
Average	1,669	27,201	41,897	56.29%	49,600	18.08%	83.26%

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F280-12

CSA Group

Determining the required capacity of residential space heating and cooling appliances

- Published late 2012
- Officially referenced in NBC
- Computer Software is available for new F280-2012

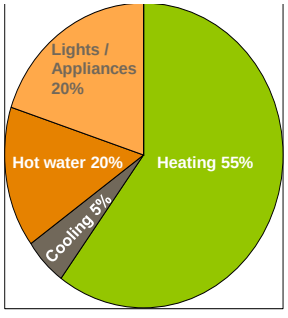
CSA F280 –M90 What we knew back then…(25 years and counting)

- Last changed in 1990
- Poor air tightness metric
- No ventilation metric?
- Outdated window metric
- Poor foundation metric

Typical 9.36 Zone 5 home (ERS 78-80)

Typical Canadian Household

Where does the $$$ go?



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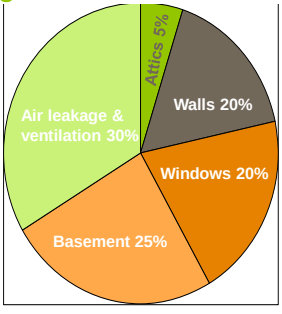
Air Leakage & Ventilation: What's the big deal?

Anatomy of Heat Loss



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Ventilation OLD F280-M90

- Ventilation was not included in core calculations
- Nearly all standards suggested Ventilation rate to be in accordance with CSA F326 (Greater of "room count" or 0.3 ACH)
- Some design standards allowed adjustment for HRVs, But rarely acknowledged.

Ventilation & Air Leakage
Industry References

- Suggested designers be conservative
  - Guided to add ventilation and air leakage

0.3 ACHnat

+

0.3 ACHnat

HVAC Load Analysis -2275 sq.ft.

	Coastal Cruising BC	Big Sky	Big Smoke	Down Home
1990 CSA F280 Heat	46,500 BTUs	105,000	68,420	74,000
House as in 2015 ** Heat Cool	30,500 19,000	69,000 22,500	40,200 26,000	39,000 20,000

* Assumes house has HRV within NBC 9.36 compliance
** 3 changes to the house: New windows, insulated basement walls, R40 attic, air tight 3.1ACH50

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Why the big change?(Zone 5)

	Original F280-M90 Building Code (0.3+0.3 NATach)	New F280-2012 Building Code (0.131ACHnat)
Total Heat Loss	68420 BTUs	40,200 BTUs
Air Leakage Component	27690 (40%)	8900 (22%)
Ventilation Component	16500 BTUs	2005 BTUs (includes HRV)

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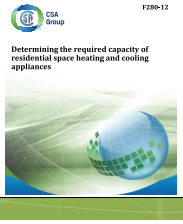
New CSA F280-2012

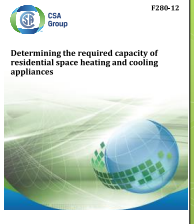
1. 4 important improvements
   - **EMBEDDED SPREADSHEETS** !! Air Leakage, Foundation and Slab on Grade.
   - Air leakage to follow AIM-2 Model –
   - Load calculations accounting for ventilation now included.
   - Foundation model improved . Applying BASE IMP
   - Window selections updated – THGM Calculation
   - Sizing limits changed
   - And more....

Appendix B Provides a very well written narrative about the technical rational Behind the updates.



New CSA F280-2012

1. What the CSA F280 – 2012 does NOT do:
   - Air system(duct design), Radiant delivery system design
   - Equipment selection
   - Ventilation design
   - Installation guidance
   - Require any energy efficiency compliance



New CSA F280 Ventilation

- The new CSA F290 – 2012 specifically requires inclusion of mechanical ventilation rate and it specifically calls out using **Principal Ventilation Rate PVC**
- CSA F280 =2012 Appendix defines Principal ventilation as ***"The amount of ventilation intended to be delivered on a continual basis"***

PVC
Principal Ventilation Capacity

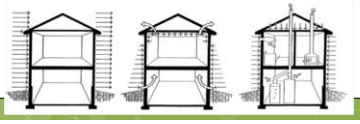
~~***TVC***~~
~~***Total Ventilation Capacity***~~

New CSA F280 Ventilation

- Heat recovery and energy recovery **credited** (finally!)
- Apparent Sensible Effectiveness % used in Calculation at -25degC

New CSA F280 : Air Leakage

1. Air leakage to follow AIM-2 Model – (HOT 2000)
   1. Air leakage affected by type of ventilation.
      1. Exhaust Only VS Balanced (HRV/ERV). Slightly negative pressure on all areas of home vs "Balanced"= little to no negative pressure.
   2. Air leakage affected by location in building. Room specific,-eg 1st floor rooms assigned increased heat load.
1. Allows direct entry of blower door results: Spreadsheets AND formula's both available.



New CSA F280 2012 Air Leakage &Ventilation

- Imbedded spreadsheet is nearly identical to HOT2000 BASE IMP application
- Output of spreadsheet becomes a "Multiplier" for calculating HL and HG by air infiltration

Envelope Air Leakage Calculator

Supplemental tool for CAN/CSA-F280

Weather Station Description	
Province:	British Columbia
Region:	Vancouver (Granville & 41 Ave)
Weather Station Location:	Open flat terrain, grass
Anemometer height (m):	10
Local Shielding	
Building Site:	Open sea,fetch > 5 km
Walls:	No local shielding
Flue:	Heavy
Highest Ceiling Height (m):	6.4
Building Configuration	
Type:	Detached
Number of Stories:	Two
Foundation:	Full
House Volume (m^3):	553
Air Leakage/Ventilation	
Air Tightness Type:	Energy Tight (ACH=1.5)
Custom BDT Data:	ELA @ 10 Pa: 298.57 cm^2
	1.5 ACH @ 50 Pa
Mechanical Ventilation (L/s):	Total Supply: 0 Total Exhaust: 0
Flue Size	
Flue #:	#1 #2 #3 #4
Diameter (mm):	0 0 0 0
Envelope Air Leakage Rate	
Heating Air Leakage Rate (ACH/H):	0.127
Cooling Air Leakage Rate (ACH/H):	0.080

New CSA F280 2012 Air Leakage &Ventilation

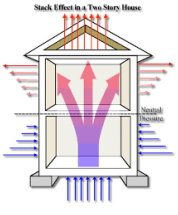
What are the implications of infiltration or air leakage?

Zone 4-5
2 story, Single Detached
15,000 volume ft3
55F Delta T

- Loose 10ACH50 : **12,300 btu**
- Code 3.57 ACH50: **4,400 btu**
- EE 1.5ACH50: **1800 btu**

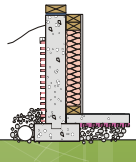
New CSA F280 2012 Air Leakage &Ventilation

Summary:
- AIM2 ; It's the way houses leak in Canada (Cold Climates) Apportion the HL accordingly
- Air leakage matters: Know your ACH50 numbers and pass along to your HVAC designer
- Ventilation : Apply PVC rates for HLHG.
- Take credit for balanced ventilation with HEAT Recovery



New CSA F280 Enhanced below grade Foundation heat loss & Slab on Grade model

1. Foundation model improved –based on HOT 2000 "BASESIMP" (regression based algorithm)
2. New embedded spreadsheets applied
3. Greater range of basement insulation measures recognized and underground conditions (33,000 separate calculations)



New CSA F280 Enhanced below grade Foundation heat loss model

- Note: Requires pre-calculation for EQUIVALENT Floor Width and Length
- Heat Loss apportioned to rooms based on primarily on perimeter exposure.

