RTU Optimization

Evaporative Condenser Air Pre-Cooling
Variable Fan and Compressor Control

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Sponsored by Southern California Edison

Evaporative Pre-Cooling

- Evaporate water sensibly cool outdoor air prior to entering condensing unit
- Improve air conditioning cycle efficiency and reduce demand
- Potentially use rainwater capture or greywater as water source (non-potable water)

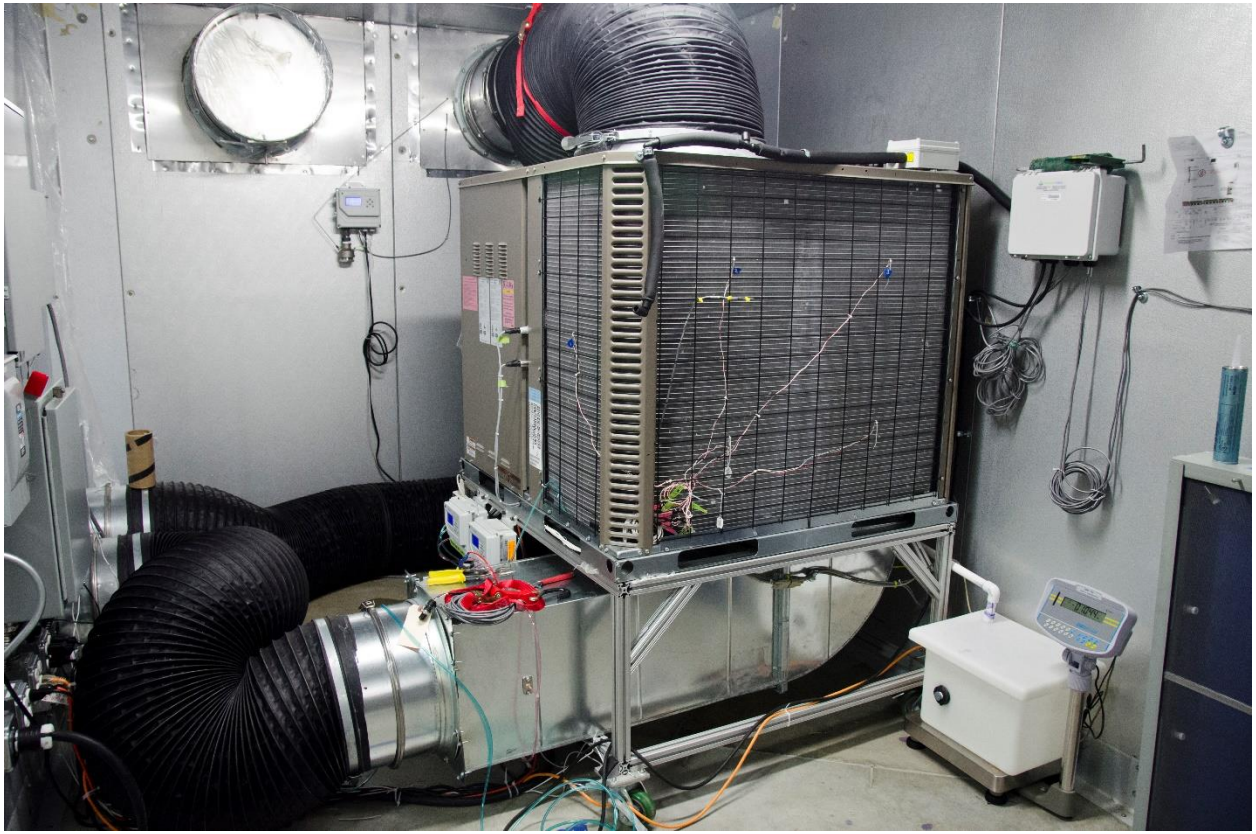
Fan and Compressor Speed Control

- Reduce fan speed to decrease capacity at part load conditions (or peak conditions, when pre-cooling is present)
- Reduce compressor speed to control latent cooling (control of humidity)

