BUFFALO WILD WINGS®

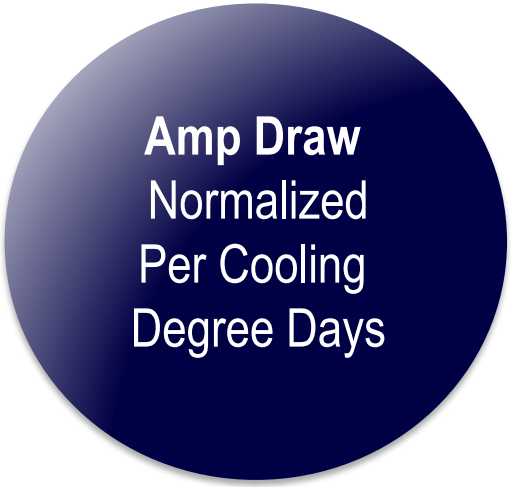
40484 Murrieta Hot Springs Rd.,
Murrieta, CA 92563

# Data Analysis Of IceCOLD® Test Conducted On A Packaged Air Conditioning Unit and two Condensing Units

October 07, 2014

## Increased Cooling Efficiency

**Pre Test**




**Post Test**

**38% Less**
**Amp-hours Consumed**
**To Maintain Set-Point Temperature**

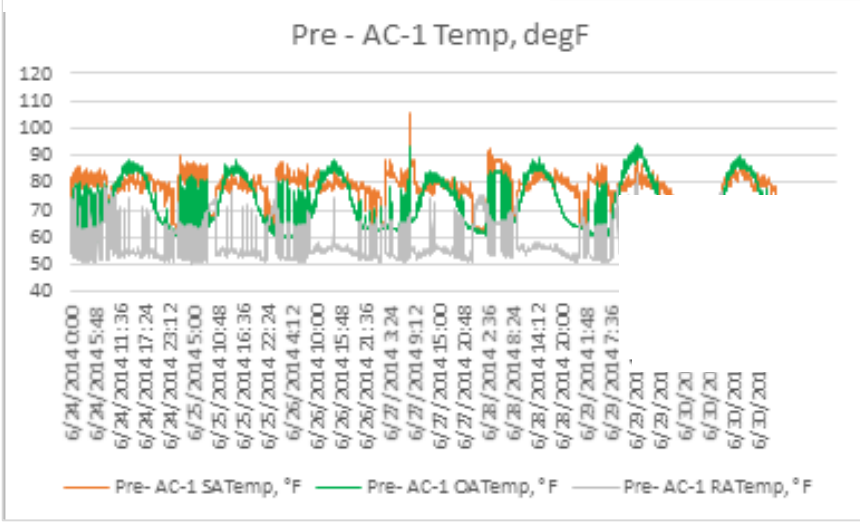
## Logged Data

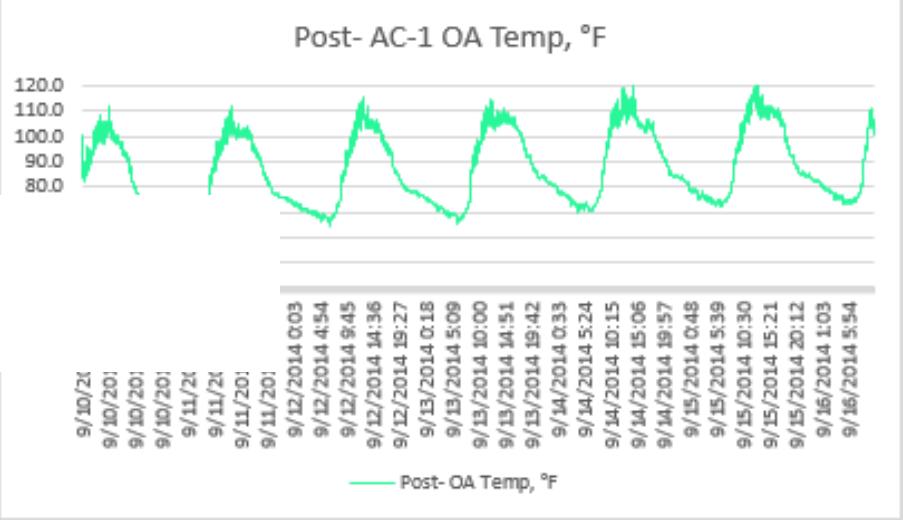
Test parameters selected for measurements enable evaluating the potential for increased cooling efficiencies across varying ambient temperatures and heat loads. Withy this, the Supply and Return Air temperatures were controlled.

