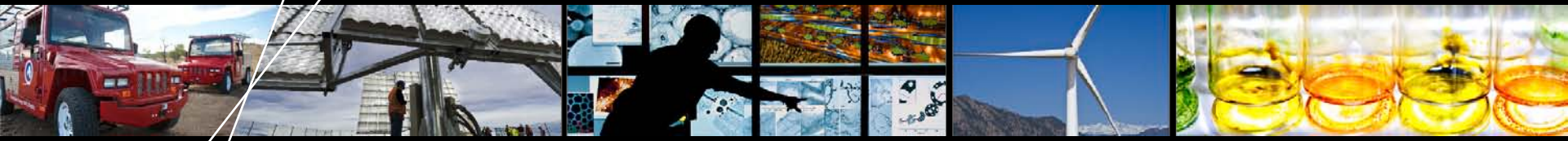
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Laboratory Performance Testing of Residential Dehumidifiers



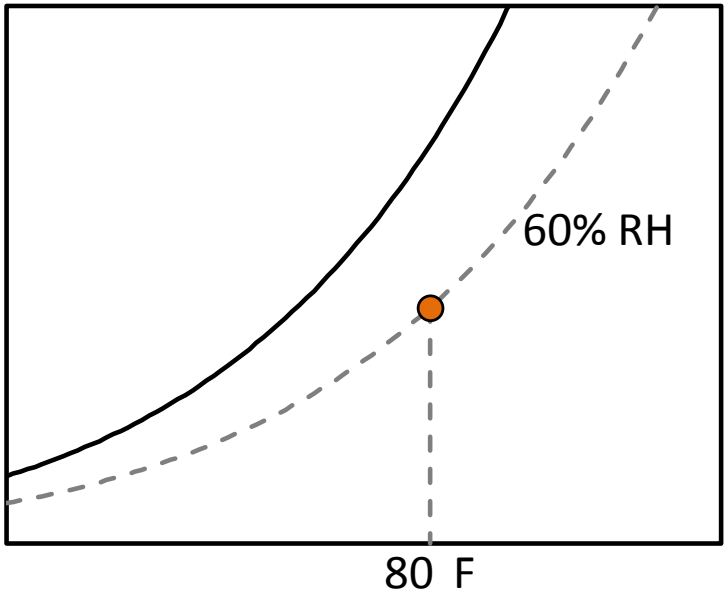
Building America Stakeholders Meeting

Jon Winkler

March 2, 2012

Motivation

Dehumidifier Manufacturer Data



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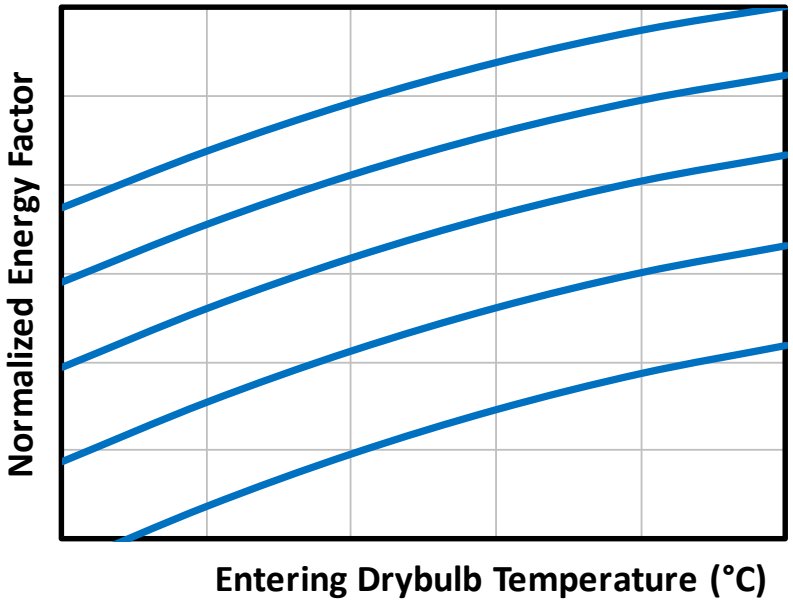
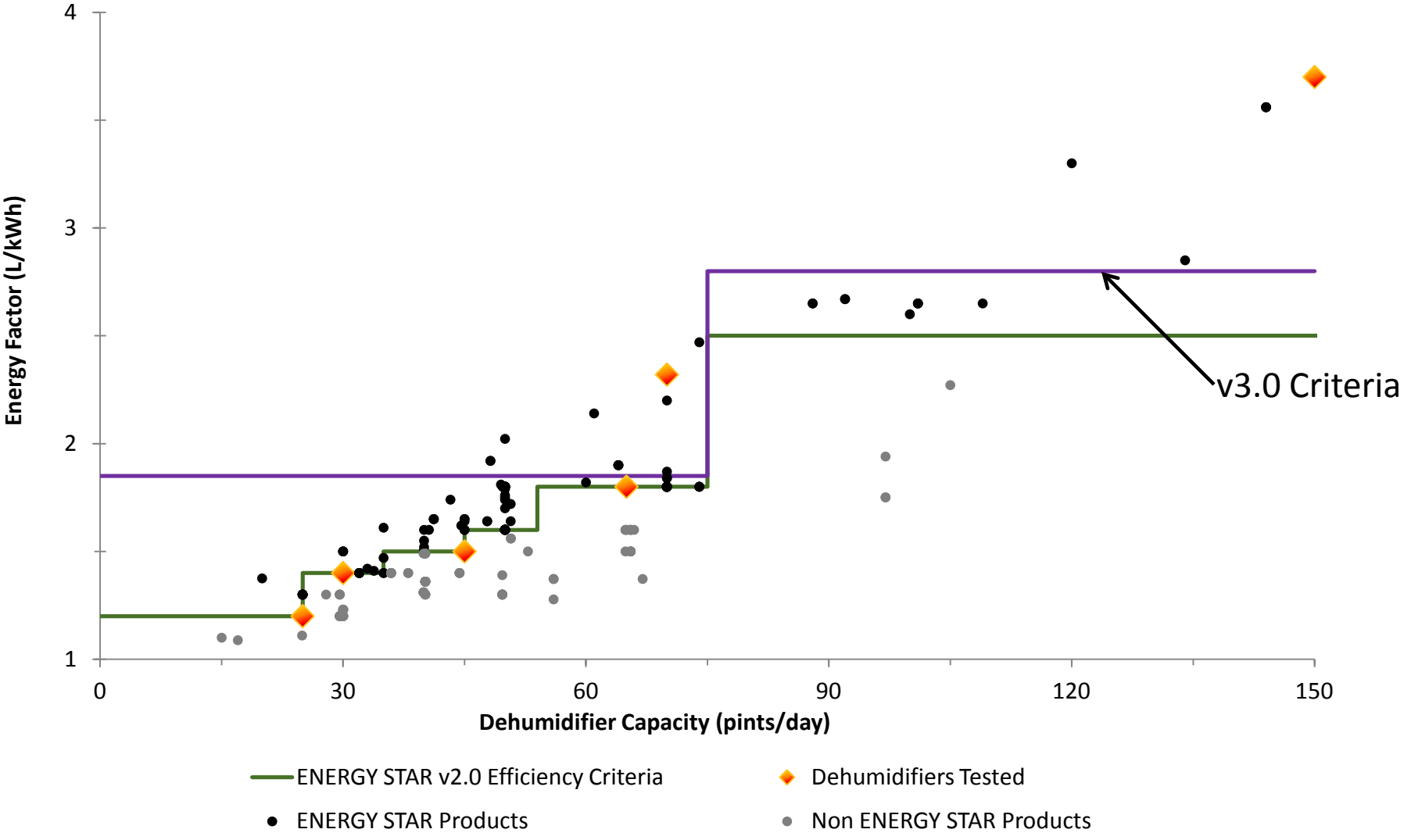
Simulation Tool Input



$$Performance = f\left(T_{in}, RH_{in}\right)$$

- **Solution: Performance map across a variety of operating conditions**

ENERGY STAR Efficiency Criteria



NREL Technical Report

Laboratory Test Report for Six ENERGY STAR® Dehumidifiers

Jon Winkler, Dane Christensen, and Jeff Tomerlin

NREL/TP-5500-52791

December 2011

http://www.nrel.gov/docs/fy12osti/52791.pdf

Tested Dehumidifiers

Brand Name	Model #	Capacity[1] (pints/day)	Energy Factor[1] (L/kWh)	Airflow Rate (cfm)
Ultra-Aire	XT150H	150	3.7	415[2]
Ultra-Aire	70H	70	2.32	160[2]
Santa Fe[3]	Compact	70	2.37	170[2]
General Electric (GE)	ADER65LP	65	1.8	195/175/155
Soleusair	SG-DEH-45-1	45	1.5	103/91/81
Comfort Aire	BHD-301-G	30	1.4	N/A
Frigidaire	FAD251NTD	25	1.2	N/A

[1] Performance at the rated inlet condition of 80°F, 60% relative humidity (RH) (AHAM 2008)