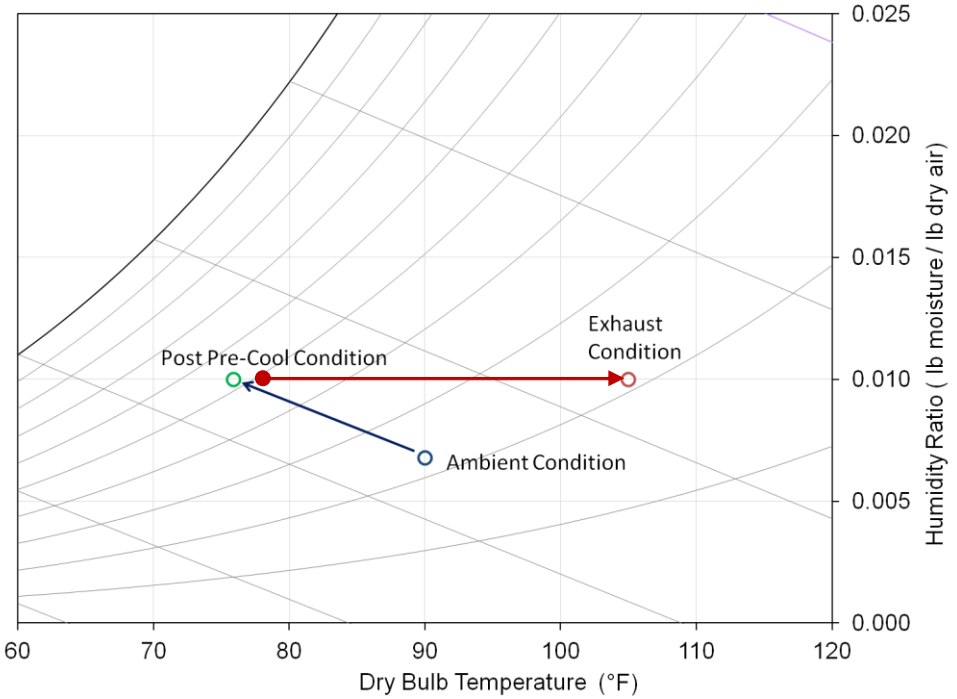
Evaporative Pre-cooler Test Protocol

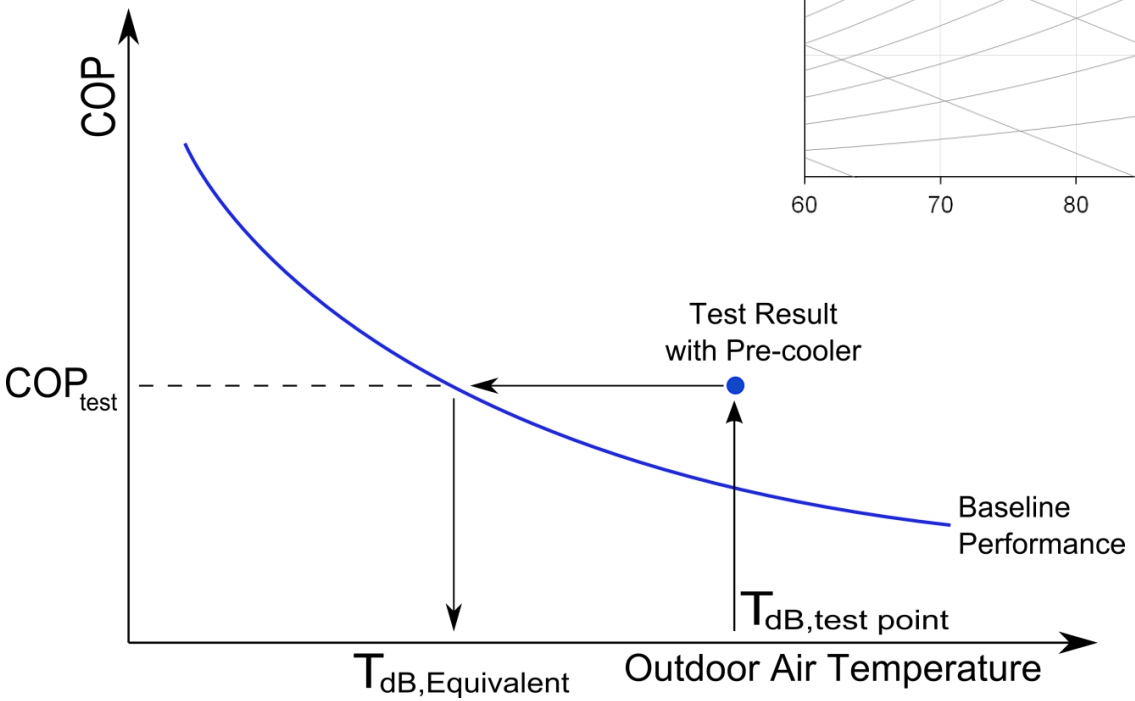
- Laboratory test of evaporative condenser air pre-coolers
- Test protocol development (ASHRAE Standards Project Committee SPC 212P)
- WCEC tested five pre-coolers on 4-ton York RTU
- Results reported to manufacturers