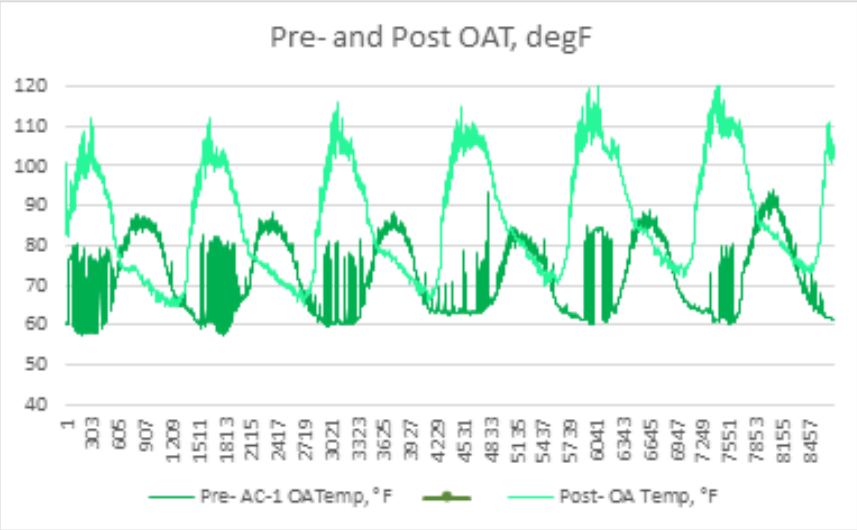
Areas that were logged and analyzed:

1. **Amp Draw** (1 minute intervals)
2. **Ambient Air Temperature** (1 minute intervals)
3. **Supply and Return Air Temperature** (1 minute intervals)
4. **Cooling Degree Days (calculated)**

# Measurements Scene – Supply, Return & Ambient Temperatures




| | AC-1 | | | CDD |
|---|---|---|---|---|
| Temperture, degF | Avg OAT | SAT | RAT | BP=65 F |
| Pre-treatment | 73.2 | 77.7 | 58.5 | 8.18 |
| Post-treatment | 87.2 | | | 22.2 |
| Avg deltaT | 14.05 | | | |

Presented comparison of Outdoor Air Temperatures before and after IceCold treatment indicates, that post-treatment measurement was performed at much warmer ambient conditions