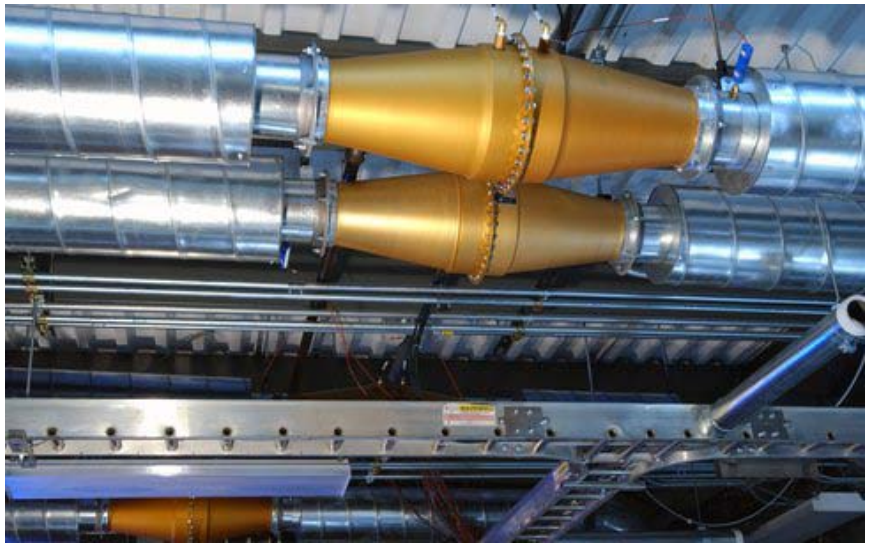
[2] Flow rate specified at 0 in. water gauge (WG)

[3] Unit was tested under a reduced set of operating conditions due to nearly identical performance with the Ultra-Aire 70H

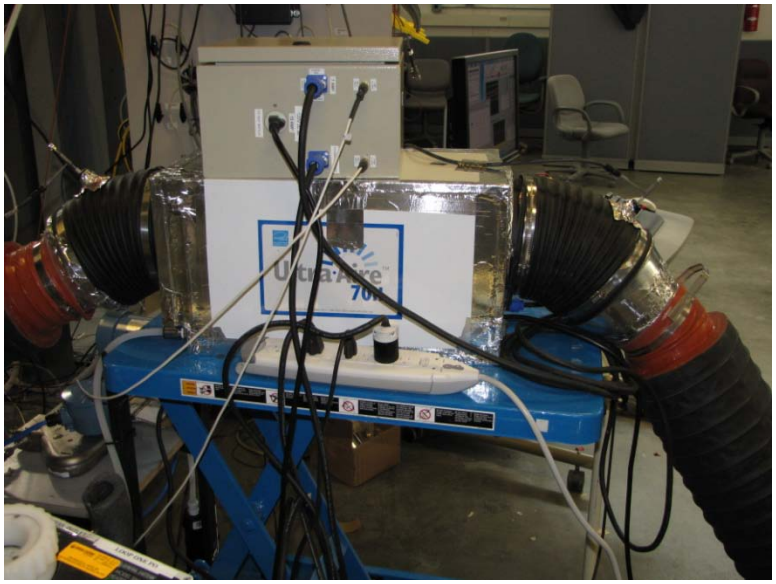
- **Steady state testing**
  - Water removal rate
  - Energy factor
- **Units with multiple fan settings were tested at the highest flow rate only**