Test Unit in WCEC Environmental Chamber

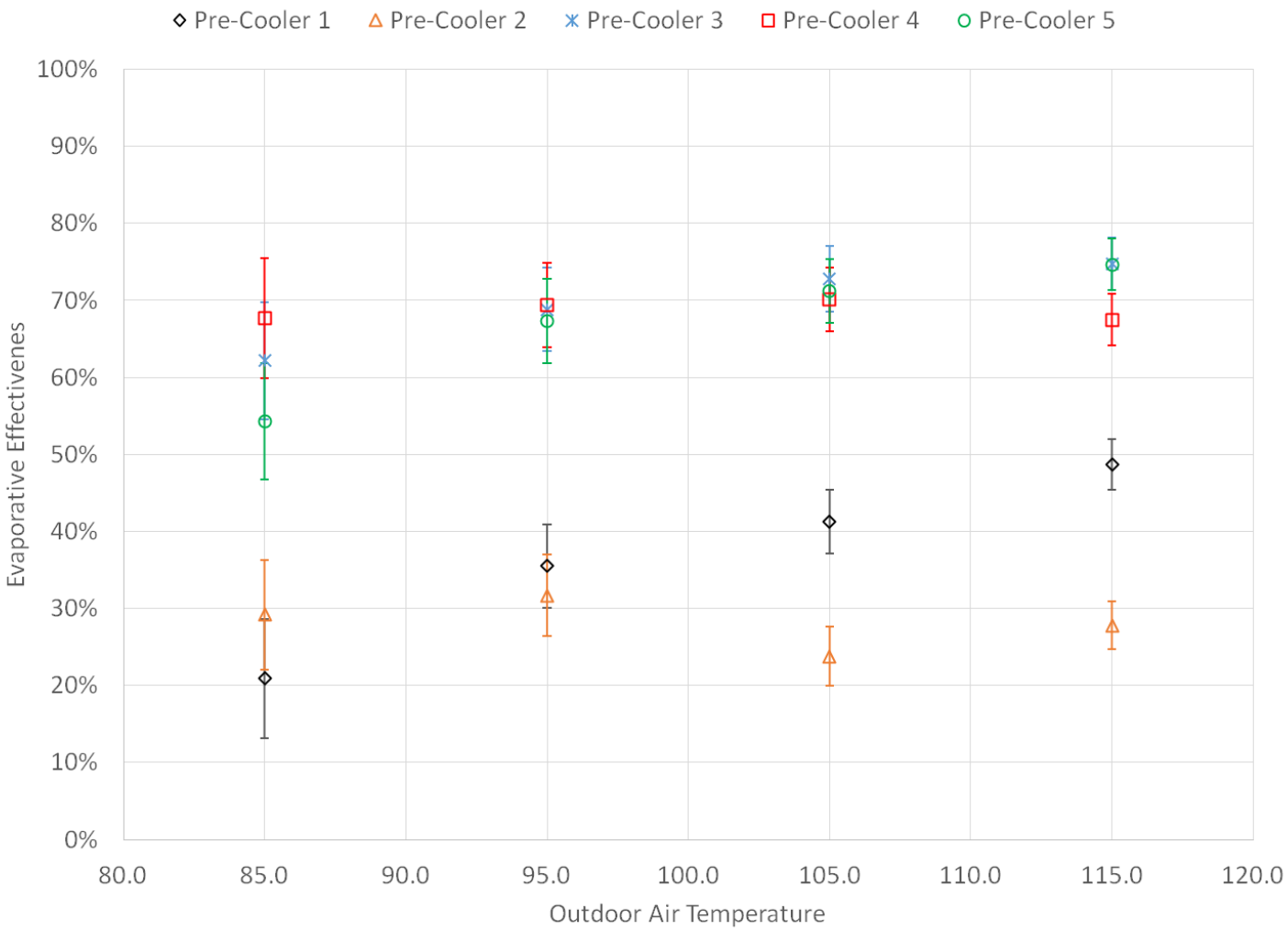


Measuring Evaporative Effectiveness





Evaporative Pre-cooler Test Results