# Compressor Current and Ambient Temperature measurements at AC-1

Energy Consumed strongly depends on Ambient Temperature

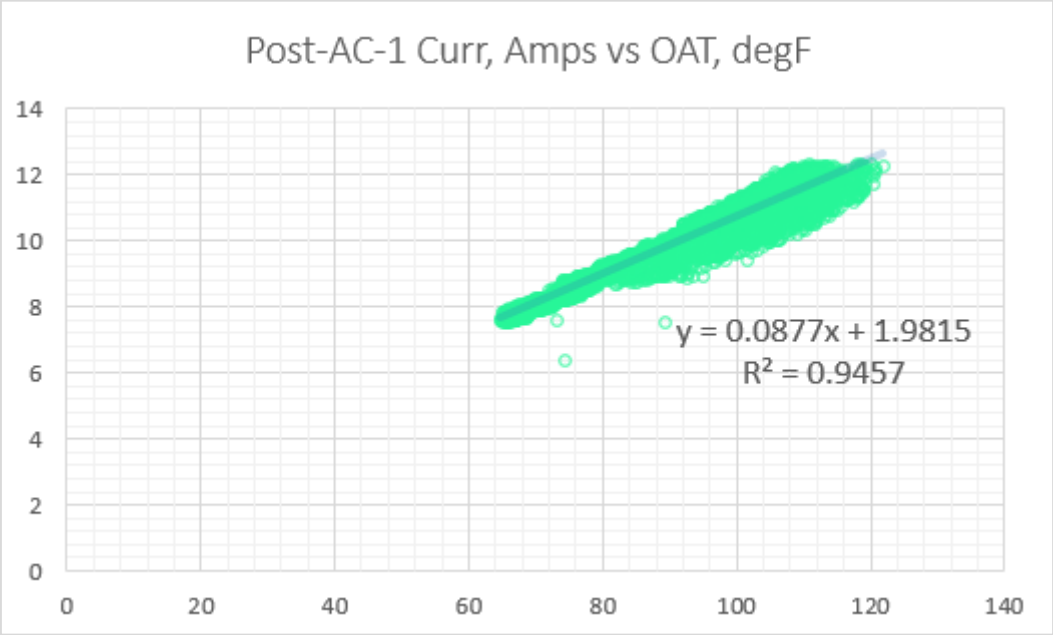


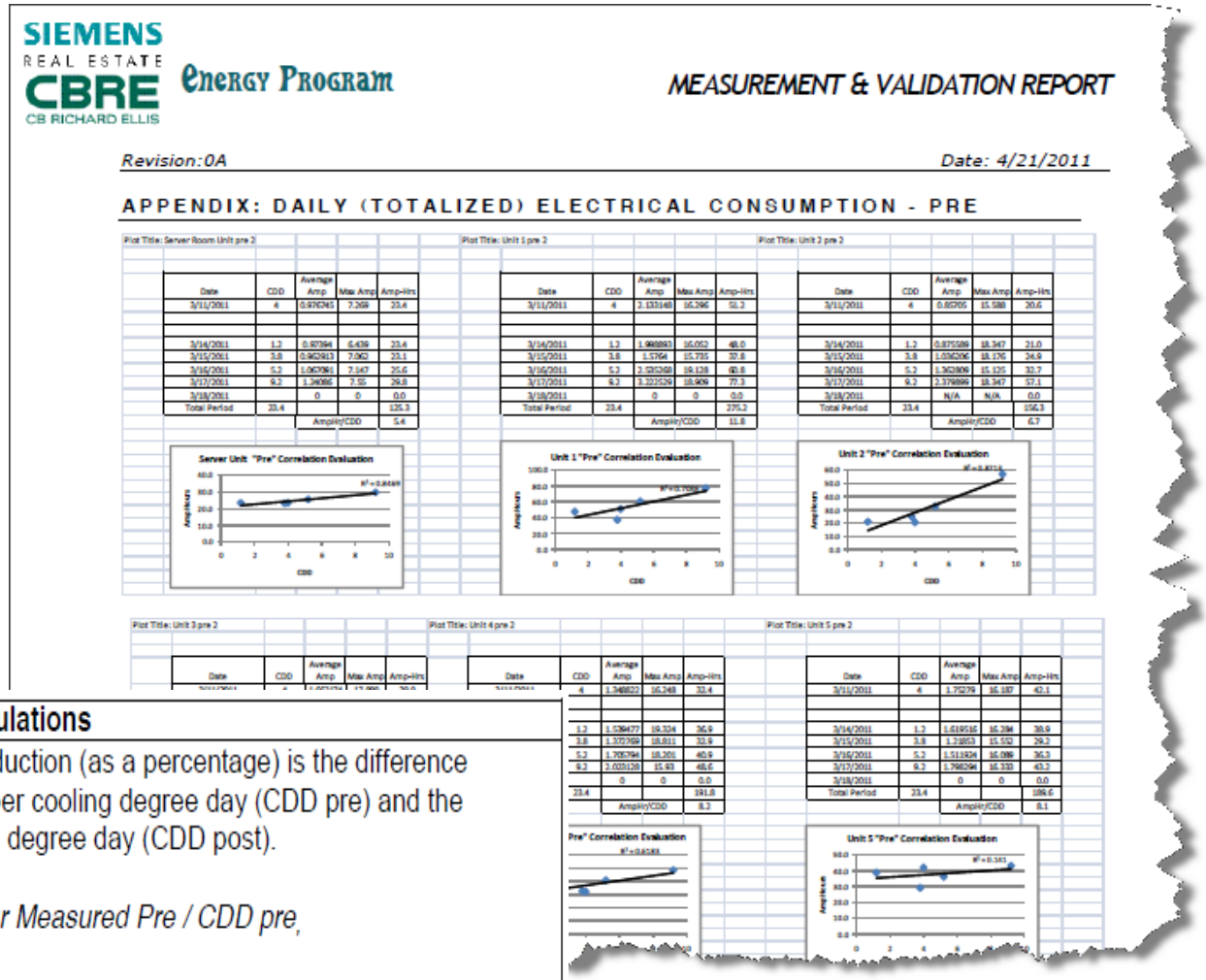

Chart above represents relationship between electric current drawn by AC unit and ambient temperature.
Linear regression line and corresponding regression equation indicate strong current-temperature dependency.
That clearly requires to perform energy comparison in weather-normalized forms.

# Pre- and Post-treatment measurements – energy use comparison with weather normalization

| | Pre- AC-1 | Pre- CU-1 | Pre- CU-3 |
|---|---|---|---|
| Amp-hrs/CDD | 104.3 | 42.4 | 61.3 |
| Amp-hrs | 853.4 | 346.6 | 501.8 |
| Hours ON | 100.2 | 53.7 | 51.9 |
| Avg Amps | 8.5 | 6.5 | 9.7 |
| | Post- AC-1 | Post- CU-1 | Post- CU-3 |
| Amp-hrs/CDD | 57.1 | 23.8 | 23.8 |
| Amp-hrs | 1,268.9 | 530.1 | 528.3 |
| Hours ON | 131.7 | 78.2 | 64.1 |
| Avg Amps | 9.6 | 6.8 | 8.2 |
| Amp-hrs/CDD Sav | 45.3% | 43.7% | 61.3% |

IceCold treatment leads to >40% of savings in Amp-hours/CDD