Advanced HVAC Systems Laboratory

NREL/PIX 11461
Credit: Warren Gretz, NREL



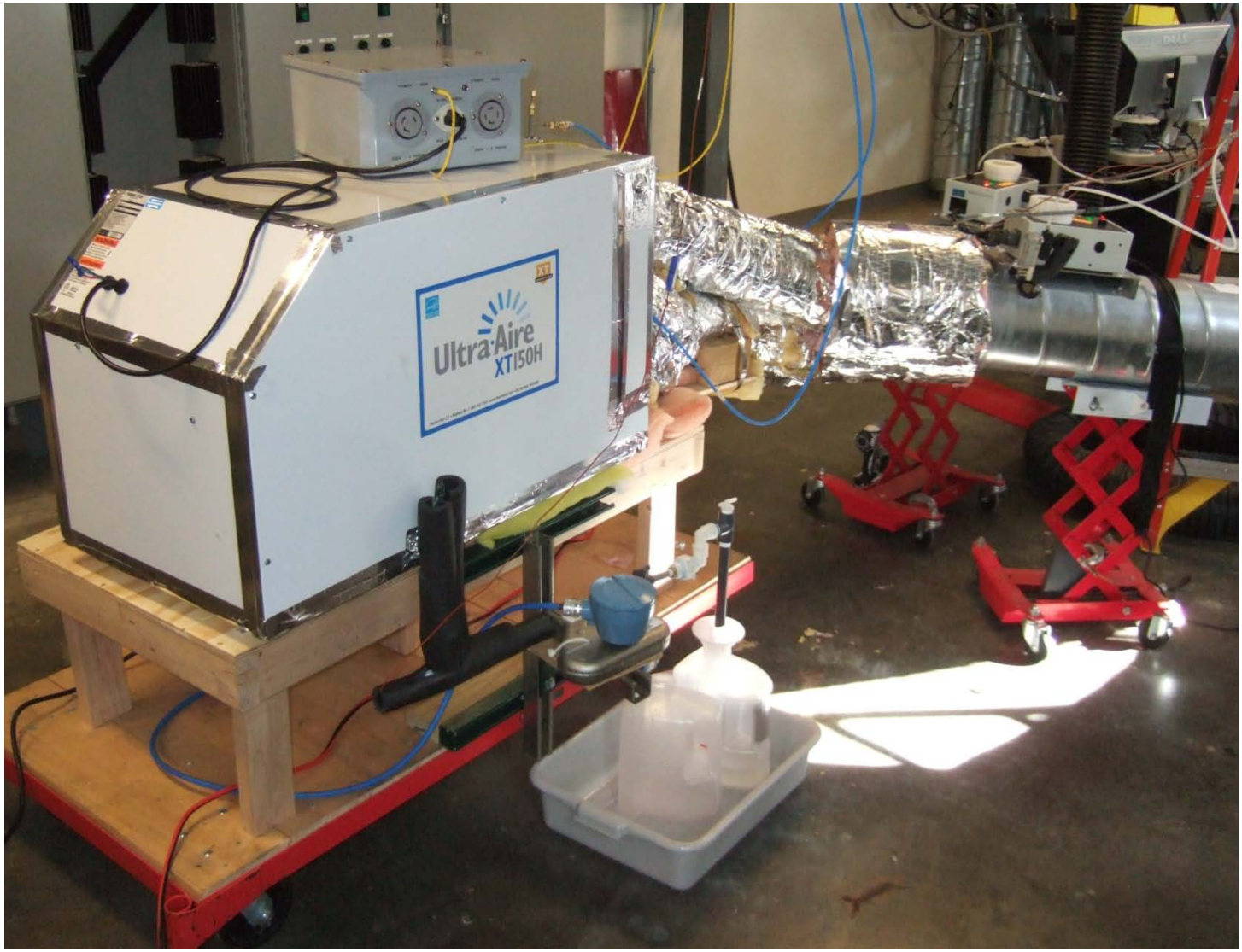
NREL/PIX 1326
Credit: Warren Gretz, NREL