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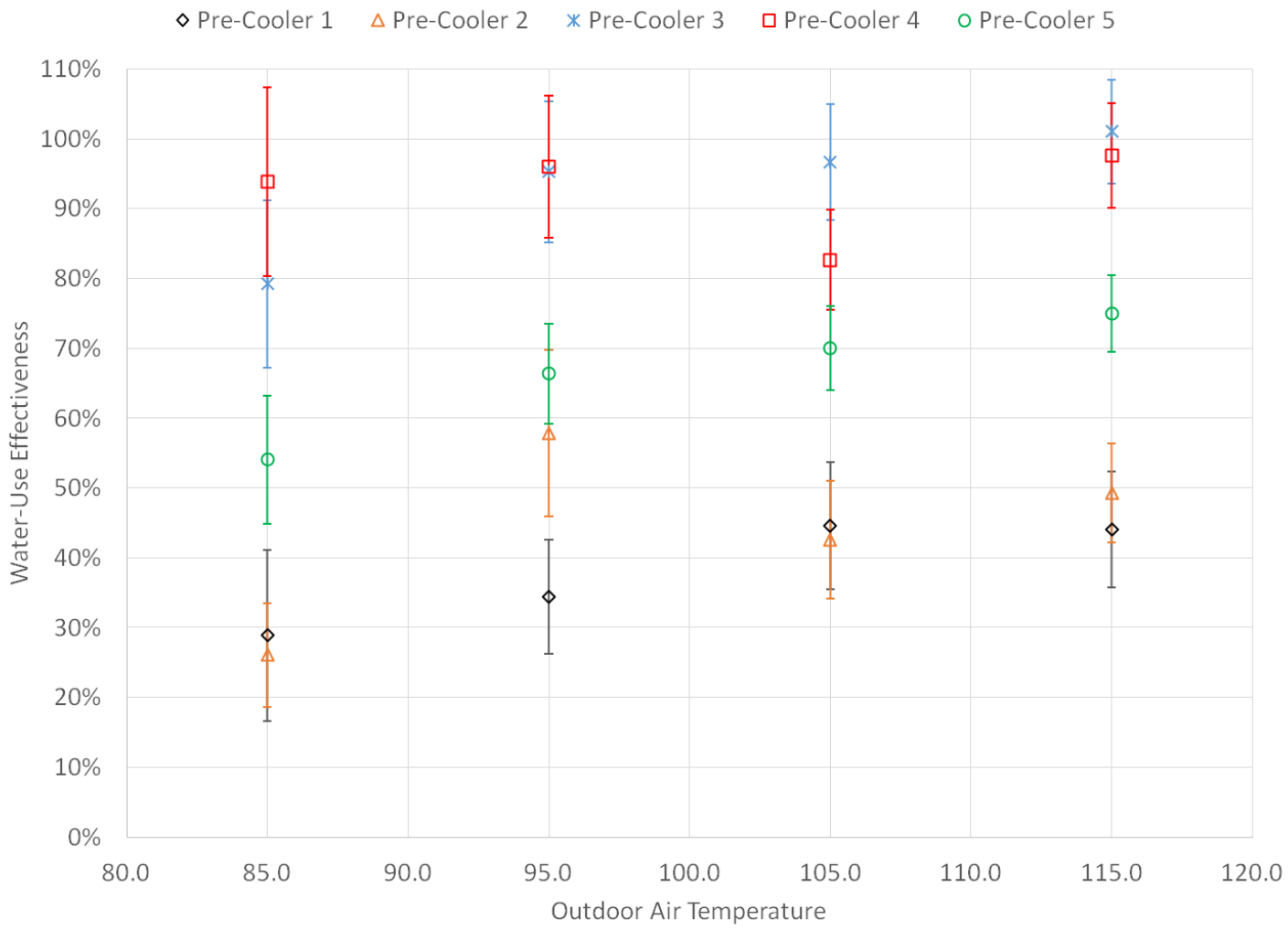
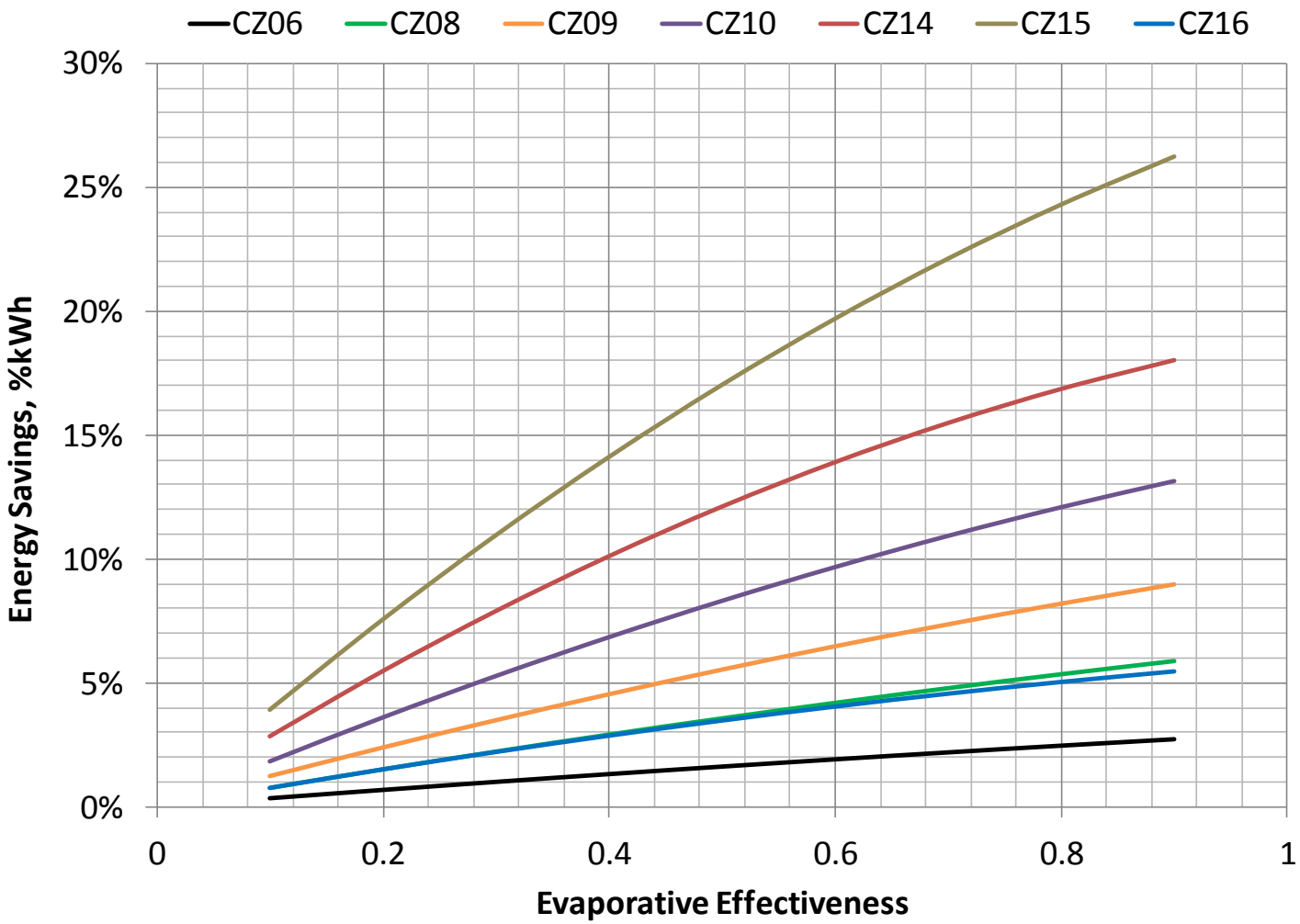