5530btu
Watts x 3.412=btu

Residential Foundation Thermal Load Calculator

Supplemental tool for CAN/CSA-F280

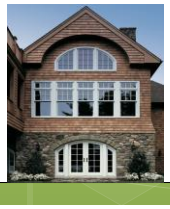
Weather Station Description	
Province:	Manitoba
Region:	Winnipeg
Site Description	
Soil Conductivity:	Normal conductivity: dry sand, loam, clay
Water Table:	Normal (7-10 m, 23-33 Ft)
Foundation Dimensions	
Floor Length (m):	12.4
Floor Width (m):	6.4
Exposed Perimeter (m):	0
Wall Height (m):	2.5
Depth Below Grade (m):	1.75
Window Area (m^2):	0
Door Area (m^2):	0
Insulation Configuration	
Radiant Slab	
Heated Fraction of the Slab:	0
Fluid Temperature (°C):	33
Design Months	
Heating Month	1
Foundation Loads	
Heating Load (Watts):	**1621**

New CSA F280 Enhanced below grade Foundation heat loss & Slab on Grade model

Summary
- The ground is a heat sink (get over it)
- Orientation and placement of insulating materials matters!
- Separate spreadsheet for basements vs slab-on-grade

New CSA F280 Windows Modeling Enhancements

A few things we do know about windows:
1. More glass
2. Triples are on the horizon (U value matters)
3. Coatings matter!!! (SHGC, condensation potential)
4. Huge impact on Air Conditioning Loads.



New CSA F280 Windows Modeling Enhancements

•New THGM (Transparent Assembly Heat Gain Multiplier) incudes solar heat gain coefficient (SHGC), solar radiation, internal shading
- More accurately accounts for intermittent loads (High Solar gain Winter and Summer)
  Increasingly, homes have more glass, more insulation, etc.

NEW CSA F280-2012 SHGC NUMBERS MATTER!

The effect of SHGC…
200 sq ft Glass
Vancouver

SHGC **.60**

N& Shaded: 4400 btu
S: 8800 btu
E/W: 11,600 btu
SE/SW: 12, 500 btu

SHGC **.40**

N& Shaded: 3200 btu
S: 6100 btu
E/W: 8000 btu
SE/SW: 8300 btu

SHGC **.21**
N& Shaded: 2000 btu
S: 3600 btu
E/W: 4600 btu
SE/SW: 4100 btu

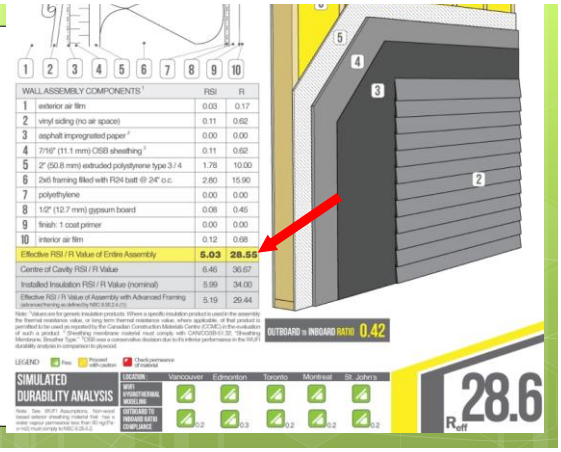
New CSA F280 Windows Modeling Enhancements

- Summary
- Over 15% WWR start considering Triple pane for better overall effective R value of home.
- Windows and SHGC drive CFM requirements = air handler size = duct size
- Be careful of ER (and High Solar Gain SHGC)
- Optimize U and SHGC for comfort , energy efficiency and cost

New CSA F280
Effective R values applied

Effective R values referenced

- Big initial change for industry
  - NBC 9.36
  - Energy Star "Opaque Assembly" document
- Allows for innovation
- Builder/ Designer Tools being developed
  - Owens Corning Thermal wall Calculator
  - Canadian Wood Council Thermal Calculator
- Finally recognition of
  - CONTINUOUS EXTERIOR INSULATION
  - ADVANCED FRAMING (19.2 or 24"oc)



New CSA F280
Internal Gains

Appliance loads updated. Standard now states:

A heat gain of 1.27 Btu/h/ft² of gross floor area but not lower than 2730 Btu/h , shall be applied to one or more electric peak load rooms that are present in the building (e.g. family, living, and/or kitchen)

New CSA F280 2012
vs
Energy Modeling (HOT2000)

What to expect;

- **Load identification and calculation will produce similar results(loads)**
- **Room by Room HLHG can be provided through Hot 2000 by a licensed Certified Energy Evaluator.**

New CSA F280
Equipment Sizing limitations

- Sub clauses regarding to Solid Fuel fired appliances, Oil fired furnaces, boilers , and Air to Air heat pumps have been eliminated from the new standard
- The new standard simply requires that the total heat output capacity of all heating systems installed in a building or room shall be **not less then 100% of the total heat loss** for the building or each room
- No changes have occurred for a systems **cooling capacity. System must meet min 80% of load**.

New CSA F280
Equipment Sizing limitations

The CSA Committee recognized that inexperienced designers and contractors may feel compelled to add unneeded capacity without this restriction in place, **HOWEVER it was felt that greater flexibility in system design was needed to respond to the reality of new homes and the expectations of todays homeowners**

Examples:

- A home with 25% gazing on East and West facing windows.
- Heat Pump Sizing: Heating "tonnage" out strips cooling
- Combo systems:

The NEW CSA F280-2012 in action!

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HVAC and Envelope Optimization: Current System Applications and Testing Results

Zone 5&6 Test Home

- Production style single detached AND attached
- CSA F280-2012 applied with comparison to HOT2000 HLHG Room-by-Room Calculations
- All homes received full HVAC commissioning
- 20+ homes completed and monitored.
- 4 of the homes have simple "smart" thermostats that can be remotely monitored for Temperature, RH and cycle time.

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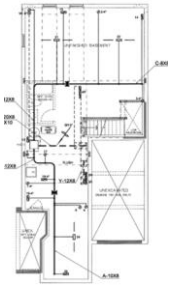
What does this look like on a Production Built Zone 5 Home?

•Builder had a house plan. A famously popular plan that was reproduced and built 30+ times each year.

•Builder was currently building the home to ERS 81 and now moving to 83. Wanted to assess impact of NEW F280-2012 on more efficient home

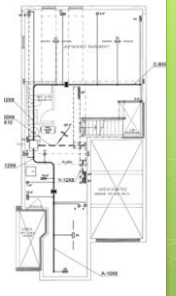


HVAC and Envelope Optimization: Current System Applications and Testing Results

Original Design: ERS 80
- •CSAF280-M90
- •Main Trunks and takeoffs sealed in basement
- •32896 btu/h Envelope Loss
- •13371 btu/h ventilation/Infiltration loss

TOTAL COMBINED HEAT LOSS: 46267 btu/h

•Furnace: Single stage, 93% (60,000 btu/h furnace)
•Blower/CFM: 720
•Main Trunks: 14x8 / 22x8
•Branch Runs: 5" and 6"



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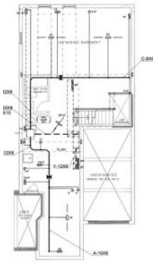
HVAC and Envelope Optimization: Current System Applications and Testing Results

NEW DESIGN: ERS 83
- CSA F280-2012
- Main Trunks and SUPPLY branches sealed to diffuser
- 27471 btu/h Envelope loss (vs 32896btu/h)
- 1514 btu/h Ventilation/Infiltration (vs 13371 btu/h)

TOTAL COMBINED HEAT LOSS **28985 btu/h** (vs 46267)

- Furnace: 2 stage, 95-6% w/ECM (45,000 btu/h furnace)
- Still oversize by 140%+….
- However, FIRST STAGE will allow firing up only 25,000 btu/h
- Blower/CFM: 720 High



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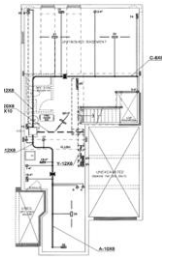
HVAC and Envelope Optimization: Current System Applications and Testing Results

- 5 fewer supply runs total
- 1 less return duct & grille
- Main duct 2 - 16x8 down to 2 – 12x8
- Most runs are now 4" dia.



HVAC and Envelope Optimization: Current System Applications and Testing Results

The Results:

- Air system static pressure: Increase of 26% in main trunk system compared to the original design
- Higher average CFM at face of diffuser= better throw.
- Increased CFM at diffuser did NOT result in noticeable noise increase

Ongoing:

- Monitoring of Cycle time and Interior Temp and RH.
- Additional Testing for Temperature Rise and Temp at Diffuser in Heating conditions.