# Methodology - Data Comparison & Analysis



SIEMENS REAL ESTATE CBRE CB RICHARD ELLIS — Energy Program

MEASUREMENT & VALIDATION REPORT

Revision:0A — Date: 4/21/2011

APPENDIX: DAILY (TOTALIZED) ELECTRICAL CONSUMPTION - PRE

Plot Title: Server Room Unit pre 2

| Date | CDD | Average Amp | Max Amp | Amp-Hrs |
|---|---|---|---|---|
| 3/11/2011 | 4 | 0.976245 | 7.269 | 23.4 |
| | | | | |
| | | | | |
| 3/14/2011 | 1.2 | 0.97394 | 6.439 | 23.4 |
| 3/15/2011 | 3.8 | 0.962813 | 7.062 | 23.1 |
| 3/16/2011 | 5.2 | 1.067981 | 7.147 | 25.6 |
| 3/17/2011 | 9.2 | 1.24086 | 7.55 | 29.8 |
| 3/18/2011 | | 0 | 0 | 0.0 |
| Total Period | 23.4 | | | 125.3 |
| | | Amp-Hr/CDD | | 5.4 |

Plot Title: Unit 1 pre 2

| Date | CDD | Average Amp | Max Amp | Amp-Hrs |
|---|---|---|---|---|
| 3/11/2011 | 4 | 2.133148 | 16.296 | 51.2 |
| | | | | |
| | | | | |
| 3/14/2011 | 1.2 | 1.948863 | 16.052 | 48.0 |
| 3/15/2011 | 3.8 | 1.5764 | 15.735 | 37.8 |
| 3/16/2011 | 5.2 | 2.525268 | 18.128 | 60.6 |
| 3/17/2011 | 9.2 | 3.222529 | 18.909 | 77.3 |
| 3/18/2011 | | 0 | 0 | 0.0 |
| Total Period | 23.4 | | | 275.2 |
| | | Amp-Hr/CDD | | 11.8 |