Impact of Dry Media

- Impact on power, capacity, and efficiency when media is present, air conditioning is running, but pre-cooler is not running at mild outdoor air temperatures.
- Benefits of pre-cooling must exceed media penalty to achieve net benefit

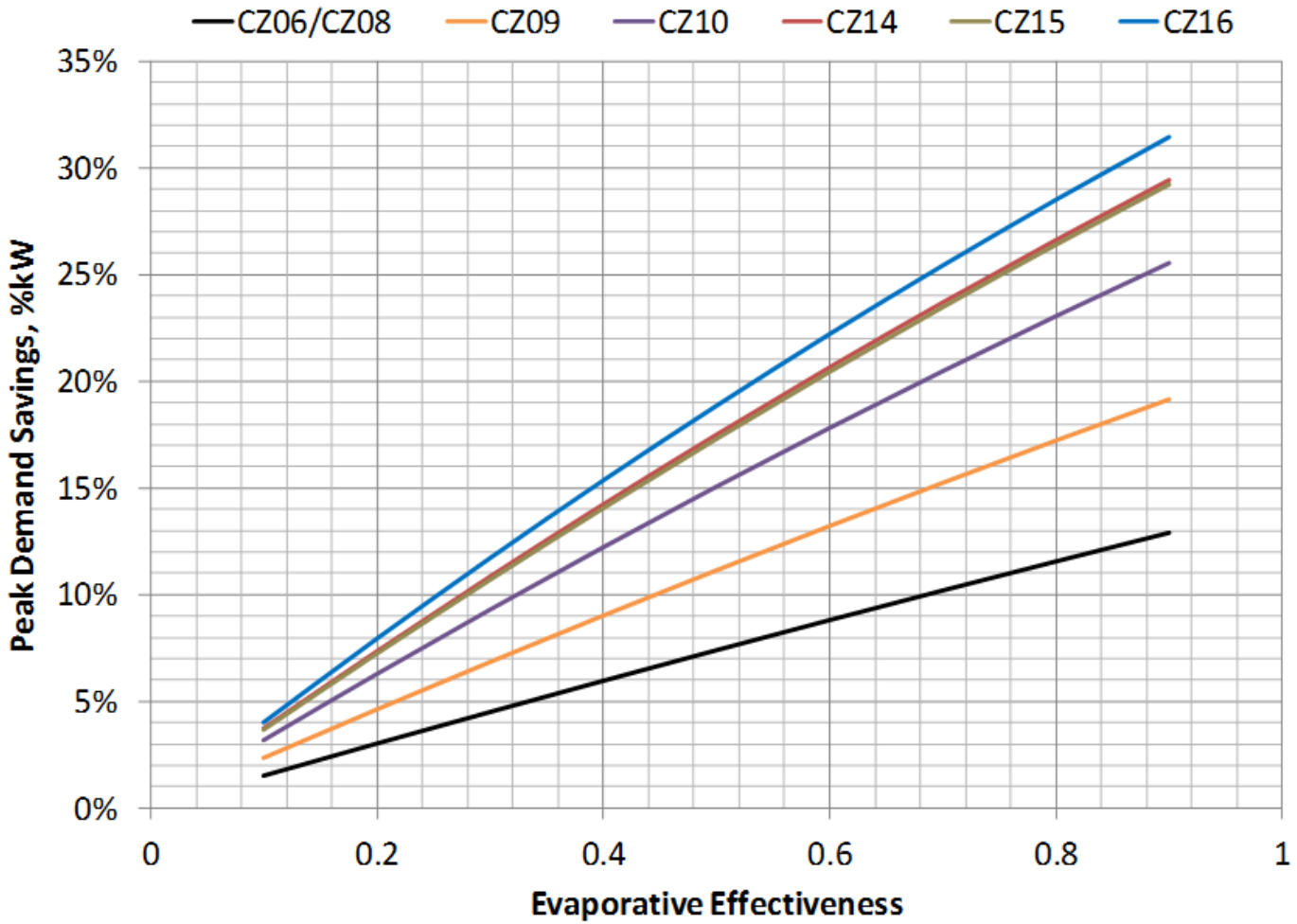
	% Power Impact	% Capacity Impact	% COP Impact
PC1	1.70%	-9.21%	-10.50%
PC2	N/A	N/A	N/A
PC3	0.55%	-0.77%	-1.06%
PC4	0.73%	-0.45%	-0.93%
PC5	N/A	N/A	N/A

