Rating the Performance of HVAC Systems in a HERS Rating

RESNET Building Performance Conference

February 28th, 2017

Introduction

Installation defects in HVAC systems are commonplace

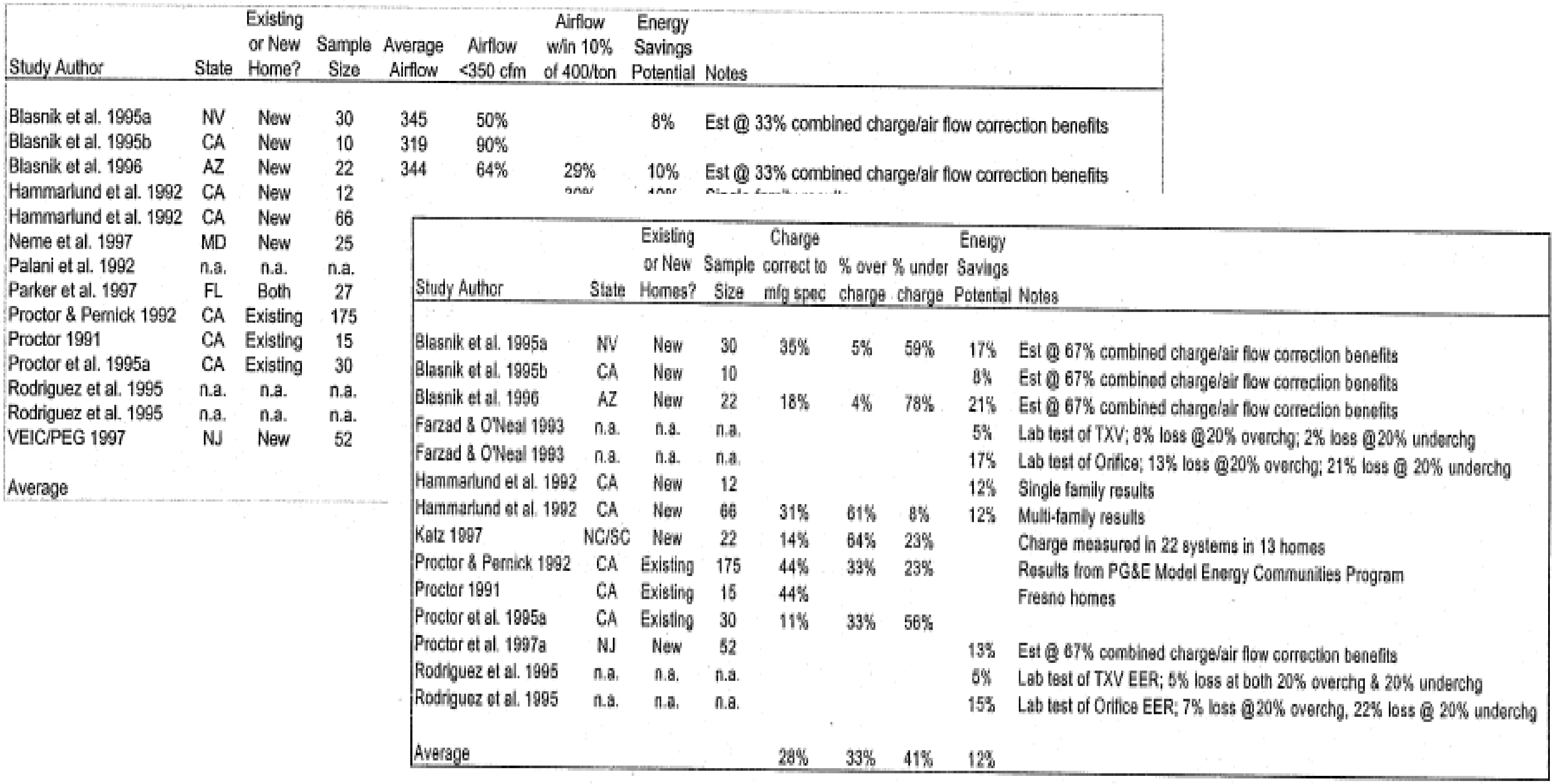
Installation defects in HVAC systems are commonplace

- Improper airflow:
  - Average airflow ~20% below target. Blasnik et al. (1995)
  - Average airflow 14% below design. Proctor (1997)
  - Measured airflow ranging from 130 - 510 CFM / ton. Parker (1997)
  - 70% of units had airflow < 350 CFM / ton. Neme et al. (1999)
  - Improper airflow in 44% of systems. Mowris et al. (2004)

Installation defects in HVAC systems are commonplace

- Incorrect refrigerant charge:
  - In 57% of systems. Downey/Proctor (2002)
  - In 62% of systems. Proctor (2004)
  - In 72% of systems. Mowris et al. (2004)
  - In 82% of systems. Proctor (1997)