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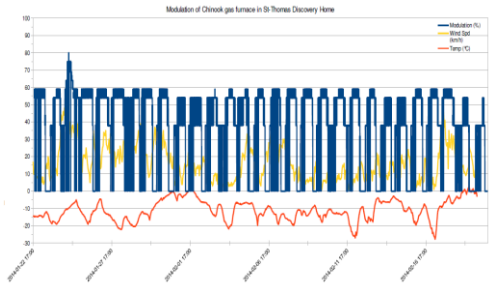
2400 sqft Zone 5 Test Home



Typically performed at 60% of BTU Capacity (18 of 30K)

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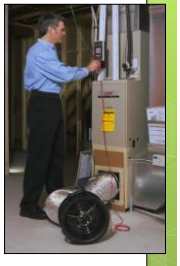
- Test & monitor now. Know what is happening in your homes today…



New CSA F280-2012 and Distribution Design:

New Realities, New Opportunities

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Example of Calculations applying CSA F280-2012 *- Typical 2300 sq.ft. house-*

	1995 Code	EGR 80	EGR 86
Heat Loss (BTUs)	86,000 BTUs	41,000 BTUs	27,000 BTUs
Heat Gain (BTUs / Tons)	39,500 BTUs (3.5 Ton)	26,000 BTUs (2.5 Ton)	16,000 BTUs (1.5 Ton)
Annual Energy $	$ 4900**	$ 2850**	$ 1950**

** $1200 to $1400 in electrical usage

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Example of Calculations applying CSA F280-2012 *- Typical 2300 sq.ft. house-*

	1995 Code	EGR 80	EGR 86
Load	86,000 BTUs 3.5 tons	41,000 BTUs 2.25 tons	27,000 BTUs 1.25 tons
Air Flow	1450 CFM	750 CFM	450 CFM
Duct sizes • **Mains** • **Branch**	8"x30" 5" – 6"	8" x 18" 5"	8" x 10" 3"- 4"

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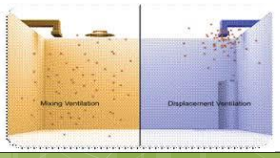
Displacement VS Dilution

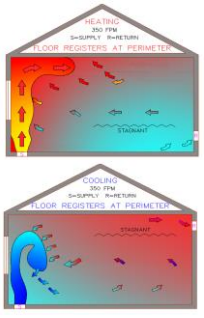
- Small loads = Small Air volume
- Displacement air management can be tricky
- Dilution /mixing air management may be key e.g. Proper tempering and mixing of air
- Move to continuous low to mid volume CFM to maintain even temperatures AND increase ventilation effectiveness
- Low Temp air supply and Higher R exterior surfaces require/allow new diffuser placement (high interior wall)

Dilution /Mixing Air Management:

THROW is equally as important as Return Air in Low Load Homes

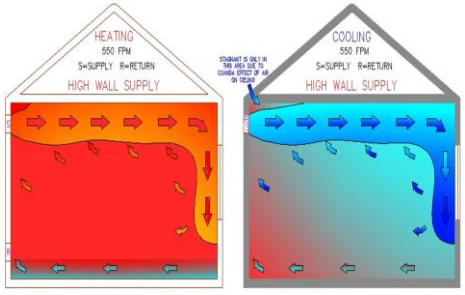
- Pushing /Throwing air conditions rooms better than "pulling" air
- Diffuser **selection** matters
- Diffuser **placement** matters





Managing air by Diffusion:

THROW is equally as important as Return Air in low load homes



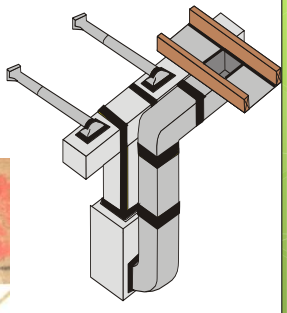
PART LOADS are KING!

SMART Controls + SMART /EFFICIENT Equipment

- Low load homes don't need set-back thermostats
- Low speed, continuous air or room conditioning is ideal (Set it and forget it!)

Sealing of Air Delivery System

- Getting air where you need it
- Allowing balancing & seasonal adjustment to work
- Empowers zoning to work



New Reality's in HVAC Design and Performance

- The ability to **"Balance" a system** is critical to keep todays discerning homeowner comfortable.
- You cant balance a sieve!!!
- Properly sized and sealed air systems maintain optimum static pressure

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New Reality's in HVAC Design and Performance

- Dual Fuel applications
- Air Source Heat Pumps

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The challenges and opportunity's

PERMIT / PLAN REVIEW-we need to know:

- Standard Designer Information Sheets provided by CSAF280 Templates
- Page 1 provides all assumptions and calculation results.
- Spreadsheets are embedded:

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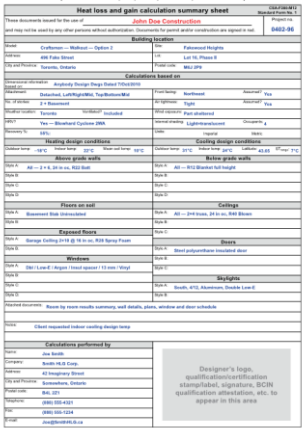

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2015 and beyond

The challenges and opportunity's

Going forward we need to know:

1. Homes are becoming MORE efficient
2. LOADS are dropping
3. Air tightness Matters
4. Test and Monitor : What are YOUR numbers in the field? Temperatures, Pressures, cycle times
5. Windows are critical to cooling(and ultimately duct sizing)
6. GOOD DUCT SEALING makes a world of difference.
7. Part Loads are King! Smart controls and Smarter (more efficient) motors.
8. Heat Recovery Ventilation OR Energy Recovery Ventilation make a difference-
9. Move on from good "returns" and start providing better "THROW"
10. Get ready for more discerning clients….

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Thank You!

ANDREW ODING CEA, LEED AP
Senior Building Science Associate

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Does Size Matter?

Made to Renovate (2 min)

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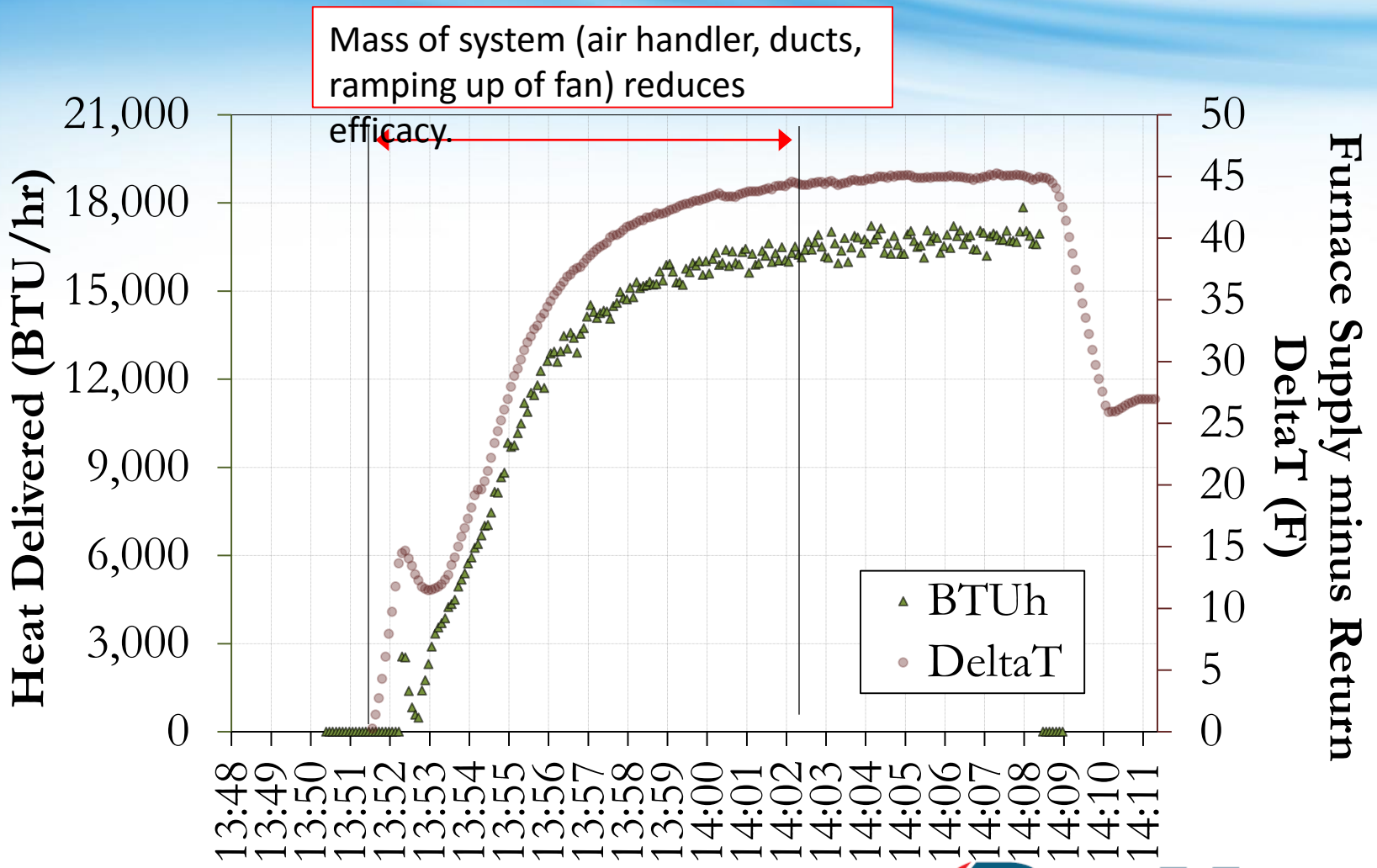
"WE SOLVED THE PROBLEM"