Plot Title: Unit 2 pre 2

| Date | CDD | Average Amp | Max Amp | Amp-Hrs |
|---|---|---|---|---|
| 3/11/2011 | 4 | 0.85705 | 15.588 | 20.6 |
| | | | | |
| | | | | |
| 3/14/2011 | 1.2 | 0.875586 | 18.347 | 21.0 |
| 3/15/2011 | 3.8 | 1.036206 | 18.176 | 24.9 |
| 3/16/2011 | 5.2 | 1.362806 | 15.125 | 32.7 |
| 3/17/2011 | 9.2 | 1.379896 | 18.347 | 57.1 |
| 3/18/2011 | | N/A | N/A | 0.0 |
| Total Period | 23.4 | | | 156.3 |
| | | Amp-Hr/CDD | | 6.7 |

Server Unit "Pre" Correlation Evaluation — Amp-Hours — CDD

Unit 1 "Pre" Correlation Evaluation — Amp-Hours — CDD

Unit 2 "Pre" Correlation Evaluation — Amp-Hours — CDD

Plot Title: Unit 3 pre 2

Plot Title: Unit 4 pre 2

| Date | CDD | Average Amp | Max Amp | Amp-Hrs |
|---|---|---|---|---|
| | 4 | 1.348822 | 16.248 | 32.4 |
| | | | | |
| | | | | |
| | 1.2 | 1.536477 | 19.324 | 36.9 |
| | 3.8 | 1.372769 | 18.811 | 32.9 |
| | 5.2 | 1.705794 | 18.201 | 40.9 |
| | 9.2 | 2.025128 | 15.93 | 48.6 |
| | | 0 | 0 | 0.0 |
| | 23.4 | | | 191.8 |
| | | Amp-Hr/CDD | | 8.2 |

Plot Title: Unit 5 pre 2

| Date | CDD | Average Amp | Max Amp | Amp-Hrs |
|---|---|---|---|---|
| 3/11/2011 | 4 | 1.75279 | 16.187 | 42.1 |
| | | | | |
| | | | | |
| 3/14/2011 | 1.2 | 1.619516 | 16.394 | 38.9 |
| 3/15/2011 | 3.8 | 1.21853 | 15.592 | 29.2 |
| 3/16/2011 | 5.2 | 1.511404 | 16.088 | 36.3 |
| 3/17/2011 | 9.2 | 1.798294 | 16.330 | 43.2 |
| 3/18/2011 | | 0 | 0 | 0.0 |
| Total Period | 23.4 | | | 188.6 |
| | | Amp-Hr/CDD | | 8.1 |

Pre" Correlation Evaluation

Unit 5 "Pre" Correlation Evaluation — Amp-Hours

## Savings Calculations

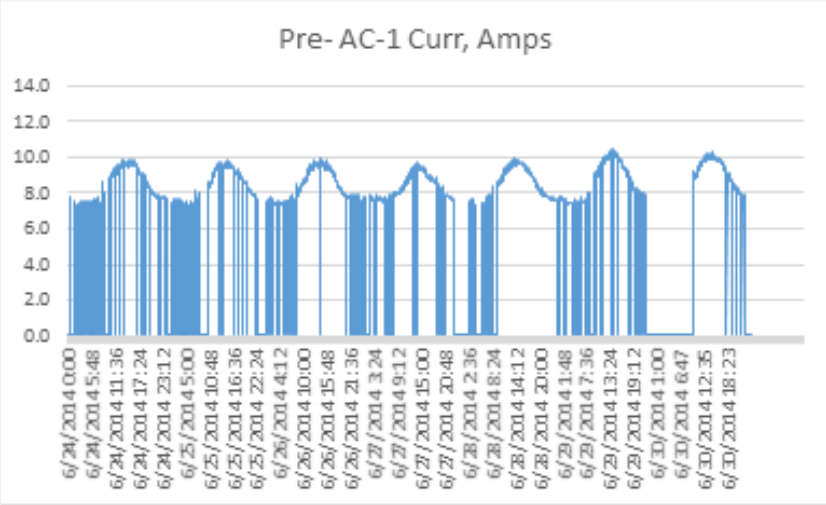
The formula utilized to calculate the energy savings reduction (as a percentage) is the difference between the calculated baseline energy consumption per cooling degree day (CDD pre) and the calculated post-retrofit energy consumption per cooling degree day (CDD post).