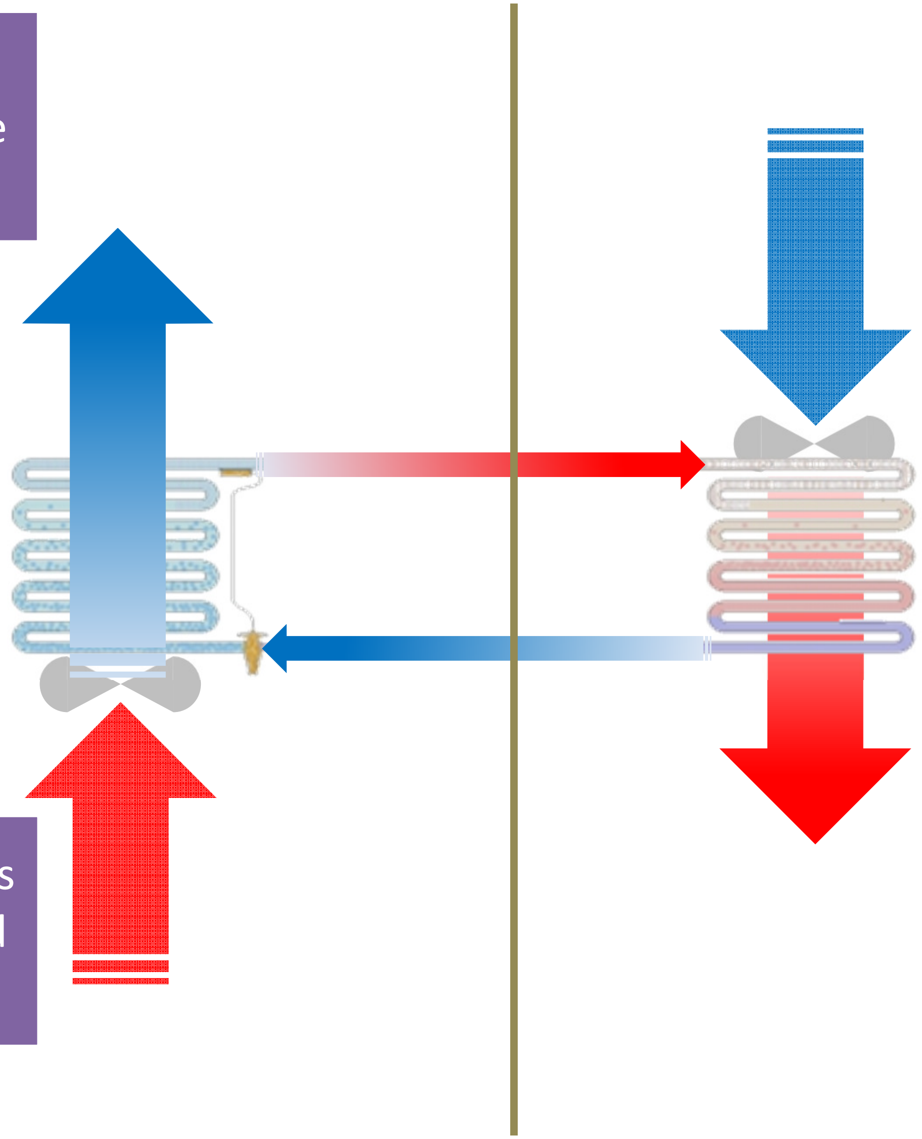
Installation defects in HVAC systems are commonplace



Study Author	State	Existing or New Home?	Sample Size	Average Airflow	Airflow <350 cfm	Airflow w/in 10% of 400/ton	Energy Savings Potential	Notes
Blasnik et al. 1995a	NV	New	30	345	50%		8%	Est @ 33% combined charge/air flow correction benefits
Blasnik et al. 1995b	CA	New	10	319	90%			
Blasnik et al. 1996	AZ	New	22	344	64%	29%	10%	Est @ 33% combined charge/air flow correction benefits
Hammarlund et al. 1992	CA	New	12					
Hammarlund et al. 1992	CA	New	66					
Neme et al. 1997	MD	New	25					
Palani et al. 1992	n.a.	n.a.	n.a.					
Parker et al. 1997	FL	Both	27					
Proctor & Pernick 1992	CA	Existing	175					
Proctor 1991	CA	Existing	15					
Proctor et al. 1995a	CA	Existing	30					
Rodriguez et al. 1995	n.a.	n.a.	n.a.					
Rodriguez et al. 1995	n.a.	n.a.	n.a.					
VEIC/PEG 1997	NJ	New	52					
Average								

Study Author	State	Existing or New Homes?	Sample Size	Charge correct to mfg spec	% over charge	% under charge	Energy Savings Potential	Notes
Blasnik et al. 1995a	NV	New	30	35%	5%	59%	17%	Est @ 67% combined charge/air flow correction benefits
Blasnik et al. 1995b	CA	New	10				8%	Est @ 67% combined charge/air flow correction benefits
Blasnik et al. 1996	AZ	New	22	18%	4%	78%	21%	Est @ 67% combined charge/air flow correction benefits
Farzad & O'Neal 1993	n.a.	n.a.	n.a.				5%	Lab test of TXV; 8% loss @20% overchg; 2% loss @20% underchg
Farzad & O'Neal 1993	n.a.	n.a.	n.a.				17%	Lab test of Orifice; 13% loss @20% overchg; 21% loss @ 20% underchg
Hammarlund et al. 1992	CA	New	12				12%	Single family results
Hammarlund et al. 1992	CA	New	66	31%	61%	8%	12%	Multi-family results
Katz 1997	NC/SC	New	22	14%	64%	23%		Charge measured in 22 systems in 13 homes
Proctor & Pernick 1992	CA	Existing	175	44%	33%	23%		Results from PG&E Model Energy Communities Program
Proctor 1991	CA	Existing	15	44%				Fresno homes
Proctor et al. 1995a	CA	Existing	30	11%	33%	56%		
Proctor et al. 1997a	NJ	New	52				13%	Est @ 67% combined charge/air flow correction benefits
Rodriguez et al. 1995	n.a.	n.a.	n.a.				6%	Lab test of TXV EER; 5% loss at both 20% overchg & 20% underchg
Rodriguez et al. 1995	n.a.	n.a.	n.a.				15%	Lab test of Orifice EER; 7% loss @20% overchg, 22% loss @ 20% underchg
Average				28%	33%	41%	12%	

Installation defects in HVAC systems are commonplace



Inside the House

1

Warm indoor air is blown over a cold refrigerant coil.