- Building houses better – codes, voluntary programs, NZE
- High Performance Homes – lower loads
  - Low BTU equipment (including 15,000 modulates to 6,000)
- Comfort - Noise reduction & humidity management
  - Short-cycling & over-shooting
- Sq ft is at a premium $$
  - Mechanical footprint
- Find us $$ to offset the cost to solve the problem
  - Customers expect it
- Easy to Operate – set it & forget it

Why Modulation ?



How can we do better?

- Low cfm, longer cycles,
- Less call-backs – comfort, balance, noise
- Reduce and optimize mechanical footprint
- SHOW ME THE $$ - competitive and better system
- Flexible - energy usage, regional preferences

Canadian Home Builders' Association

Dettson;
Proud member Net Zero Energy Housing Council

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RIGHT-SIZED SYSTEM – HEATING and COOLING

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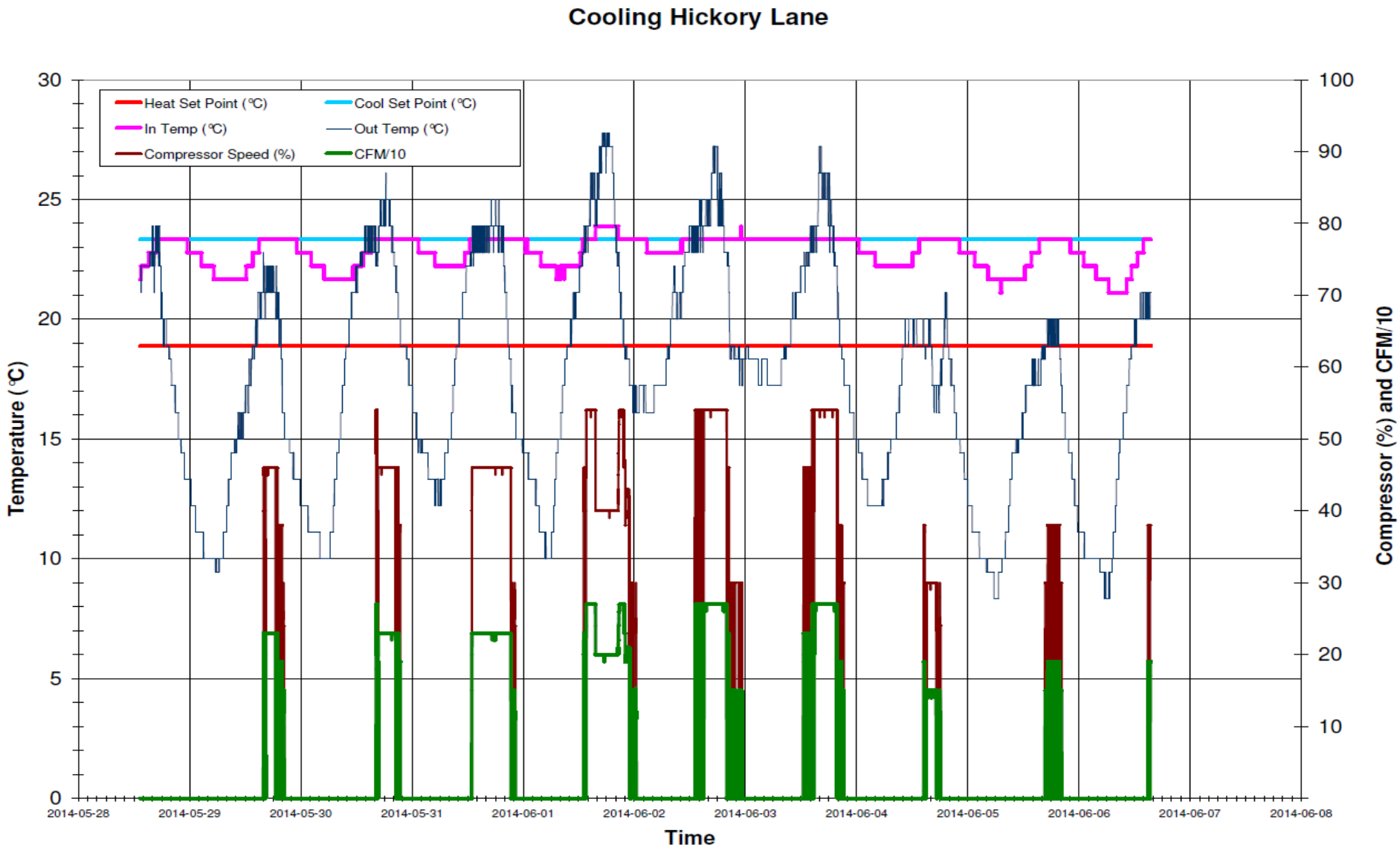
Modulating Cooling