Evaporative Pre-cooler Test Results



Source: http://www.etcc-ca.com/sites/default/files/reports/HT11SCE021_Condenser_Evap_Air_Final.pdf

Evaporative Pre-cooler Test Results



Source: http://www.etcc-ca.com/sites/default/files/reports/HT11SCE021_Condenser_Evap_Air_Final.pdf

Evaporative Pre-cooler Test Report

LABORATORY TEST: EVAPORATIVE COOLER PRE-COOLER TEST REPORT

WCEC

Evaporative Pre-Cooler Manufacturer:
Description of Pre-cooler: Water delivery: Spray nozzles fed by booster pump @220psig
Nozzle Operation: Continuous operation, on/off control
Media: 1" thick foamed polyester

RTU Brand: York
RTU Model for Test: D6NZ048N06525NX
RTU Serial Number: W1H3034594
Nominal Tonnage: 4 tons

Manufacturer Notes: Recirculation pump used for test can serve pre-cooling equipment for 20-ton cooling unit.

Test Operator: Robbie McMurry
Laboratory: Western Cooling Efficiency Center
Address: 215 Sage Street Ste 100, Davis, CA
Phone: 530-752-3262

Face Velocity (ft/s):
Condenser Air (Baseline): 4.4
Condenser Air (w\Pre-Cooler): 4.2
Pre-Cooler Media Surface: 2.4

	Test Conditions					Measured			Predicted RTU Performance			
	Outdoor Conditions			Indoor Conditions								
Test Date	Dry Bulb (°F)	Wet Bulb (°F)	DB - WB (°F)	Dry Bulb (°F)	Wet Bulb (°F)	Evaporative Eff. (%)	Water-Use Eff. (%)	Pre-Cooler Power (kW)	Power (kW) Change(%)	Capacity (ton) Change(%)	EIR (kw/ton) Change(%)	Water-use (Gal/nominal ton)
6/27/14 12:26	85.0	67.1	17.9	80.0	67.0	67%	86%	0.302	-11%	4%	-14%	1.5
6/24/14 21:29	95.0	70.1	24.9	80.0	67.0	70%	93%	0.271	-16%	8%	-22%	2.0
6/26/14 14:05	105.0	73.0	32.0	80.0	67.0	71%	80%	0.290	-22%	12%	-31%	2.9
6/23/14 18:17	115.0	75.7	39.3	80.0	67.0	68%	98%	0.284	-26%	17%	-37%	2.8
6/20/14 16:33	75.0	Dry Pre-cooler Test, Effect of Media Restriction							0.6%	-0.7%	1.2%	NA