NREL/PIX 19737
Credit: Bethany Sparn, NREL

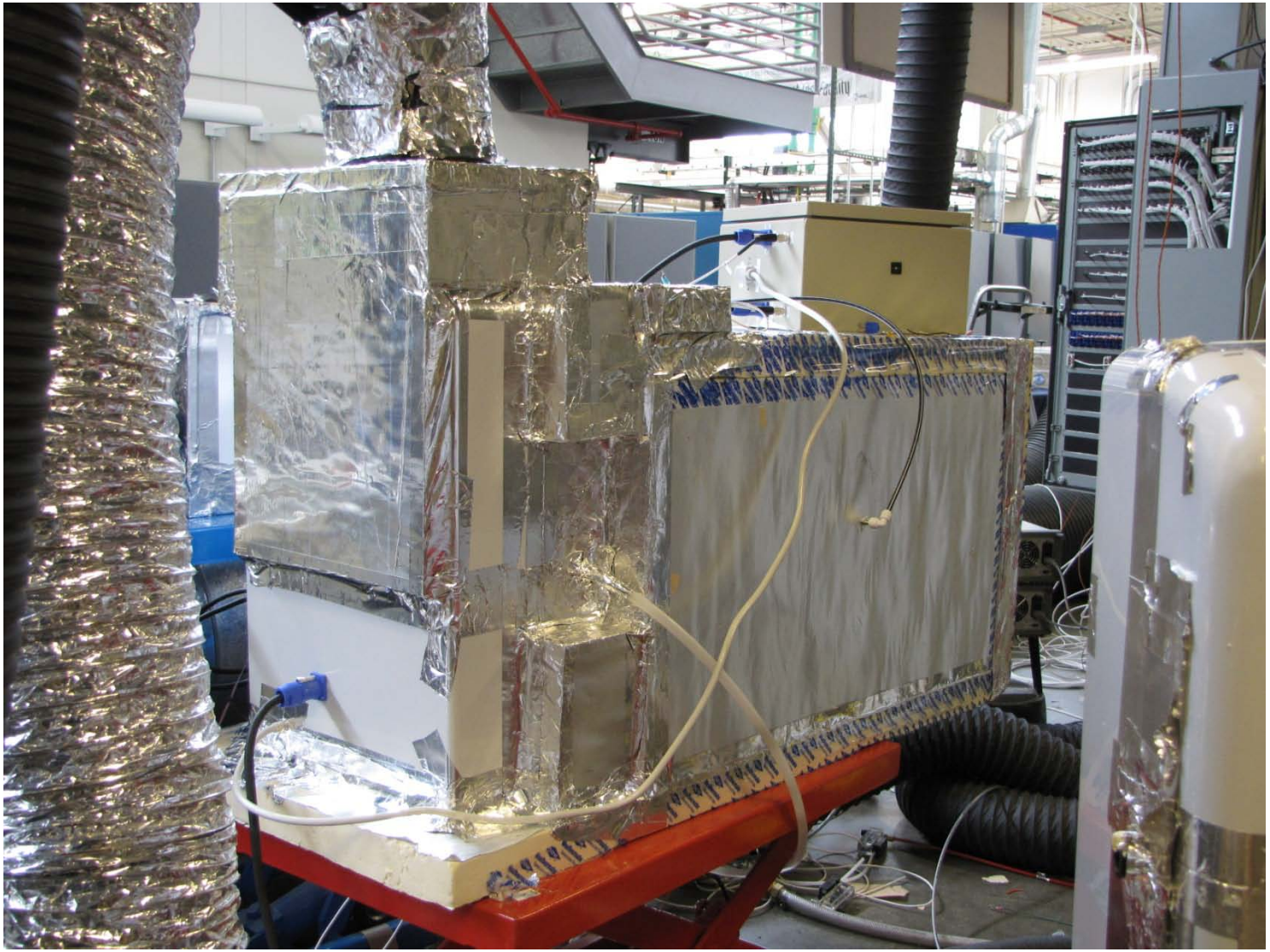
NREL/PIX 19738
Credit: Bethany Sparn, NREL

Test Setup – Ducted Units



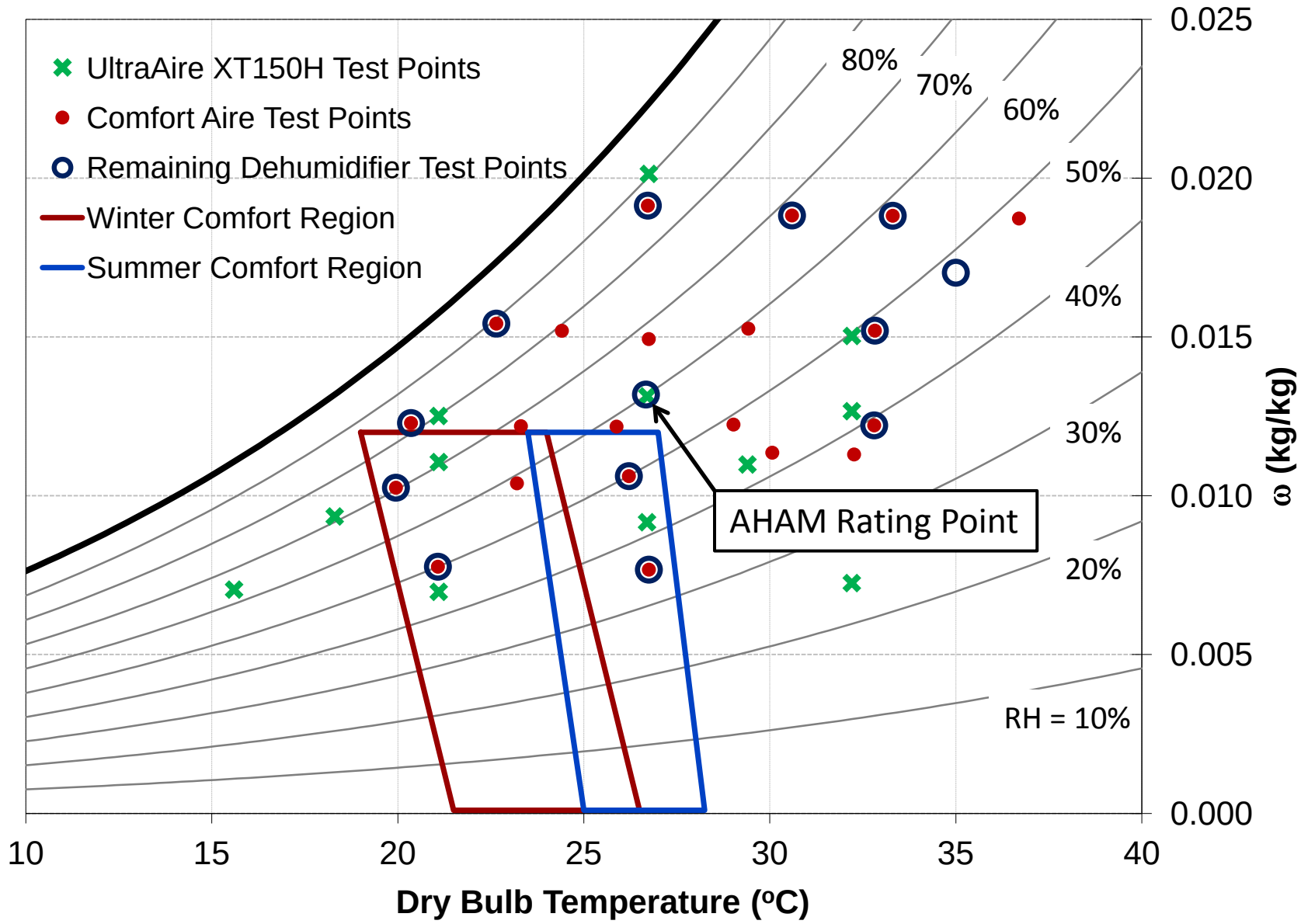
NREL/PIX 19601
Credit: Dane Christensen, NREL