2

The air’s heat is transferred to the refrigerant.

Outside the House

3

Outdoor air is blown over the hot refrigerant coil.

4

The refrigerant’s heat is transferred to the outdoor air.

The role of ENERGY STAR Certified Homes: Current program requirements

- The program added HVAC design & installation requirements ~ 2012.
- Binary approach – all requirements must be met for certification.
- **HVAC designers** must document key design parameters regarding:
  - The whole-house ventilation system (ASHRAE 62.2).
  - The heating & cooling load calculations (ACCA Manual J).
  - The heating & cooling equipment selection (ACCA Manual S).
  - The duct design (ACCA Manual D).
- **HVAC contractors** must document key field commissioning parameters:
  - HVAC fan airflow using static pressure, fan-speed setting, & blower table.
  - Refrigerant charge (generally using superheat or subcooling).
  - Measuring & balancing register/grille airflow is recommended, but not required.

The role of ENERGY STAR Certified Homes: Current program requirements

- **Raters** must verify key design parameters to ensure proper design:
  - Outdoor design temperature used in loads.
  - Number of occupants used in loads.
  - Conditioned floor area used in loads.
  - Window area used in loads.
  - Predominant SHGC used in loads.
  - Orientation used in loads.
  - Variation in loads across orientations.
  - Cooling capacity relative to sizing limit.
- **Raters** must verify key parameters in the field to ensure proper installation:
  - Heating and cooling equipment model numbers.
  - Static pressure (Rater-measured, but not currently compared to design)
  - Duct leakage – both leakage to outside and total.
  - Pressure balancing of bedrooms.
  - Visual inspection of filter.

Overlap between ENERGY STAR and ACCA

- The ENERGY STAR program requirements for HVAC are built upon ACCA standards - Manual J, Manual S, Manual D, and a subset of Std. 5 QI: HVAC Quality Installation Specification.
- In addition, ENERGY STAR requires HVAC contractors to be credentialed by an HVAC Quality Installation Training & Oversight Organization (HQUITO).
- There are currently two national HQUITO's – ACCA and Advanced Energy.
- HVAC companies (not individual contractors) earn the credential on an annual basis. They must demonstrate that they have the proper procedures in place to deliver quality-installed systems.
- There is currently limited oversight of individual installations by HQUITO's, as Raters were intended to fulfill this role.

The role of ENERGY STAR Certified Homes: What's worked?

- We've brought a lot of attention to an overlooked area.
- Our team is talking with HVAC professionals for the first time.
- Raters and HVAC professionals are talking with each other for the first time.
- Builders are starting to understand that HVAC systems have to be properly designed and installed to work properly.
- Requirements that could easily be verified by Raters have taken hold:
  - Measurement of, and limit on, total duct leakage.
  - Return-air pathways from bedrooms, verified through pressure limits.
- We've learned a lot.

The role of ENERGY STAR Certified Homes: What hasn't worked?

- The industry, as a whole, doesn't deliver proper design and installation by default yet (similar to Grade I insulation installation at the launch of that standard).
- Lack of uniform, practical, standards led to inconsistencies between contractors and raters.
- Workflow challenges trumped technical challenges.
- No credit in the HERS index was a significant obstacle.

Where Do We Go From Here?

- ACCA initiated a proposal that RESNET include an evaluation of HVAC design and installation in the HERS index.
- In 2016, RESNET tasked EPA with leading a working group to draft a standard that will accomplish this.
- The working group encompasses a diverse set of stakeholders interested in solving this problem:

Jim Bergman, Redfish Instruments	James Jackson, Emerson
Greg Cobb, Apicis Energy	Chris Reynolds, AE
Wes Davis, ACCA	Dave Roberts, NREL
Brett Dillon, IBS Advisors	Dennis Stroer, CalcsPlus
Philip Fairey, FSEC	Iain Walker, LBNL
Dean Gamble, EPA	Dan Wildenhaus, ClearResult
Charlie Haack, ICF	Jon Winkler, NREL

Guiding Principles

- Take a ‘carrot’ rather than a ‘stick’ approach.
- Reward incremental improvement by HVAC professionals and Raters.
- Rely upon procedures that:
  - Can be performed by both HVAC professionals and Raters.
  - Favor consistency over breadth.
  - Provide value in and of themselves (e.g., static pressure).

Overview of Grading Concept

Grading Concept

- Follow the insulation quality-installation model:
  - Grade III: The default. No QI is done. No penalty and no credit.
  - Grade II: Rater reviews key design parameters for accuracy and takes accurate measurements of key installation parameters. The resulting values indicate that the system is not great, but not terrible.
  - Grade I: Rater duplicates the tasks in Grade II, but the resulting values indicate that the system falls within tolerance of ACCA's QI Std.

Potential Workflow:
Step 1: Collection of HVAC Design Documents

- Rater collects standardized HVAC design documentation.
- While this makes the workflow more complex, it's absolutely necessary.
- Without knowing the design intent, not enough information is available to properly assess the installation.

Potential Workflow:
Step 2: Review of HVAC Design Documents

- Rater reviews HVAC design documentation to ensure that:
  - It reflects the rated home.
  - Meets minimum requirements.

Potential Workflow:
Step 3: Completion of Diagnostic Tests in the Field

- Rater completes diagnostic tests on the installed equipment in the following areas:
  - Total airflow of HVAC system
  - Refrigerant charge of HVAC system
  - Wattage of HVAC fan (or static pressure as a proxy)

Potential Workflow:
Step 4: Rater Enters Field Results in HERS Software

- Rater enters field data into HERS software, which:
  - Uses the field data to apply an installation adjustment factor to the HVAC equipment.
  - Generates the HERS index with this factor applied.
  - Assigns an installation grade to the system.