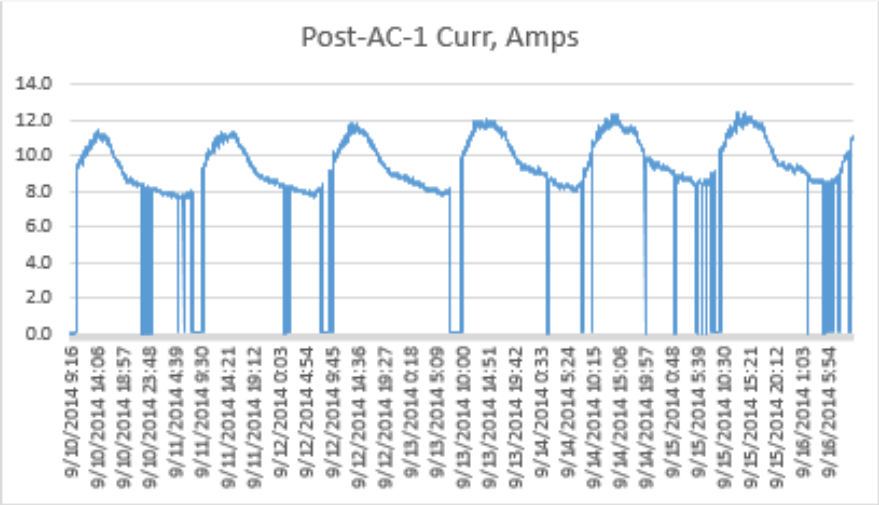
*Amp-Hour Baseline = Amp-Hour Measured Pre / CDD pre*