Test Setup – Standalone Units



NREL/PIX 19604
Credit: Jon Winkler, NREL

Test Conditions



Measured Performance

Dehumidifier	Capacity (pints/day)	
	Rated	Measured
Ultra-Aire - XT150H[1]	150	150.0
Ultra-Aire - 70H	70	77.1
General Electric	65	70.4
Soleusair	45	48.3
Comfort Aire	30	43.1
Frigidaire	25	26.9

Measured Performance

Dehumidifier	Capacity (pints/day)		Energy Factor (L/kWh)		Airflow Rate (cfm)	
	Rated	Measured	Rated	Measured	Rated	Measured
Ultra-Aire - XT150H[1]	150	150.0	3.7	3.8	415	330
Ultra-Aire - 70H	70	77.1	2.3	2.6	160	165
General Electric	65	70.4	1.8	1.9	195	193
Soleusair	45	48.3	1.5	1.6	103	107
Comfort Aire	30	43.1	1.4	1.7	N/A	179
Frigidaire	25	26.9	1.2	1.1	N/A	88

Performance Modeling

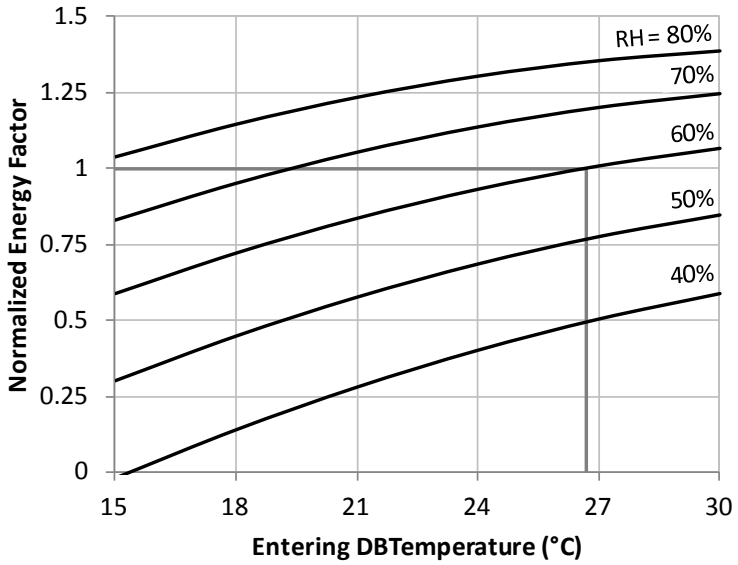
- **Rated performance inputs**
  - Water removal rate (L/day)
  - Energy factor (L/kWh)
  - Air flow rate (m^3/s)
- **Normalized curves to adjust rated performance**
  - Water removal rate
  - Energy factor