Diagnostic Tests Under Consideration

Total HVAC Airflow

- Five test procedures under consideration.
- All but #5 have been incorporated into CA code:
  1. Fan flowmeter / Pressure Matching
  2. Flow grid
  3. Powered Flow Capture Hood
  4. Passive Flow Capture Hood
  5. Static pressure + fan-speed setting

Fan flowmeter / Pressure Matching

1. Measure static pressure created in supply plenum during operation of HVAC system.
2. Turn off HVAC system, connect a fan-flowmeter, and block other return air flow paths.
3. Turn on flowmeter fan and adjust to achieve same static pressure in supply plenum.
4. Determine HVAC airflow by recording airflow of flowmeter fan.


6/7/2002

Fan flowmeter / Pressure Matching

Pros	Cons
Accurate: +/- 5%	Can’t reach high flows for big systems: needs extrapolation
Uses equipment many Raters already own	If installed at a return – need to account for duct leakage
	Need at least one large low air flow resistance return duct

Flow Grid

1. Measure static pressure created in supply plenum during operation of HVAC system.
2. Install calibrated flow grid in filter slot.
3. Measure pressure difference using flow grid. Correct pressure using value measure in Step 1.
4. Determine HVAC airflow by converting corrected pressure to airflow.

Flow Grid

Pros	Cons
Easy/simple for many systems	Multiple returns are hard to deal with
Can work at higher flows	Need to make sure a good seal is achieved around the plate perimeter
	Less accurate +/- 15%

Powered Flow Capture Hood

1. Turn on HVAC system.
2. Connect powered flow capture hood to return grille.
3. Turn on capture hood and allow its fan to adjust until pressure is equalized.
4. Resulting airflow of capture hood determines HVAC airflow.

Powered Flow Capture Hood

Pros	Cons
Easy to use	Can be heavy/unwieldy
Flowmeters with high flow resistance less sensitive to placements and flow non-uniformity	Can be more expensive than passive devices
	Needs power

Passive Flow Capture Hood

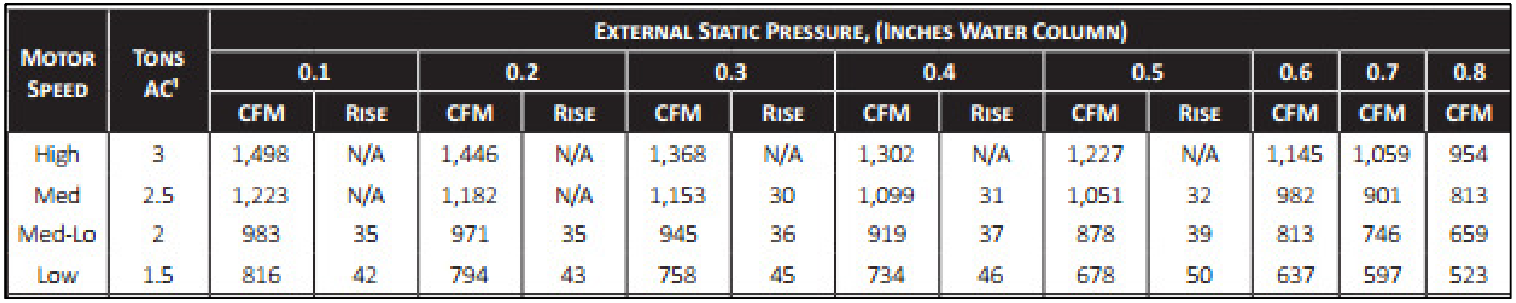
1. Turn on HVAC system.
2. Connect passive flow capture hood to return grille.
3. Turn on capture hood and allow reading to stabilize.
4. Resulting airflow of capture hood determines HVAC airflow.

Passive Flow Capture Hood

Pros	Cons
Easy to use	Sensitive to placement
	Extra uncertainty on branched systems
	Will not always fit around air inlet

Static pressure + fan-speed setting

1. Turn on HVAC system.
2. Measure external static pressure of system's supply side and return side.
3. Determine fan-speed setting through visual inspection.
4. Using blower table information, look up total external static pressure and fan-speed setting to determine airflow.



Motor Speed	Tons AC[1]	External Static Pressure, (Inches Water Column)												
		0.1		0.2		0.3		0.4		0.5		0.6	0.7	0.8
		CFM	Rise	CFM	Rise	CFM	Rise	CFM	Rise	CFM	Rise	CFM	CFM	CFM
High	3	1,498	N/A	1,446	N/A	1,368	N/A	1,302	N/A	1,227	N/A	1,145	1,059	954
Med	2.5	1,223	N/A	1,182	N/A	1,153	30	1,099	31	1,051	32	982	901	813
Med-Lo	2	983	35	971	35	945	36	919	37	878	39	813	746	659
Low	1.5	816	42	794	43	758	45	734	46	678	50	637	597	523

Static pressure + fan-speed setting

Pros	Cons
Requires only pressures to be measured	Need blower chart or equivalent data (may be included on HVAC design report)
Works for all flows	Need to drill holes in plenums/equipment
Inexpensive equipment	Ned to place holes in consistent proper location for accurate measurement

Refrigerant Charge

- Considering using refrigerant line temperatures as a proxy for refrigerant charge.
- Investigating non-invasive procedures
  - Based on temperature measurements and manufacturers performance tables + measured airflow
- Avoid needing EPA training for refrigerant handling
- Need to do some field evaluation
- Need to consider winter/cool weather testing
  - Do we give a default (grade 2)?
  - Is it too big a problem to have a rating change depending on test season?