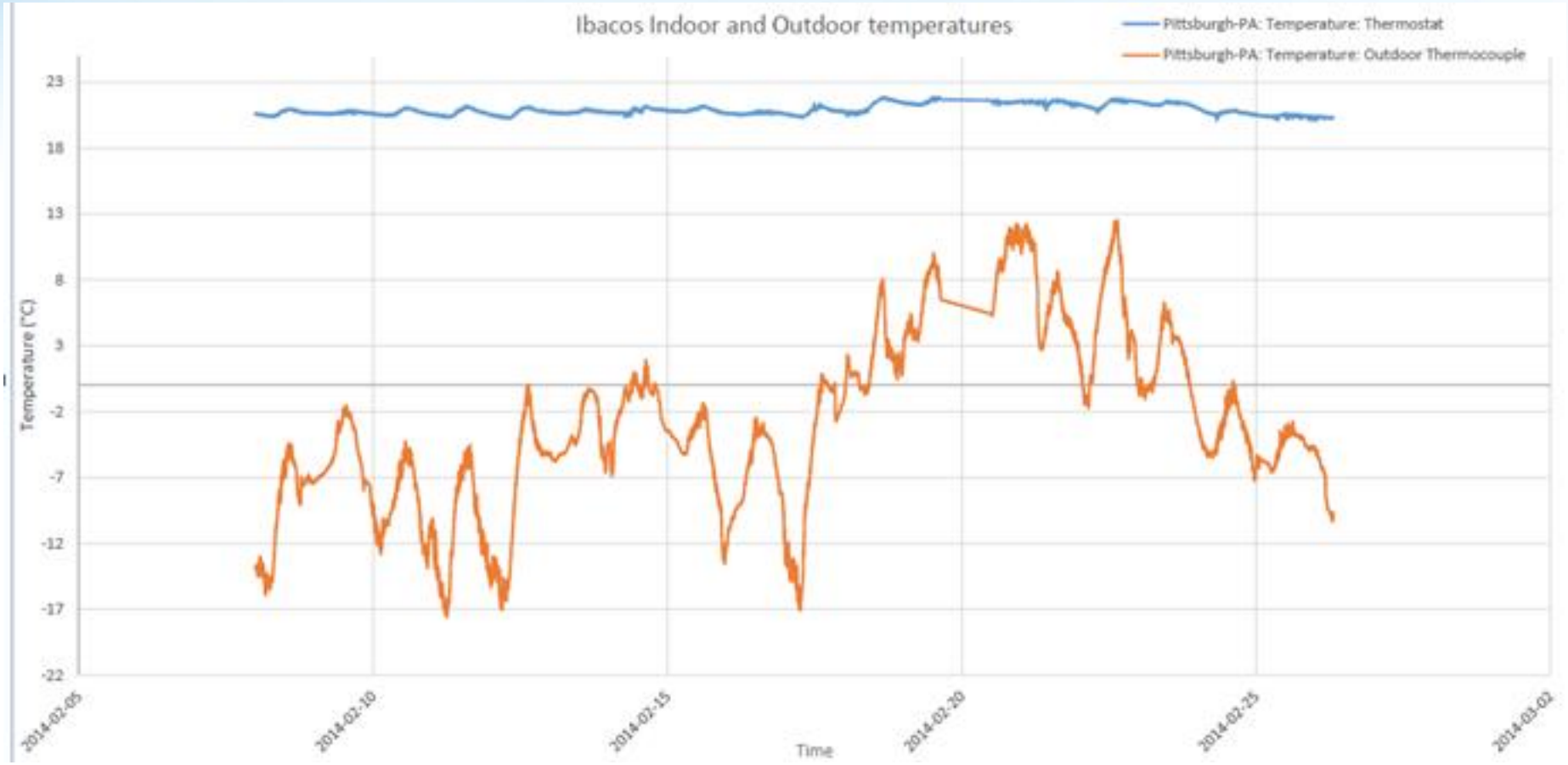
Alizé

Dettson

Modulating cooling



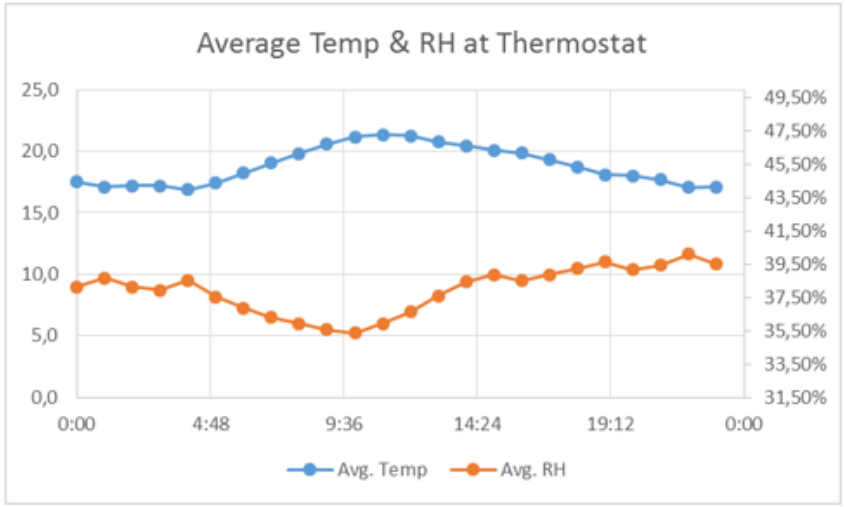
Nice and Balanced



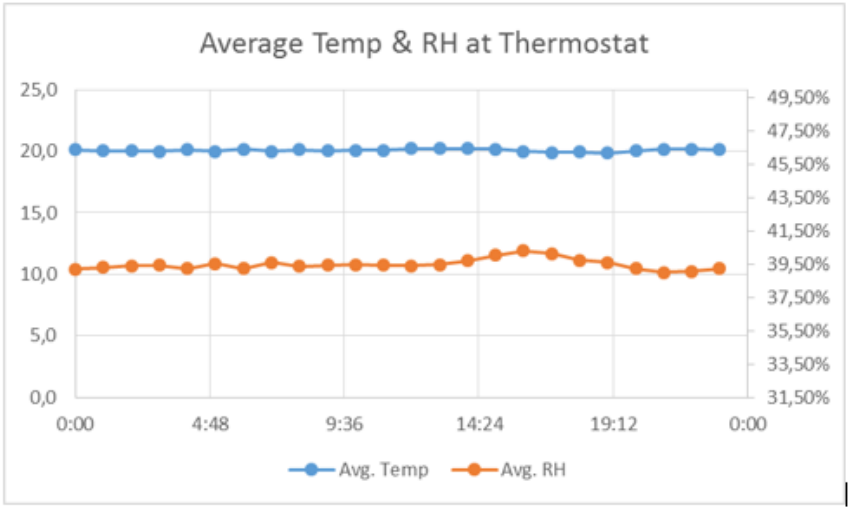
Chinook

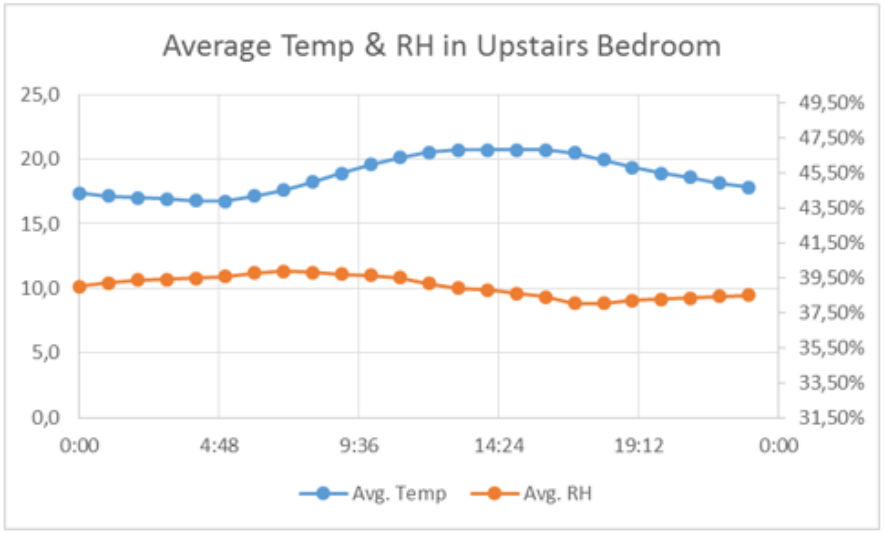
SET IT and FORGET IT

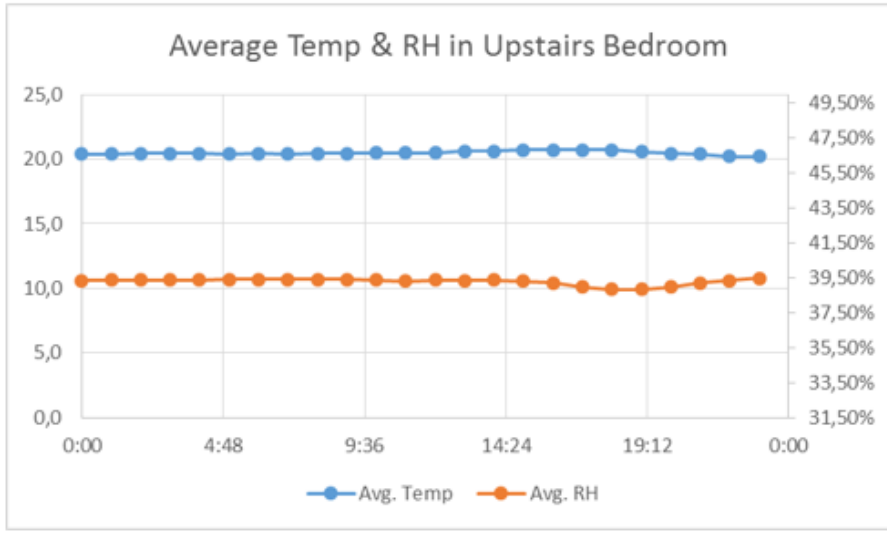
BEFORE SETBACK CORRECTION



AFTER SETBACK CORRECTION

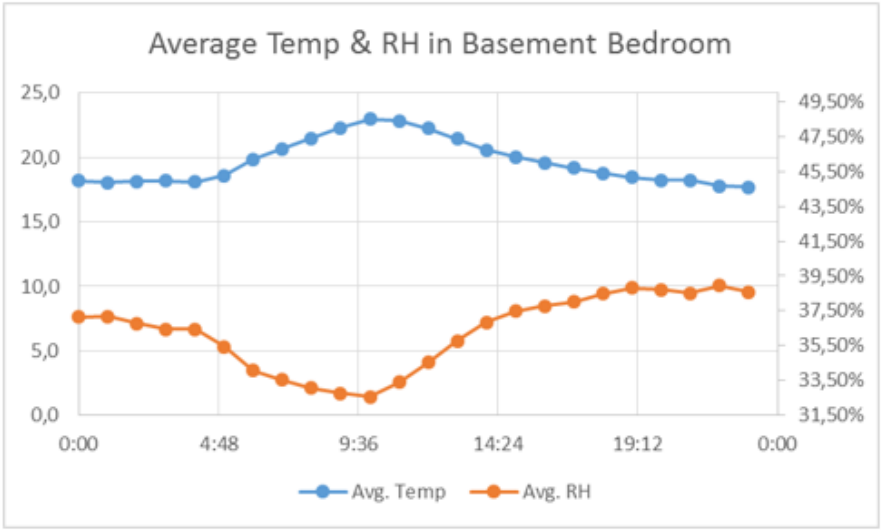




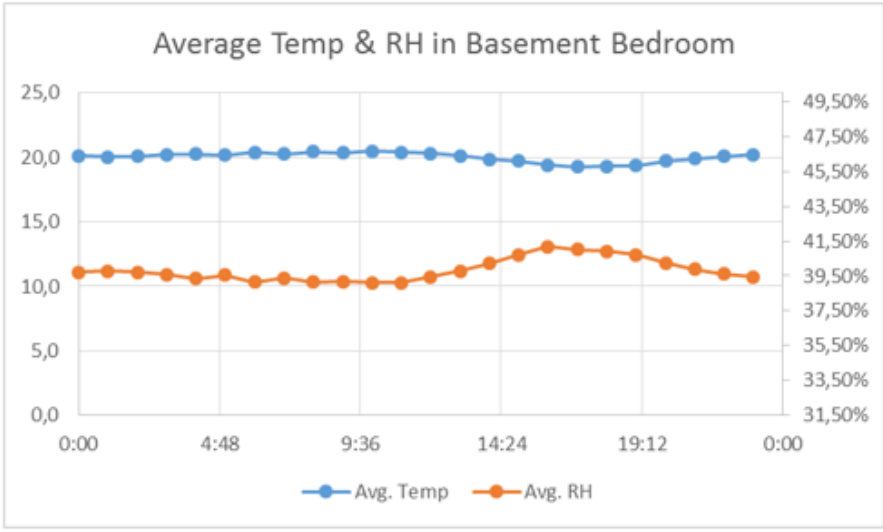


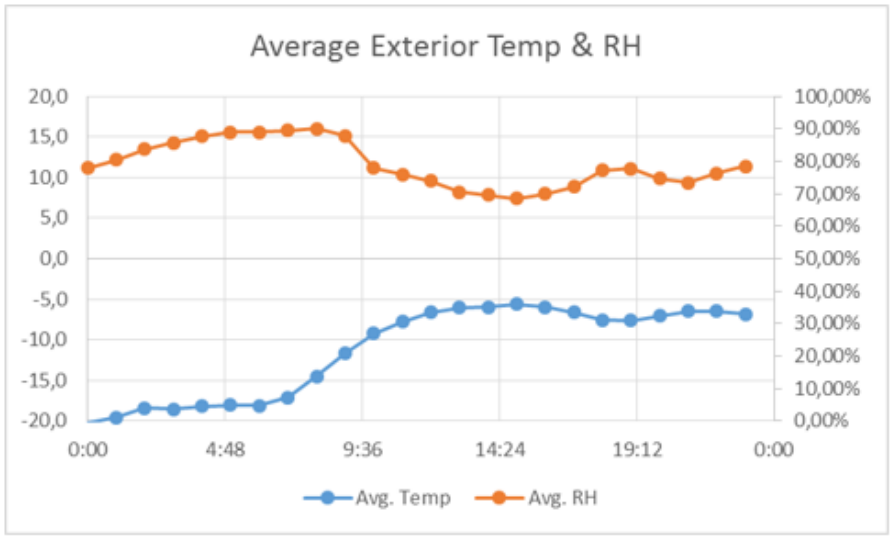
Stability = less callbacks

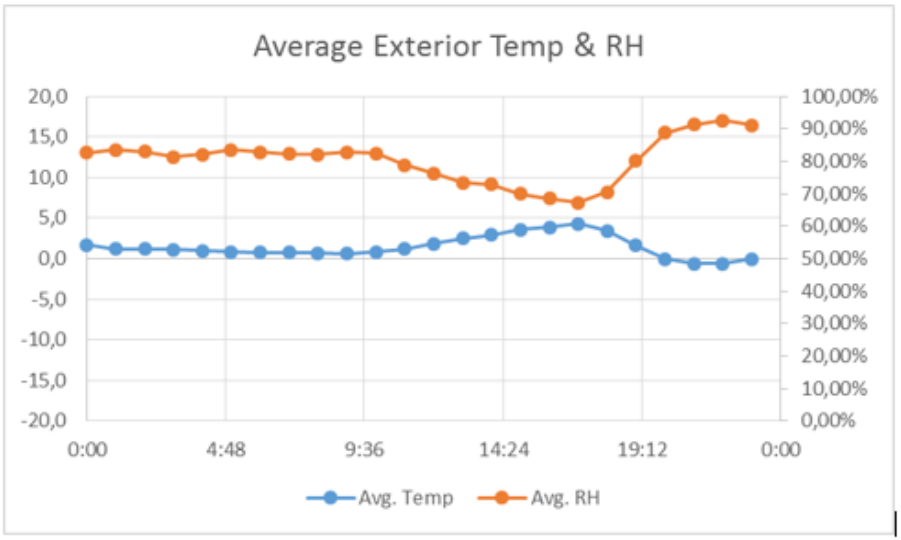