*Amp-Hour Post = Amp-Hour Measured Post / CDD post*

*Percent Reduction = (Amp-Hour Baseline – Amp-Hour Post) / Amp-Hour Baseline*

# Air Conditioning Unit AC-1 – field testing results for pre- and post-treatment

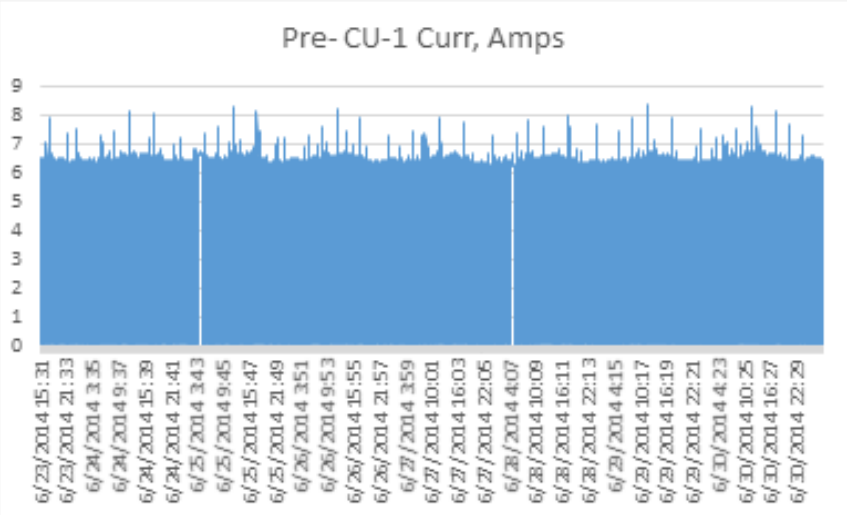


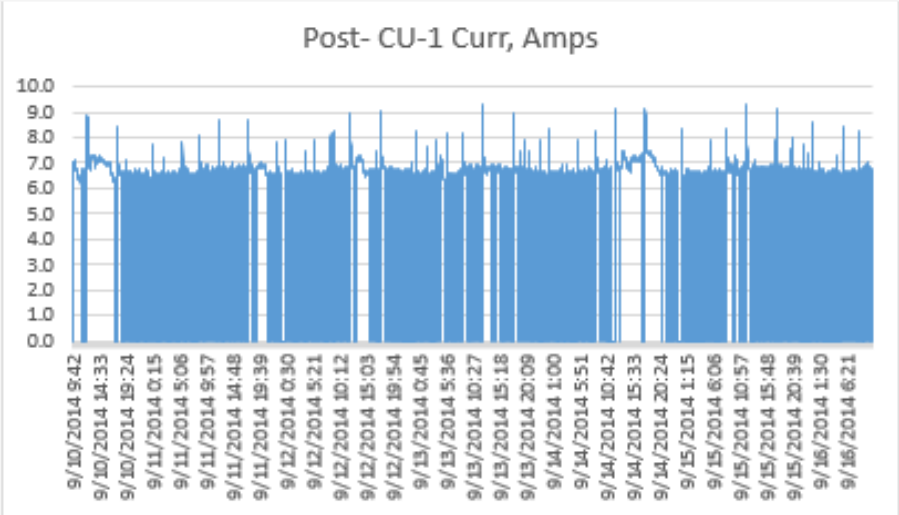




Charts above compare electric Currents drawn by AC-1 unit before and after IceCold treatment. Visual comparison indicates larger Amperage and longer operational time with after-treatment conditions. However, as earlier charts indicate, comparison shouldn't be performed of "intuitive, visual" basis.

Detailed quantitative analysis of weather-normalized energy usage clearly presents significant after-treatment energy savings, when measured in comparable ambient conditions (see below).

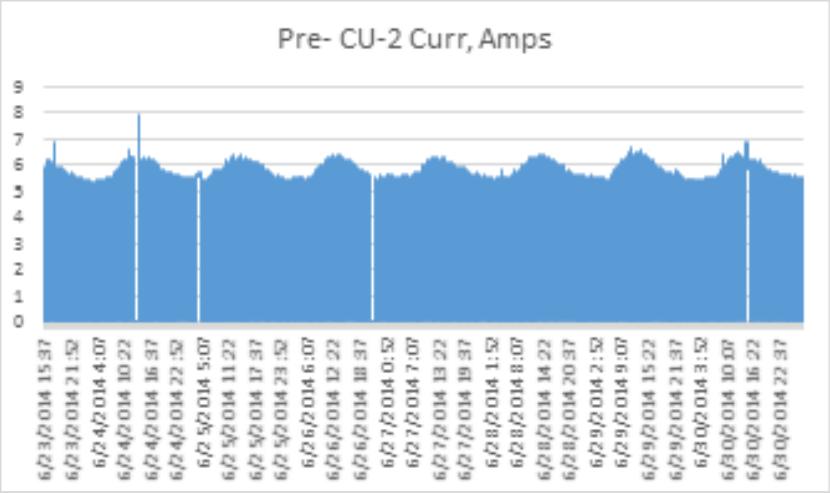
# Condensing Unit CU-1- field testing results for pre- & post- treatment