Fan Wattage

- Three procedures are under consideration:
  1. Watt meter for direct measurement
  2. Clocking whole-house meter
  3. Static pressure + fan type as a proxy

Diagnostic Tests Converted to Credit

The NIST study

- In September 2014, NIST published an important study that analyzed the sensitivity of installation faults on HVAC performance.
  - Conducted a literature review on HVAC faults.
  - Used laboratory testing to derive equations that correlate design and installation faults with COP impacts.

- http://acca.org/quality (Quality Saves Energy)

- HVAC WG determined this to form the underpinnings of an HVAC grading system in the RESNET standard.

The NIST study

- Heat pump
  - Layers heating efficiency benefits on top of cooling deficiencies (e.g., oversized heat pump).
  - Bias impacts of cooling dominated climates
- Chicago, Houston, Las Vegas, Minnieapolis, Washington D.C
- PSC Fan Motor
- Ducts in:
  - Conditioned space (basement), and
  - Unconditioned space (attic)

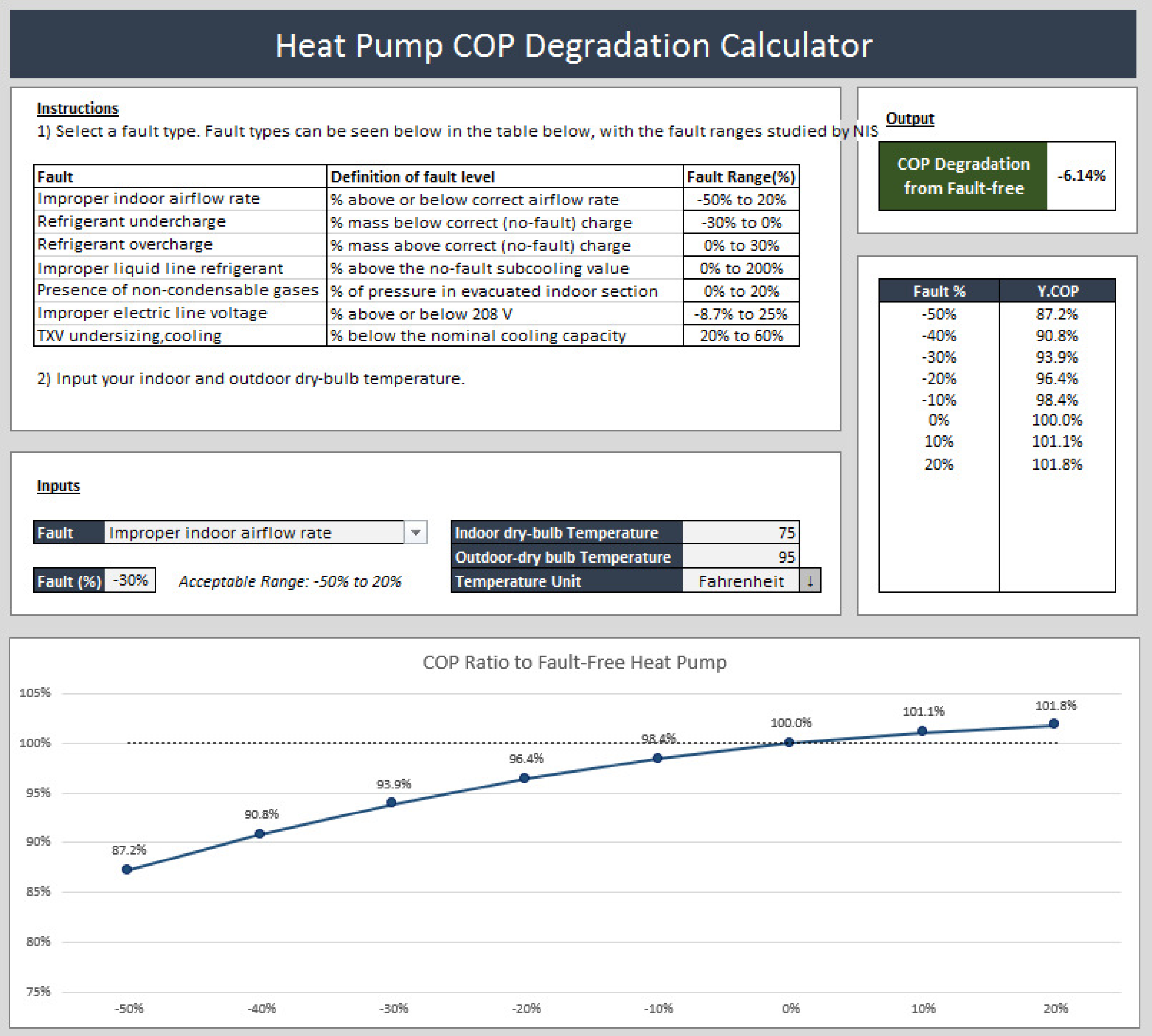
Faults Analyzed in NIST Study

Fault Type	Fault Levels (%)	
	Cooling mode	Heating mode
Heat Pump Sizing (pg. 46)	-20, 25, 50, 75, 100	-20, 25, 50, 75, 100
Duct Sizing (pg. 48)	80, 100, 125, 150, 175, 200	80, 100, 125, 150, 175, 200
Duct Leakage (pg. 54)	0, 10, 20, 30, 40, 50	0, 10, 20, 30, 40, 50
Adjusting Thermostat (pg. 55)	2°F, 4°F	-
Indoor Coil Airflow (pg. 60)	-36, -15, 7, 28	-36, -15, 7, 28
Refrigerant Undercharge (pg. 64)	-10, -20, -30	-10, -20, -30
Refrigerant Overcharge (pg. 66)	10, 20, 30	10, 20, 30
Excessive Subcooling (pg. 67)	100, 200	-
Non-Condensable Gases (pg. 68)	10, 20	10, 20
Electric Voltage (pg. 69)	-8, 8, 25	-8, 8, 25
TXV Undersizing (pg. 71)	-60, -40, -20	-