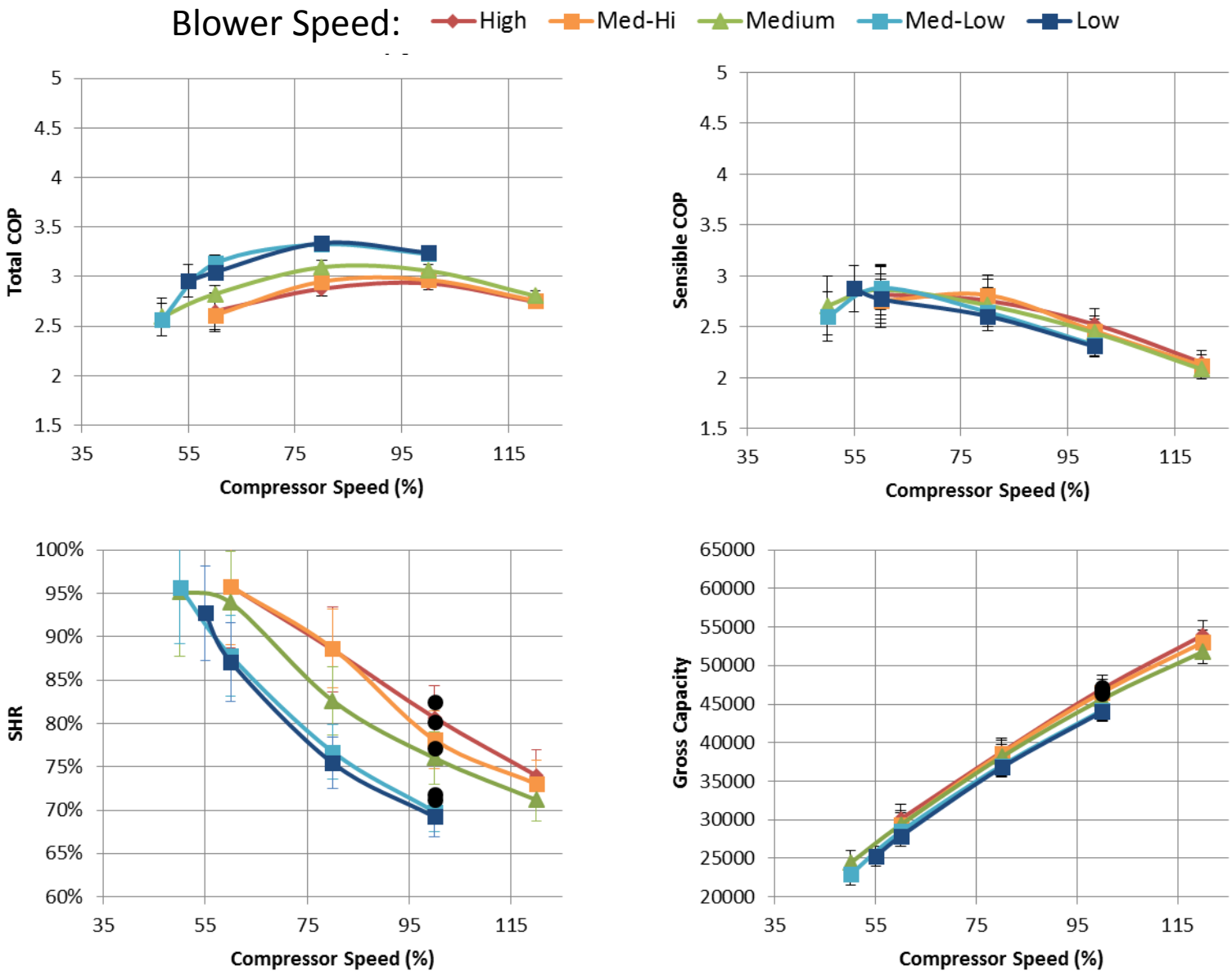
Evaporative Pre-cooler Photo Overview

Evaporative Pre-cooler Photo Close-Up

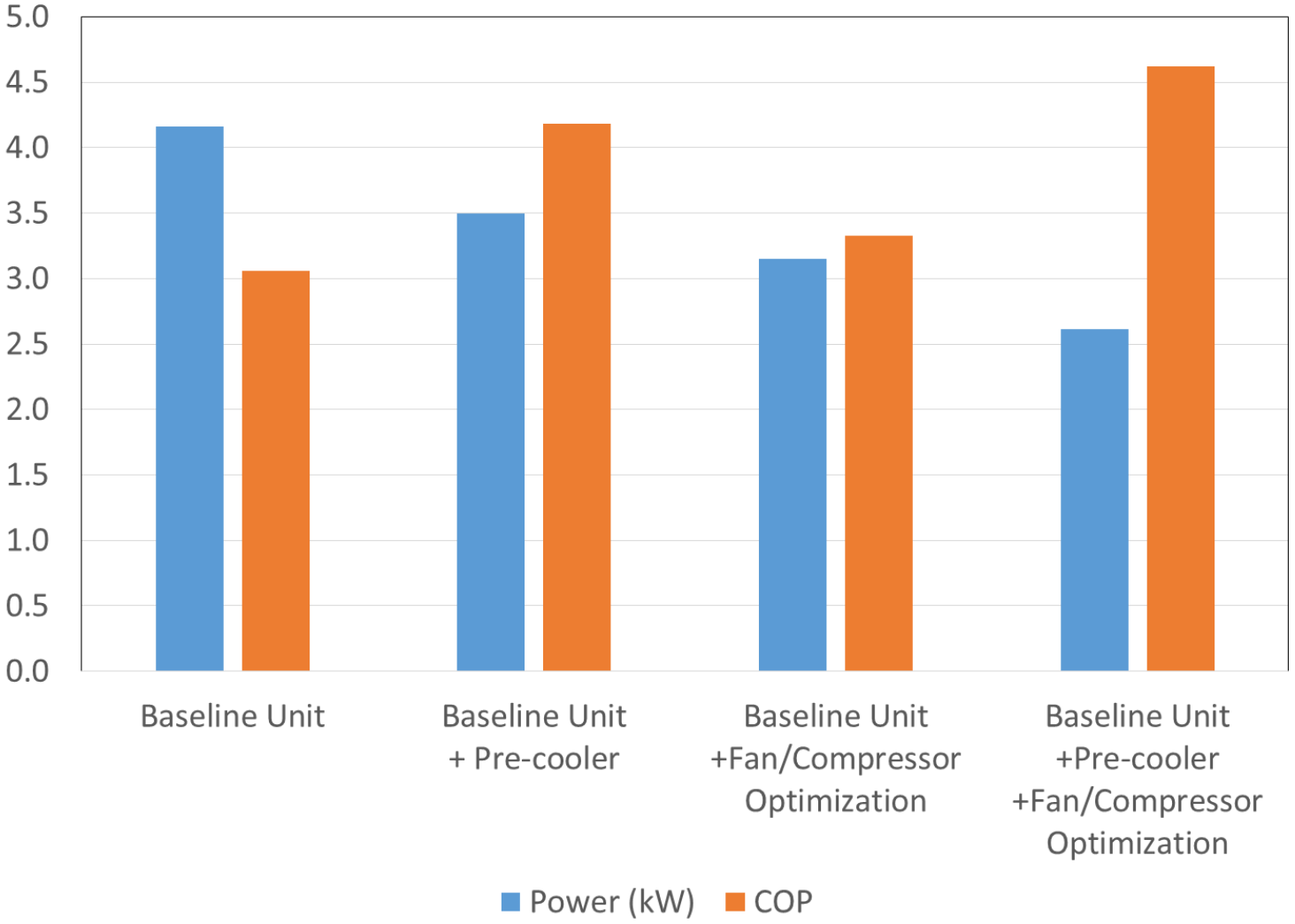
Compressor and Fan Speed Testing

- VFD installed on scroll compressor in ‘baseline’ 13 SEER packaged unit.
- Evaporator fan speed varied using taps on ECM motor
- Test Conditions:
  - OA = 75°F, 85°F, and 95°F
  - RA = 80°F DB, 67°F WB