BEFORE SETBACK CORRECTION



AFTER SETBACK CORRECTION







ENHANCED VENTILATION SYSTEM

- Continuous air flow – interlocked in with HRV/ERV
- Drive balance temp and humidity management
- Set it and forget it
- Healthy, quiet and comfortable home

We went even SMALLER

Dettson

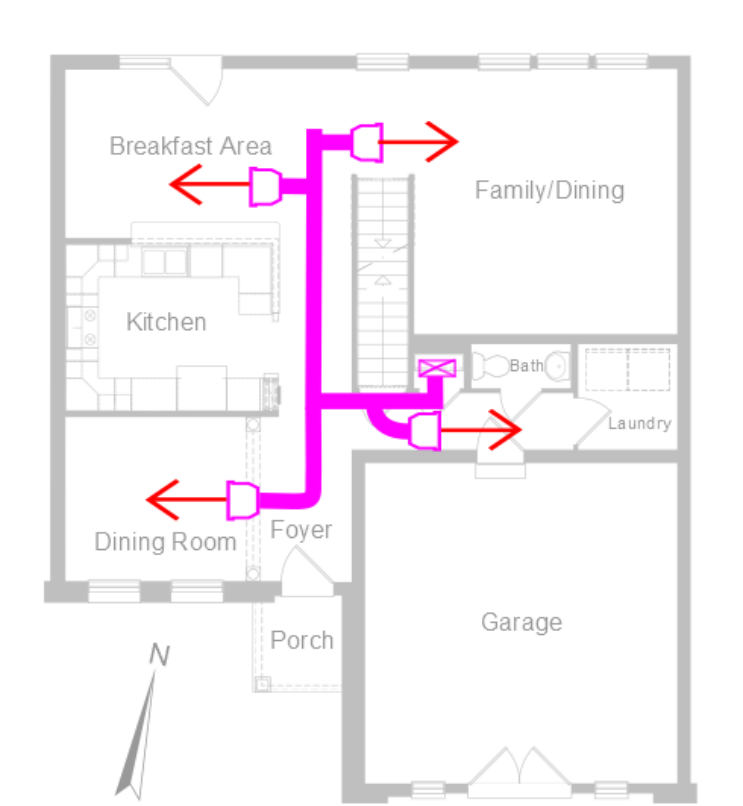
Air Distribution Challenges

- Noise – inside and outside
- Thermal Balance - Last room, bonus rooms, towns
- Mechanical Footprint – bulkheads, floor registers, spatial separation
- The Detailing - Air Leakage
- Time = $$ - labour cost for sealing