Faults Analyzed in NIST Study

- Equations created for:
    - Refrigerant-side, and total, cooling and heating capacity
    - Outdoor unit, and total, power
    - COP
- Equation inputs are:
    - Outdoor dry-bulb temperature
    - Indoor dry-bulb temperature
    - Fault type and level

Quality Installation (QI) Calculator



Heat Pump COP Degradation Calculator

Instructions

1) Select a fault type. Fault types can be seen below in the table below, with the fault ranges studied by NIS

Fault	Definition of fault level	Fault Range(%)
Improper indoor airflow rate	% above or below correct airflow rate	-50% to 20%
Refrigerant undercharge	% mass below correct (no-fault) charge	-30% to 0%
Refrigerant overcharge	% mass above correct (no-fault) charge	0% to 30%
Improper liquid line refrigerant	% above the no-fault subcooling value	0% to 200%
Presence of non-condensable gases	% of pressure in evacuated indoor section	0% to 20%
Improper electric line voltage	% above or below 208 V	-8.7% to 25%
TXV undersizing,cooling	% below the nominal cooling capacity	20% to 60%

2) Input your indoor and outdoor dry-bulb temperature.

Output

COP Degradation from Fault-free	-6.14%

Fault %	Y.COP
-50%	87.2%
-40%	90.8%
-30%	93.9%
-20%	96.4%
-10%	98.4%
0%	100.0%
10%	101.1%
20%	101.8%

Inputs

Fault	Improper indoor airflow rate
Fault (%)	-30%

Acceptable Range: -50% to 20%

Indoor dry-bulb Temperature	75
Outdoor-dry bulb Temperature	95
Temperature Unit	Fahrenheit

COP Ratio to Fault-Free Heat Pump

HERS Software Simulates QI

House Parameters Consistent Across CZ's

Parameter	Value
Number of Stories	Two
Conditioned Floor Area per Floor (ft²)	1,200
Total Conditioned Floor Area (ft²)	2,400
Perimeter (ft)	30 x 40
Ceiling Height (ft)	8.5
Bedrooms	4
Window Area & Distribution	15%, Even
Exterior Door Quantity & Total Area (ft^2)	2 Doors, [illegible]
Space Heat., Cool. & DHW	Gas Furnace, AC, Gas DHW

House Parameters Varied Across CZ's

Parameter	CZ 2	CZ 4	CZ 6
Location	Tampa, FL	St. Louis, MO	Burlington, VT
Foundation Type	Slab	Unconditioned Basement	

HERS Software Simulates QI

- Efficiency tiers:

Energy Efficiency	Tampa	St. Louis	Burlington
HERS Reference	13 SEER / 9.6 EER	13 SEER / 9.6 EER	13 SEER / 9.6 EER
ENERGY STAR 3.0	14.5 SEER / 12.0 EER	13 SEER / 9.6 EER	13 SEER / 9.6 EER
ENERGY STAR 3.1	15.0 SEER / 12.0 EER	13 SEER / 9.6 EER	13 SEER / 9.6 EER

- Two faults – three levels:

Fault	Good	Medium	Bad
Improper Airflow (1,000 Cfm)	0% (1,000 Cfm)	-25% (750 Cfm)	-50% (500 Cfm)
Refrigerant Undercharge (6lbs)	0% (6 lbs)	-15% (5.1 lbs)	-30% (4.2 lbs)