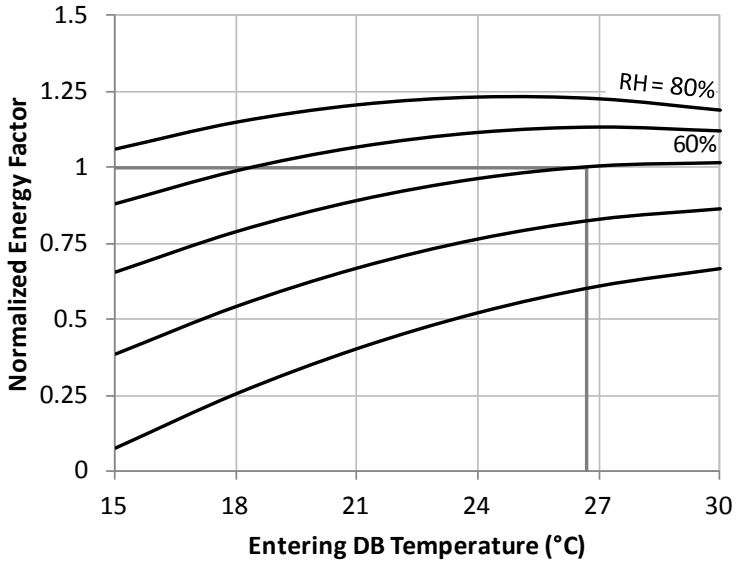
$$factor = a + b \cdot T_{in} + c \cdot T_{in}^2 + d \cdot RH_{in} + e \cdot RH_{in}^2 + f \cdot T_{in} \cdot RH_{in}$$

- **Report includes curve fit coefficients for actual and normalized performance**