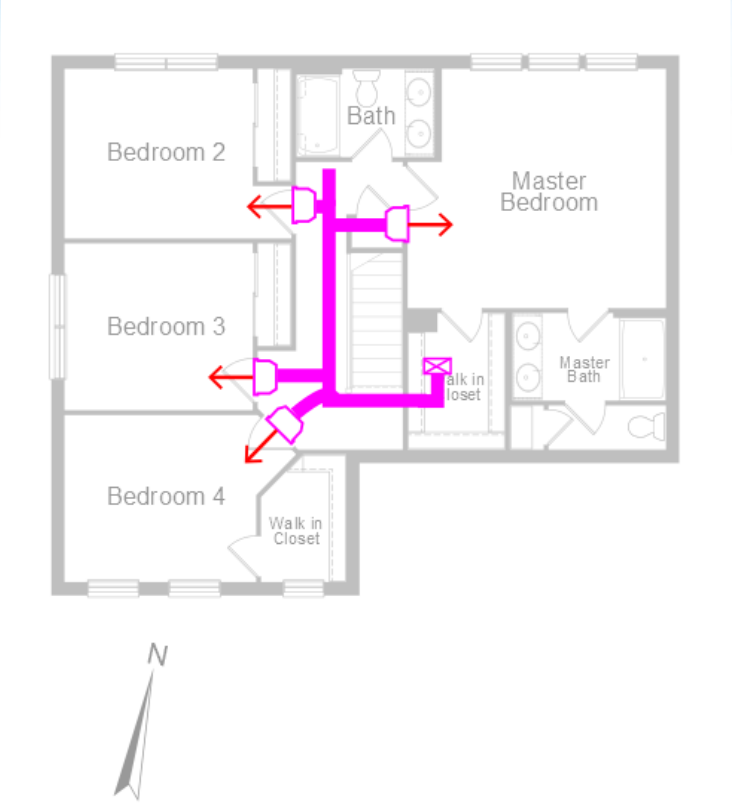
Interior Walls – 6” below ceiling

- **8” Sheet metal trunk with 2.5” flex duct supply runs**

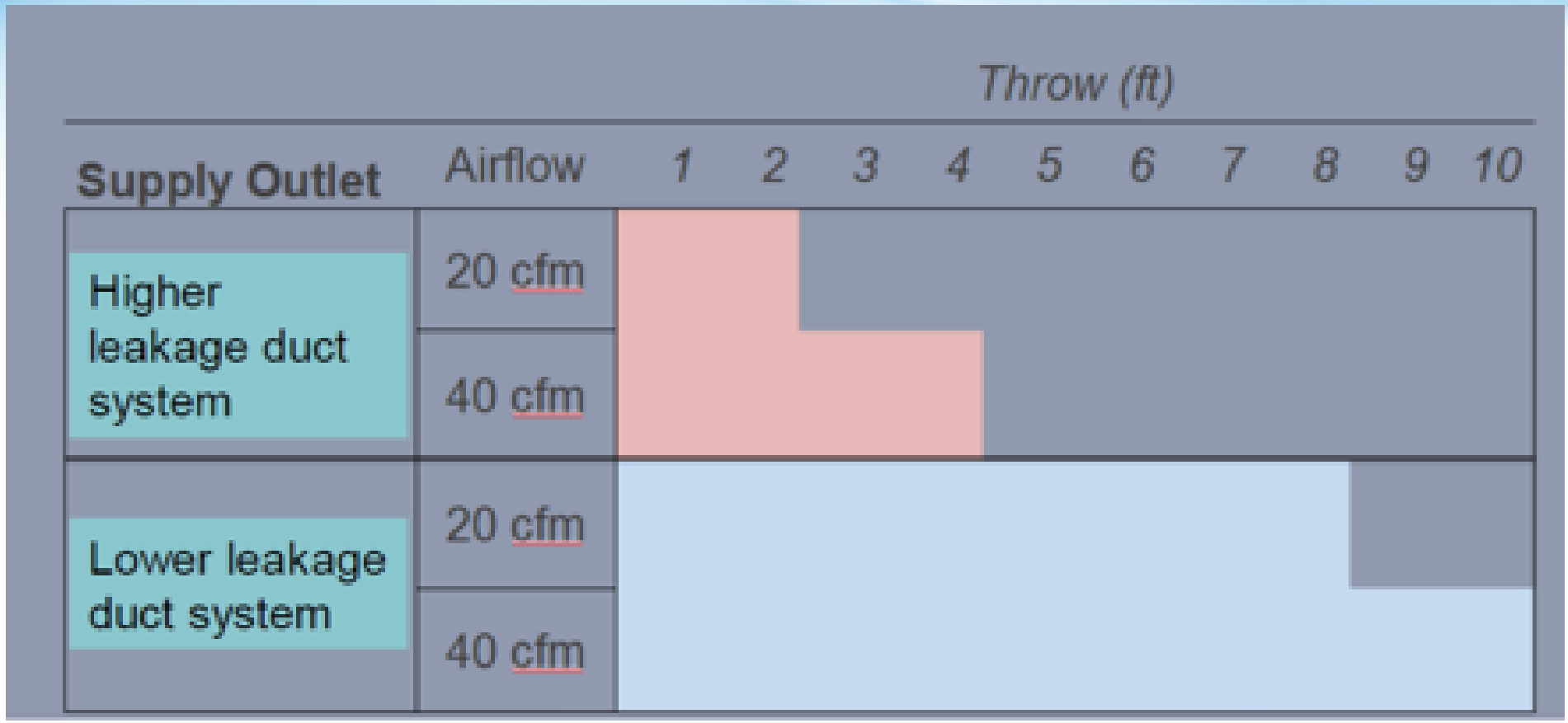
First Floor



Second Floor

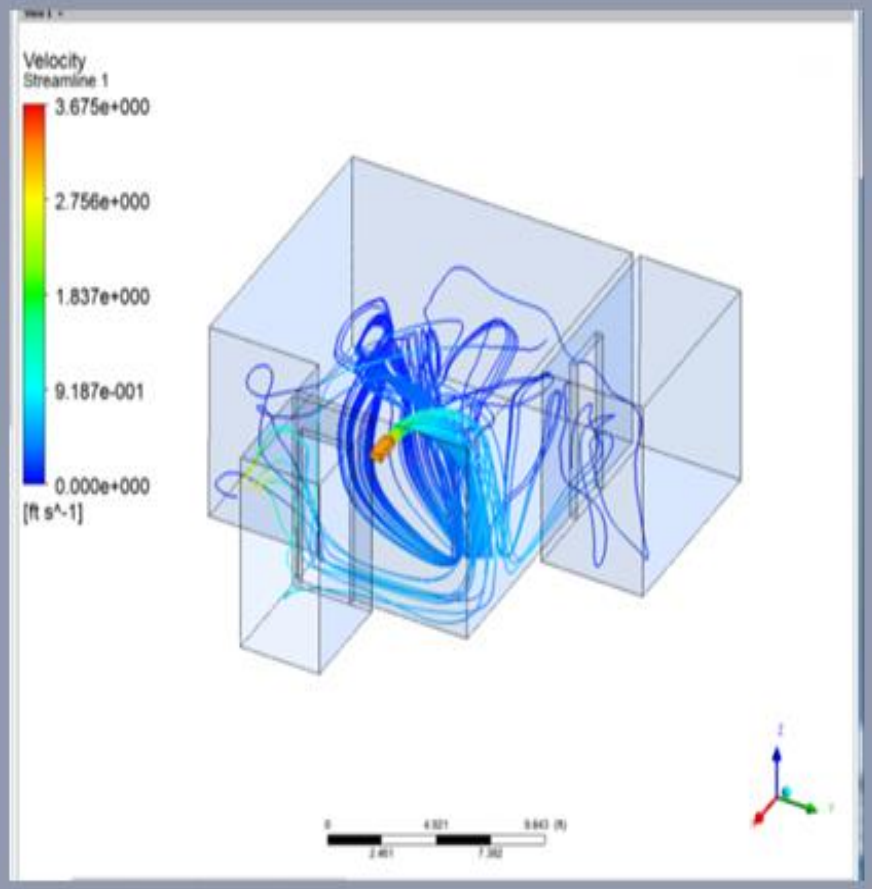


BETTER THROW

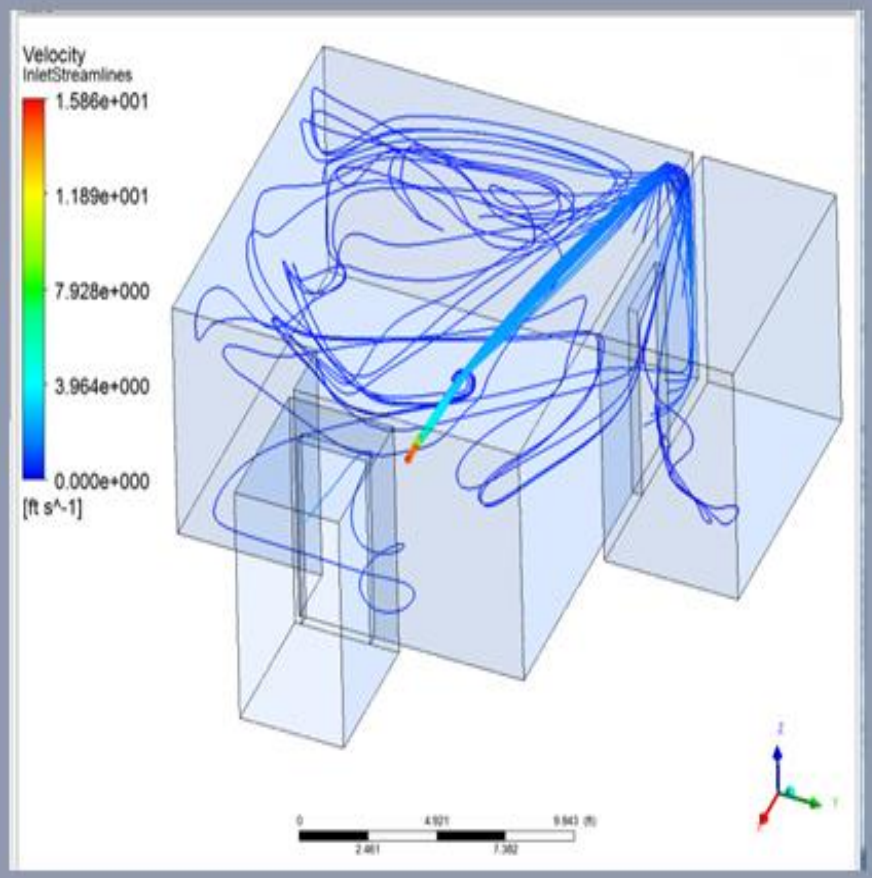


Better Throw and Mixing

Standard register



Small diffuser

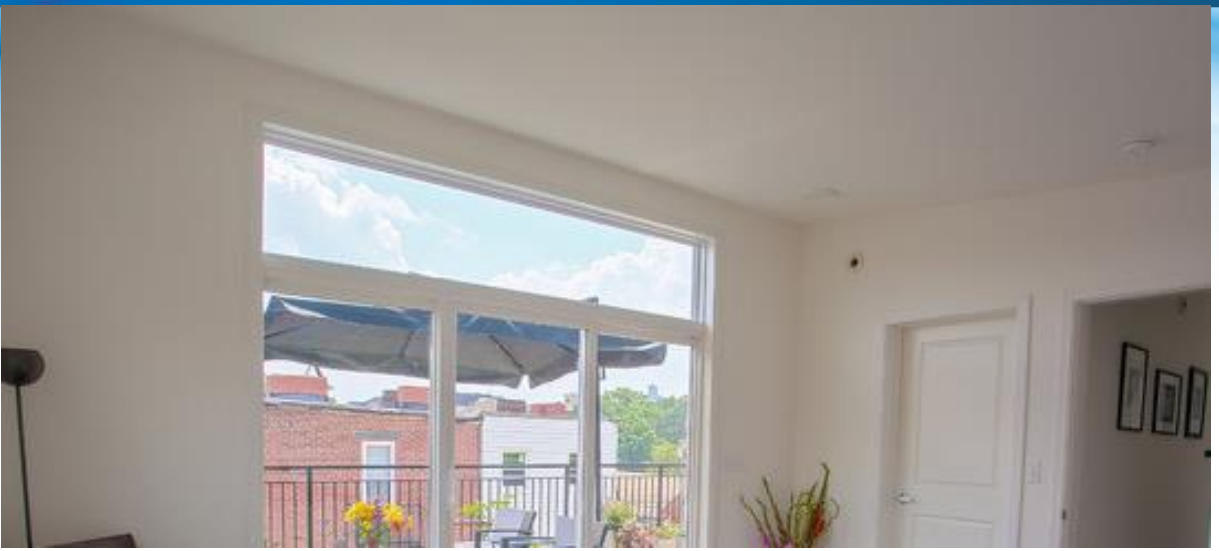


Long cycle = continuous air movement

Optimize your designs

Faster, more consistent – 2-5% leakage

Better, Faster, Cheaper



SMART DUCT SYSTEM

Benefits of the Smart Duct System

Benefits		Specifics
The RIGHT Static pressure	✓	Low – medium velocity
BETTER throw	✓	9 ft vs 3ft
BETTER mixing	✓	6” from the ceiling
IMPROVED air leakage	✓	2-5%
OPTIMIZE floor and mechanical design	✓	• Customize to meet load/room • easier & faster install
Noise Reduction	✓	• Reduce bulkheads • Better installations • Decrease sheet metal

SMART DUCT SYSTEM

Dettson

WE SOLVED THE PROBLEM

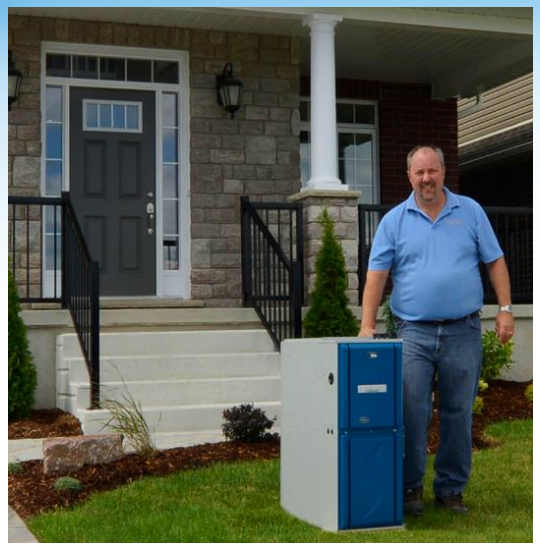
- Competitive and innovative Canadian Solution
- High Performance Homes – low loads
  - Low BTU equipment
  - Longer cycles & low cfm
- Better Comfort
  - Noise reduction and humidity management
- Optimize floor plans and mechanical design
  - Centralized ducts, reduce bulkheads, one return per floor
- Energy flexibility
- Reduce Call-backs
- Easy to operate – Set it and Forget it

Cost Efficiencies

BETTER, FASTER, COST EFFICIENT

- Durability - Modulating - Brushless DC/ECM – increased and efficient motor life
- Reliability – quality and reliable components that contractors trust and stock
- Duct Design Optimization – duct design optimization, labour savings on install, duct sealing , consistency for installs, reduce returns, decrease bulkheads
- Reduce Call-backs and warranty issues

Questions?



"It's hard to beat having a customer come up to you and thank you for installing a furnace and air conditioner system that is so quiet they keep checking on it to see if it's working.

Constant temperature, high efficiency and quieter performance are some of the benefits that our customers are commenting on. As I've said before it's like swapping out your old gas guzzling tank for a Porsche.

As a new home designer, I am extremely excited to be exploring the impact of the Smart Duct System on my floor designs.

This is a revolution in improved HVAC performance."
Doug Tarry Jr
Doug Tarry Homes

Dettson

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