kWh Impacts

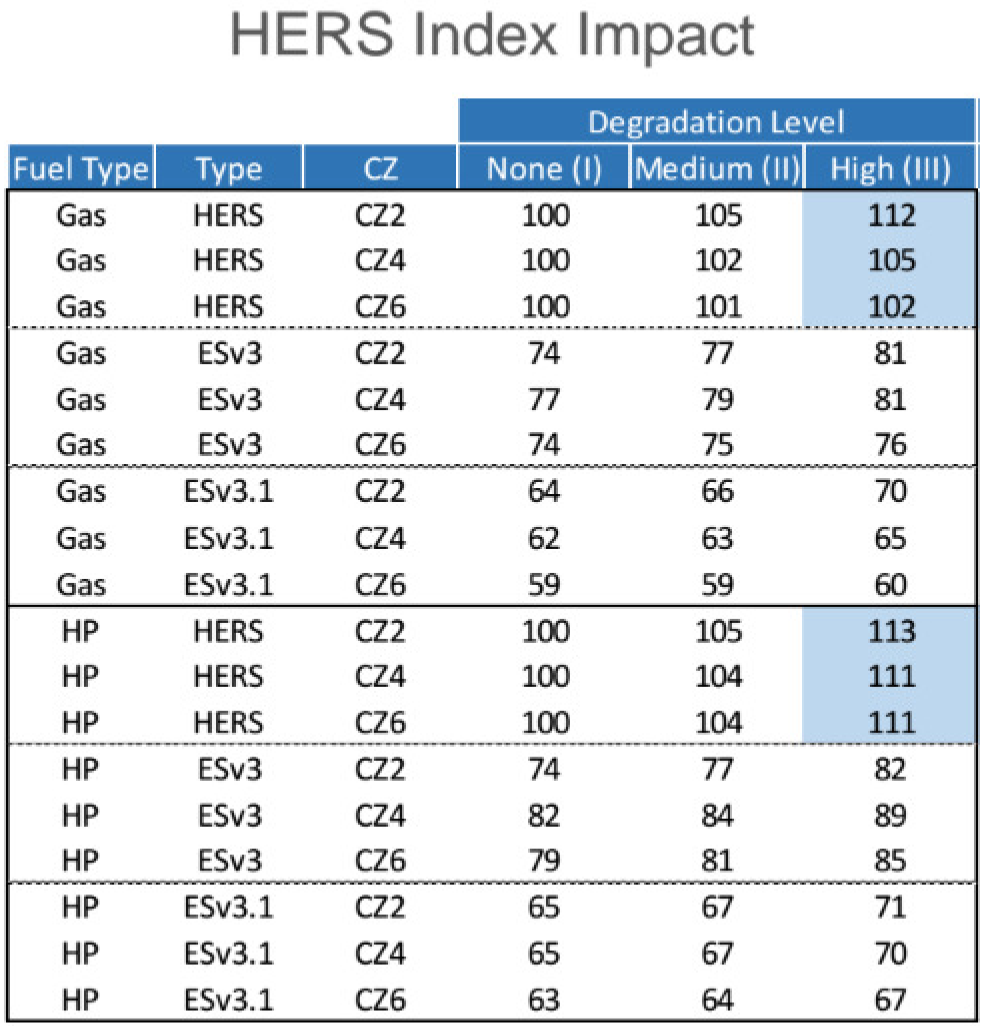
			ΔkWh Cooling			ΔkWh Heating		
			Degradation Level			Degradation Level		
Fuel Type	Type	CZ	None (I)	Medium (II)	High (III)	None (I)	Medium (II)	High (III)
Gas	HERS	CZ2	-1,226	-780	0	0	0	0
Gas	HERS	CZ4	-529	-332	0	0	0	0
Gas	HERS	CZ6	-246	-155	0	0	0	0
Gas	ESv3	CZ2	-735	-472	0	0	0	0
Gas	ESv3	CZ4	-435	-273	0	0	0	0
Gas	ESv3	CZ6	-239	-149	0	0	0	0
Gas	ESv3.1	CZ2	-567	-369	0	0	0	0
Gas	ESv3.1	CZ4	-351	-220	0	0	0	0
Gas	ESv3.1	CZ6	-186	-114	0	0	0	0
HP	HERS	CZ2	-1,227	-782	0	-163	-104	0
HP	HERS	CZ4	-528	-332	0	-1,455	-919	0
HP	HERS	CZ6	-248	-156	0	-2,453	-1,546	0
HP	ESv3	CZ2	-723	-464	0	-131	-83	0
HP	ESv3	CZ4	-374	-236	0	-991	-643	0
HP	ESv3	CZ6	-207	-130	0	-1,103	-665	0
HP	ESv3.1	CZ2	-555	-353	0	-81	-51	0
HP	ESv3.1	CZ4	-291	-182	0	-617	-406	0
HP	ESv3.1	CZ6	-188	-129	0	-796	-483	0

kWh Impacts

			ΔkWh Cooling			**ΔkWh Heating**		
			Degradation Level			Degradation Level		
Fuel Type	Type	CZ	None (I)	Medium (II)	High (III)	None (I)	Medium (II)	High (III)
Gas	HERS	CZ2	-1,226	-780	0	0	0	0
Gas	HERS	CZ4	-529	-332	0	0	0	0
Gas	HERS	CZ6	-246	-155	0	0	0	0
Gas	ESv3	CZ2	-735	-472	0	0	0	0
Gas	ESv3	CZ4	-435	-273	0	0	0	0
Gas	ESv3	CZ6	-239	-149	0	0	0	0
Gas	ESv3.1	CZ2	-567	-369	0	0	0	0
Gas	ESv3.1	CZ4	-351	-220	0	0	0	0
Gas	ESv3.1	CZ6	-186	-114	0	0	0	0
HP	HERS	CZ2	-1,227	-782	0	-163	-104	0
HP	HERS	CZ4	-528	-332	0	-1,455	-919	0
HP	HERS	CZ6	-248	-156	0	-2,453	-1,546	0
HP	ESv3	CZ2	-723	-464	0	-131	-83	0
HP	ESv3	CZ4	-374	-236	0	-991	-643	0
HP	ESv3	CZ6	-207	-130	0	-1,103	-665	0
HP	ESv3.1	CZ2	-555	-353	0	-81	-51	0
HP	ESv3.1	CZ4	-291	-182	0	-617	-406	0
HP	ESv3.1	CZ6	-188	-129	0	-796	-483	0

QI Impact on HERS Index

- HERS impacts are:
  - Climate dependent
  - Home efficiency dependent



HERS Index Impact

			Degradation Level		
Fuel Type	Type	CZ	None (I)	Medium (II)	High (III)
Gas	HERS	CZ2	100	105	112
Gas	HERS	CZ4	100	102	105
Gas	HERS	CZ6	100	101	102
Gas	ESv3	CZ2	74	77	81
Gas	ESv3	CZ4	77	79	81
Gas	ESv3	CZ6	74	75	76
Gas	ESv3.1	CZ2	64	66	70
Gas	ESv3.1	CZ4	62	63	65
Gas	ESv3.1	CZ6	59	59	60
HP	HERS	CZ2	100	105	113
HP	HERS	CZ4	100	104	111
HP	HERS	CZ6	100	104	111
HP	ESv3	CZ2	74	77	82
HP	ESv3	CZ4	82	84	89
HP	ESv3	CZ6	79	81	85
HP	ESv3.1	CZ2	65	67	71
HP	ESv3.1	CZ4	65	67	70
HP	ESv3.1	CZ6	63	64	67