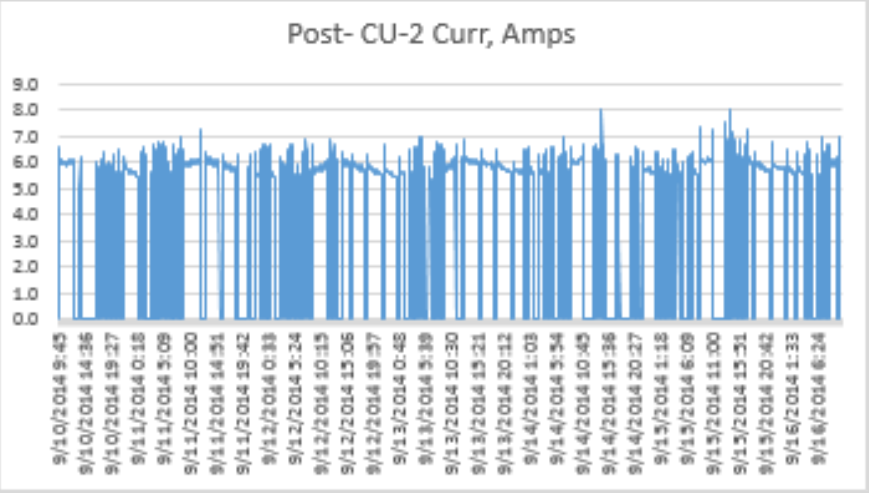



Detailed quantitative analysis of weather-normalized energy usage clearly presents significant after-treatment energy savings, when measured in comparable ambient conditions.

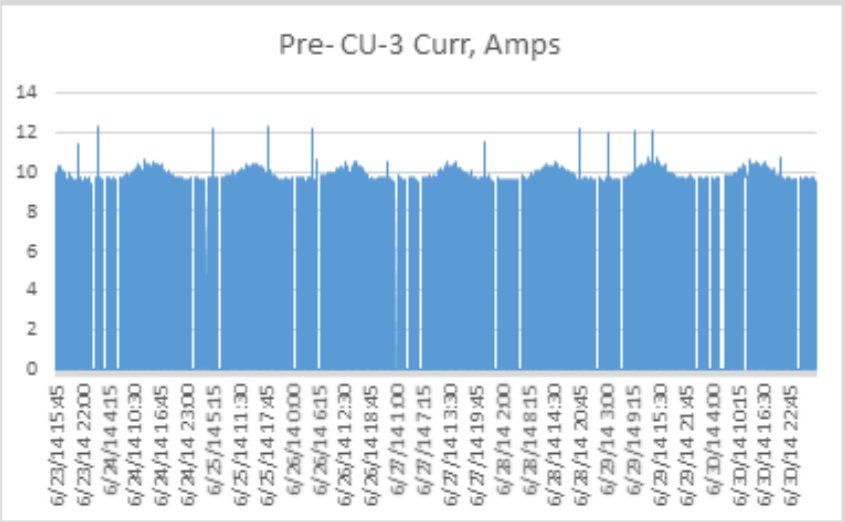
# Condensing Unit CU-2- field testing results for pre- & post- treatment

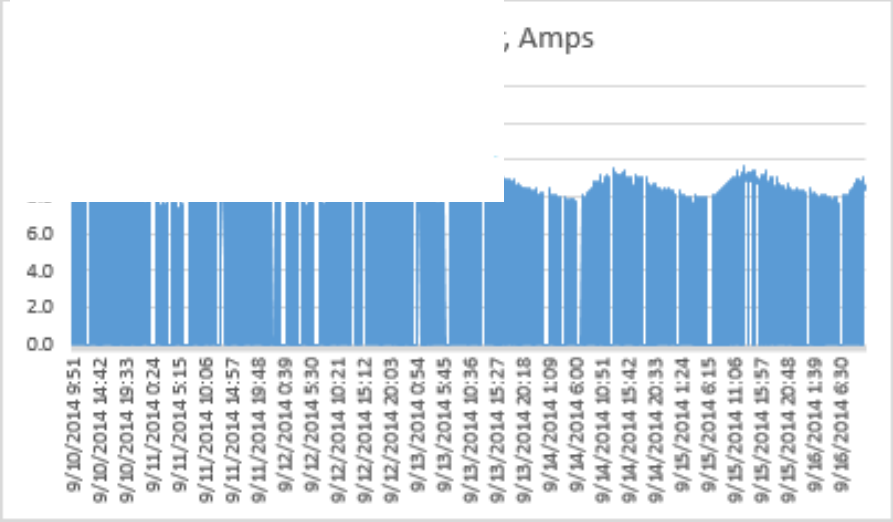



Detailed quantitative analysis of weather-normalized energy usage clearly presents significant after-treatment energy savings, when measured in comparable ambient conditions

# Condensing Unit CU-3- field testing results for pre- & post- treatment




Detailed quantitative analysis of weather-normalized energy usage clearly presents significant after-treatment energy savings, when measured in comparable ambient conditions