Plots of Lab Test Results (at 95°F OA)



Lab Data – Potential of RTU Optimization



Lab Data – Detailed Results

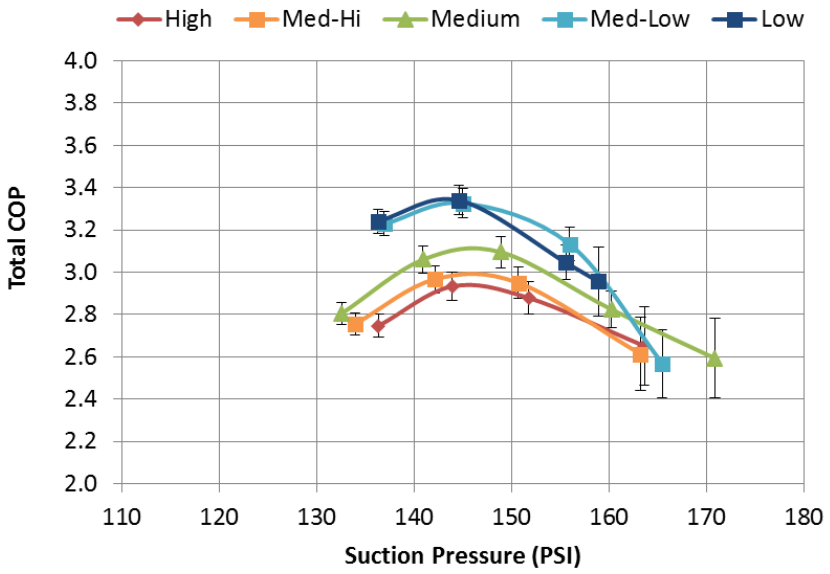
	Baseline Unit (95°F) Compressor = 100% Fan = Medium	+ Pre-cooler (75°F) Compressor = 100% Fan = Medium	+Optimized Fan and Compressor (95°F) Compressor = 80% Fan = Med Low	+ Pre-cooler (75°F) + Optimized Fan and Compressor Compressor = 80% Fan = Med Low
Capacity (kbtu/h)	43.5	50.0	35.7	41.1 (-6%)[1]
Sensible Heat Ratio	0.76	0.71	0.77	0.73 (-4%) [2]
Sensible Cap (kbtu/h)	33.0	35.5	27.5	30.0 (-9%)
Power (kW)	4.16	3.50	3.15	2.61 (-37%)
COP	3.06	4.18	3.33	4.62 (+51%)

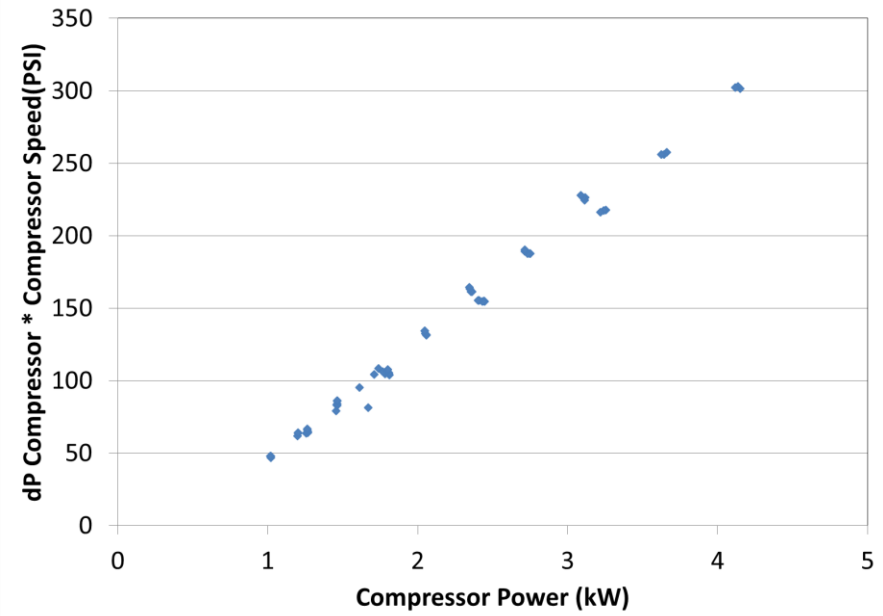
[1] Percentages are relative to baseline case in column 2.

[2] Sensible heat ratio can be increased to 1 by further dropping compressor speed, but at further reduction of total and sensible capacity

[3] Experiments were conducted at external static pressure specified by AHRI standard. Greater savings are expected from fan speed reductions in buildings with typical duct work.

Possible Control Methods





Questions?