QI Impact on HERS Index

				QI Level*		
System	Hom0e Eff.	CZ	**HERS Index Without QDI**	Bad	Medium	Good
Gas/AC	ESv3	CZ2	74	72	69	66
Gas/AC	ESv3	CZ4	77	77	75	73
Gas/AC	ESv3	CZ6	74	75	74	73
Gas/AC	ESv3.1	CZ2	64	63	59	57
Gas/AC	ESv3.1	CZ4	62	62	60	59
Gas/AC	ESv3.1	CZ6	59	59	58	58
HP	ESv3	CZ2	74	73	68	65
HP	ESv3	CZ4	82	80	76	74
HP	ESv3	CZ6	79	77	73	71
HP	ESv3.1	CZ2	65	63	59	58
HP	ESv3.1	CZ4	65	63	60	59
HP	ESv3.1	CZ6	63	60	58	57

*** Bad QDI equals poor design and install, "no" impact on HERS Index. Good equals compliance to ACCA 5 QI Standard, larger impact on HERS Index.**

QI Impact on HERS Index

HERS Index w/ Grade III Default

			Without QDI Factor	Degradation Level		
Fuel Type	Type	CZ		None (I)	Medium (II)	High (III)
Gas	ESv3	CZ2	74	66	69	72
Gas	ESv3	CZ4	77	73	75	77
Gas	ESv3	CZ6	74	73	74	75
Gas	ESv3.1	CZ2	64	57	59	63
Gas	ESv3.1	CZ4	62	59	60	62
Gas	ESv3.1	CZ6	59	58	58	59
HP	ESv3	CZ2	74	65	68	73
HP	ESv3	CZ4	82	74	76	80
HP	ESv3	CZ6	79	71	73	77
HP	ESv3.1	CZ2	65	58	59	63
HP	ESv3.1	CZ4	65	59	60	63
HP	ESv3.1	CZ6	63	57	58	60

Alternative Compliance Paths

Alternative Compliance Paths

- On-Board Diagnostics (and until then…)
- Third Party Verification

Alternative Compliance Paths: On-Board Diagnostics

- Auto industry pioneered
- ACCA Developing ANSI Standard:
  - Nomenclature: Named faults (the “code”), and what each code means
  - Communication: Protocols (device) to relay codes

Alternative Compliance Paths: On-Board Diagnostics

- Advantages:
  - Objective / Independent
  - Available 24/7
  - Potential for easier data transfer (auto-populates data fields)

Alternative Compliance Paths:
On-Board Diagnostics

- Disadvantages
  - Time to implementation
    - Standard development,
    - OEM adoption / implementation
  - Lacks evaluation of HVAC design elements (?)
  - Purchase interface?

- Neutral
  - Sensor durability
  - Variations in process (airflow: electrical measurement or flow station)
  - Must visit unit to get information?

FRAGILE
Handle with care

Alternative Compliance Paths

- Third Party Verification
  - Approved Third Parties
  - Tools
  - Sensor arrays

Alternative Compliance Paths: Approved Third Parties

- File Review: Evaluate
    - Design conditions
    - Occupants
    - Equipment sizing
    - Recorded measurements

Alternative Compliance Paths: Approved Third Parties

- Field verification
  - Confirm Installation = Design
  - Verify measurements within tolerances
  - Airflow
  - Refrigerant charge
  - On-rate combustion
  - Venting
  - Electrical
  - Duct leakage
  - Room airflow

Alternative Compliance Paths: Approved Third Parties

- Advantages
  - Technical expertise
  - Approved by RESNET
- Disadvantages
  - Expense
- Neutral
  - Objective?
  - Responsiveness?
  - Inter-communication

Alternative Compliance Paths: Tools

- Measures pressures / temperatures / volts / amps / CO (air free) / etc.
- Calculates HVAC elements
  - Airflow
  - Refrigerant Charge
  - On-rate combustion
  - Venting
  - Electrical
  - Duct leakage

iManifold

Bacharach

Parker Hannifin

Fieldpiece

UEI

Fieldpiece

Testo

Alternative Compliance Paths: Tools

- Advantages
  - Objective
  - Communicating
  - Difficult to deceive
- Disadvantages
  - Focused on one or two tasks
  - Lacks system design evaluation
- Neutral
  - Communication
  - Consistency across all platforms

Alternative Compliance Paths: Sensor Arrays

- Group of sensors that measure multiple elements (temperatures, pressures, etc.)
- Algorithms evaluate system performance

Alternative Compliance Paths: Sensor Arrays

- Advantages
  - Objective
  - Communicating
  - Difficult to deceive
- Disadvanages
  - Lacks system design evaluation
  - Communicating to subscriber
- Neutral
  - Beta test stage
  - Subscription based
  - Communicating to subscriber
  - Big Brother?

Next Steps

Summary

- Currently:
    - Assess feasibility of each diagnostic test
    - Discuss Approved Alternative Compliance
    - Interest in a pilot with Raters to ‘kick the tires’ and provide feedback

- Future
    - Draft standard language
    - Standard approval process (SDC, SMB, ANSI)
    - Training development
    - Implementation

Summary

- Background
- Concept Overview
  - Grading
  - Potential workflow
  - Tests under consideration
  - Conversion of Test Results into Credit
  - Alternative Compliance Paths
- Q & A