Energy Factor Performance Curves

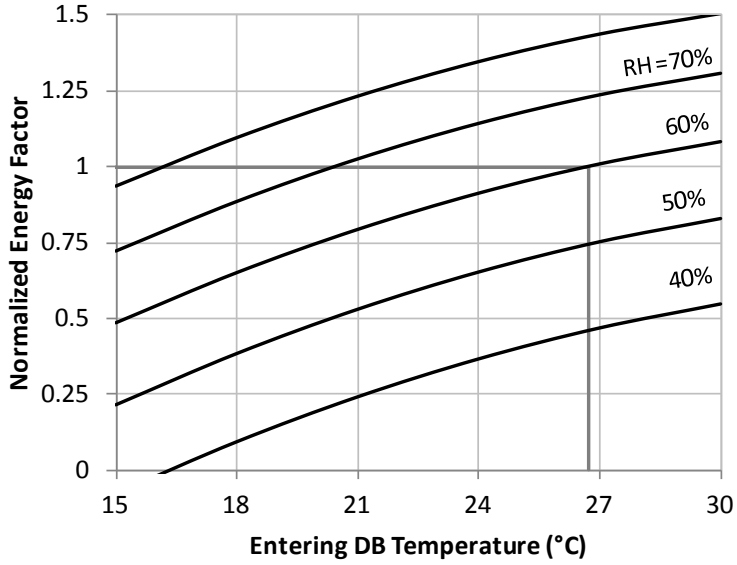
Ultra-Aire – 70 pint/day

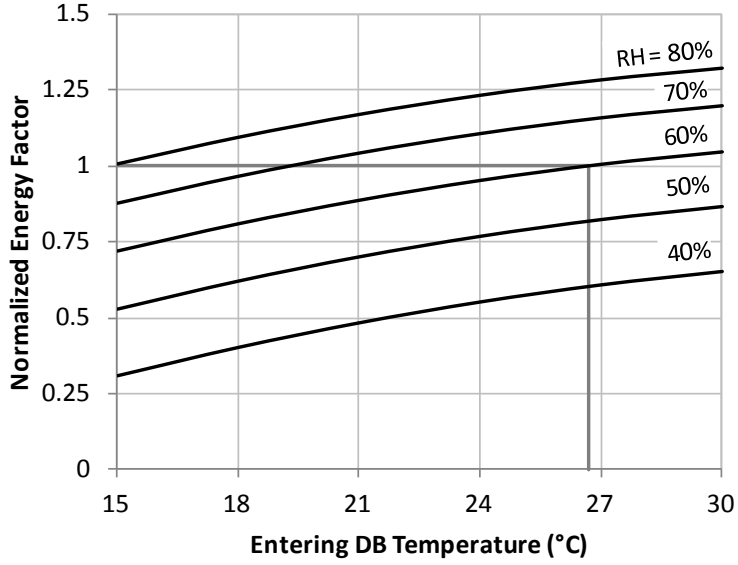




GE – 65 pint/day

Frigidaire – 25 pint/day

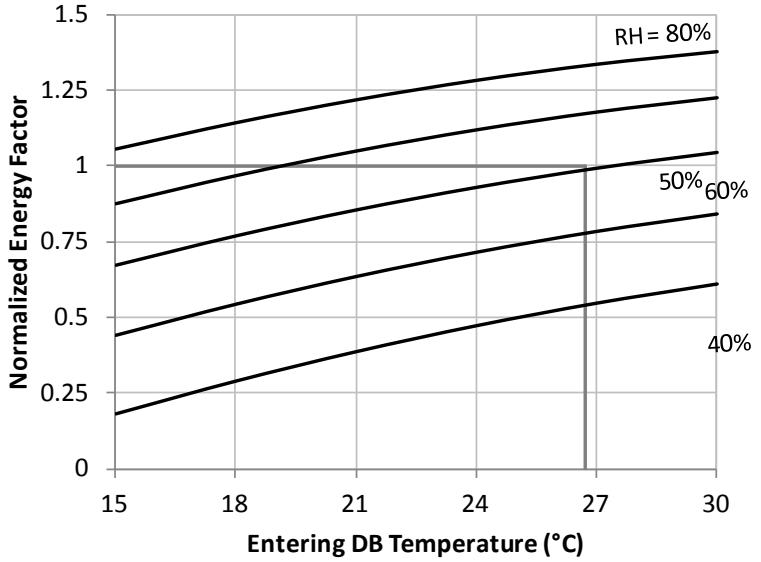




Ultra-Aire – 150 pint/day

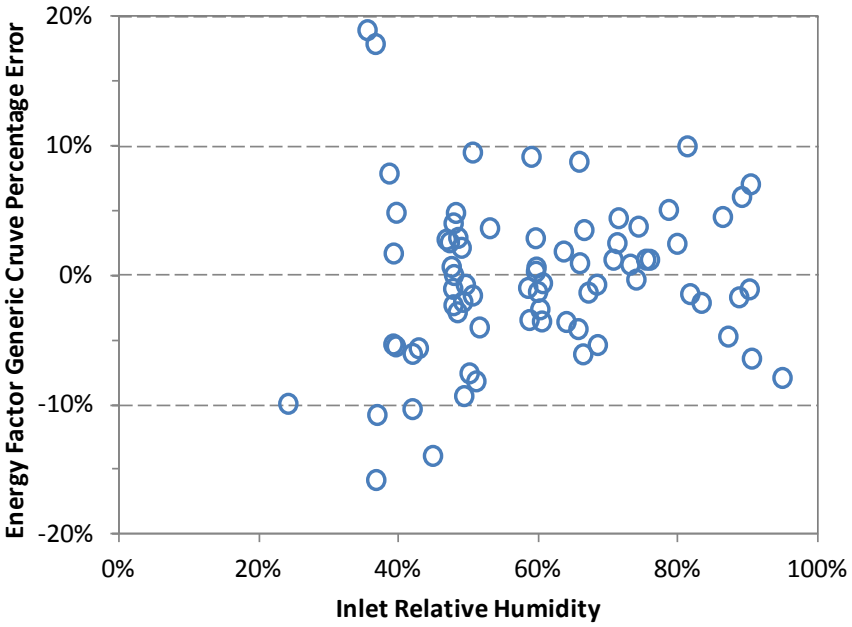
Generic Performance Curves

- **77 test points used in regression**
- **r-squared values of 0.98 and 0.97 for water removal rate and energy factor, respectively**



Mean Absolute Percentage Errors

Dehumidifier	Water Removal Rate	Energy Factor
Ultra-Aire - XT150H	6.5%	5.3%
Ultra-Aire - 70H	4.4%	3.0%
General Electric (65)	4.2%	5.7%
Soleusair (45)	4.8%	4.5%
Comfort Aire (30)	4.6%	4.8%
Frigidaire (25)	5.3%	5.8%
All Tested Units	**5.0%**	**4.8%**



Building America Gaps and Barriers

- **Gaps** (http://www1.eere.energy.gov/buildings/building_america/strategic_plan.html)
  - Space Conditioning
    - "Need to Understand Operating Performance of Existing and Emerging Supplemental Dehumidification Equipment"
  - Analysis Methods and Tools
    - "Supplemental Dehumidification Modeling"
- **Achievements**
  - NREL – Tested six vapor compression dehumidifiers
- **Planned or Ongoing Research**
  - GTI/PNNL – Performance testing several desiccant-based residential dehumidifiers

Future Work

- **What is left to achieve?**
  - Characterize the performance of centralized equipment with explicit humidity control
  - Characterize part-load/cycling losses
  - Continually observe market landscape and test high penetration and emerging equipment
- **Additional questions?**

Jon Winkler
jon.winkler@nrel.gov
303.275.4356