# Post-installation Review

**NYSERDA PON#: 2456**
**Application: IPE12629**
**Applicant: New York Times**
**Project: Treatment of Air Cooled Condensing Units**
**City, State: Jamaica, Queens, NY**

**Prepared for:**

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

**Industrial and Process Efficiency Program PON 2456**

**Date Submitted: March 11, 2017**


*Prepared by*
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Post-installation Review: New York Times

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# Contents



# Figures

## Tables

## Industrial and Process Efficiency Program, PON 2456
## Post-installation Review

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| | |
|---|---|
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| **NYSERDA Project #** | IPE 12629 |
| **Applicant** | New York Times |
| **Facility/Project** | Treatment of Air Cooled Condensing Units |

# 1. Executive Summary

**Overview**
New York Times is a leading American daily newspaper, founded and continuously published in New York City since 1851. Their distribution plant is located at One New York Times Plaza in Flushing, NY 11356.

**Figure 1 One New York Times Plaza**

The project consisted of treating air-cooled condenser coils for twenty-nine (29) air conditioning units located at the facility with a total cooling capacity of 3,475 tons. The treatment included the following:

- Mechanical and chemical cleaning (removal of corrosion and loose dirt, detergent cleaning)
- Restoration of the coil assembly
- Re-alignment of fins, if necessary
- Coating of the coil assembly (application of thinner, primer, and topcoat)

These units operate nearly 24/7 when the outside air dry-bulb temperature is above 50°F. The O&M project reduced the need to replace compressors and coils and will extend the life of the equipment.

The project is considered an Operations & Maintenance project, and NYSERDA incentives will be paid at $0.05/kWh.

The recommended approved savings for the proposed scope of work and the corresponding incentive are included in the Project Summary Table. Based on the site inspections and engineering analysis reviewed and performed by TRC Energy Services, the treatment of air cooled condensing units resulted in electricity savings of 343,474 kWh. The recommended incentive is **$17,173.72**, which is uncapped.

| Current Project Stage | Project Incremental Cost | Annual Cost Savings | Estimated Savings: Annual Electric Savings (kWh) | Estimated Savings: Demand Savings (kW) | Estimated Savings: Annual Natural Gas Savings (MMBtu) | Total Calculated Incentive | Percent Recommended Incentive Pay-Off |
|---|---|---|---|---|---|---|---|
| PA (as recv'd) | $300,000 | $179,521 | 1,561,052 | - | - | $ 78,052.60 | - |
| EA – Initial | $300,000 | $181,082 | 1,561,052 | - | - | $ 78,052.60 | |
| EA – Revised | $300,000 | $816,892 | 7,042,172 | - | - | $150,000.00 | |
| EA – Final | $300,000 | $ 39,843 | 343,474 | | - | $ 17,173.70 | |
| PIR – Initial | $300,000 | $ 39,843 | 343,474 | | - | $ 17,173.70 | |
| PIR – Revised | $300,000 | $ 39,843 | 343,474 | | - | $ 17,173.70 | |
| PIR – Final | $300,000 | $ 39,843 | 343,474 | | **-** | **$ 17,173.70** | **100%** |

**Table 1 Project Summary Table**

*Notes:*

(1) Cost savings based on analysis performed on the site's utility bill provided for month of June 2015. Total electricity use of 3,254,401 kWh at the cost of $154,196.04 results in a delivery rate of $0.047/kWh. New York Times receives a separate utility bill for electricity supply charges from Direct Energy. Total electricity use of 2,175,855 kWh at the cost of $149,549.75 results in a supply rate of $0.069 / kWh. The total rate used in cost savings calculations is $0.116/kWh.

(2) Between the PA (rev'd) stage and EA initial stages, energy cost savings were revised slightly to reflect a $0.116/kWh rate.

(3) Between the EA initial stages and EA revised stages, energy savings were based off of M&V savings for three units, and savings estimates increased significantly.

(4) Between EA revised and final stages, baseline consumption was modified to reflect consumption verified through utility bills and weather-normalized to account for 2015 and 2016 being much hotter than the typical year.

(5) Between EA final and PIR initial stages, TRC confirmed that the project cost was equal to $300,000 through review of invoices. The project cost did not change between the EA final and PIR initial stages.

(6) Between the PIR initial and PIR final stages, TRC verified that all 29 units were treated. No additional changes were made to the analysis as a result.

## 2. Recommended Project Incentive

Recommended Project Incentive = $17,173.70
Project capped at 50% of project cost? No

Because net energy savings were greater than 500,000 kWh at the EA initial stage, the reviewer recommended using M&V to validate savings. M&V was incorporated into the EA analysis, savings estimates were reduced to below 500,000 kWh, and no additional M&V will be performed at the PIR stage.

Incentivizing the estimated savings at $0.05/kWh for the performance incentive does not exceed 50% of the total project cost or incremental project cost.

## 3. Pre-Installation Inspection Results

Chris DeAlmagro met with the following personnel at New York Times on Tuesday, October 18, 2016 at 10:00 a.m.:

Tony Garbacki, New York Times

During the site visit, TRC verified the existing units, the applicant provided a detailed overview of the treatment process, and verified that the majority of units were not treated. To provide an estimate of savings at the EA phase, some units had to be treated so that M&V could be performed.

## 3.1. Site Information

New York Times is a leading American daily newspaper, founded and continuously published in New York City since 1851. Their distribution plant is located at One New York Times Plaza in Flushing, NY 11356. The project consists of treating air-cooled condenser coils for twenty-nine (29) air conditioning units located at the facility with a total cooling capacity of 3,475 tons. The majority of units are approximately 20 years and were manufactured in 1996. Of the 3,475 tons of cooling, 650 tons of cooling is associated with 9 year old units. ACU-17, ACU-19, ACU-20, ACU-21, ACU-22, and ACU-26 are not included in the scope of work.

| Unit Tag | Tons | Age (years) | Manufacturer |
|---|---|---|---|
| ACU-01 | 150 | 20 | Mammoth |
| ACU-02 | 150 | 20 | Mammoth |
| ACU-03 | 150 | 20 | Mammoth |
| ACU-04 | 150 | 20 | Mammoth |
| ACU-05 | 150 | 20 | Mammoth |
| ACU-06 | 150 | 20 | Mammoth |
| ACU-07 | 150 | 20 | Mammoth |
| ACU-08 | 150 | 20 | Mammoth |
| ACU-09 | 150 | 20 | Mammoth |
| ACU-10 | 150 | 20 | Mammoth |
| ACU-11 | 90 | 20 | Mammoth |
| ACU-12 | 90 | 20 | Mammoth |
| ACU-13 | 130 | 20 | Mammoth |
| ACU-14 | 160 | 20 | Mammoth |
| ACU-15 | 160 | 20 | Mammoth |

| Unit Tag | Tons | Age (years) | Manufacturer |
|---|---|---|---|
| ACU-16 | 40 | 20 | AAON |
| ACU-18 | 60 | 20 | AAON |
| ACU-23 | 50 | 20 | AAON |
| ACU-24 | 70 | 20 | AAON |
| ACU-25 | 25 | 20 | AAON |
| ACU-27 | 150 | 20 | Mammoth |
| ACU-28 | 150 | 20 | Mammoth |
| ACU-29 | 150 | 20 | Mammoth |
| ACU-30 | 50 | 9 | Mammoth |
| ACU-31 | 110 | 9 | Mammoth |
| ACU-32 | 110 | 9 | Mammoth |
| ACU-33 | 40 | 9 | AAON |
| ACU-34 | 170 | 9 | Mammoth |
| ACU-35 | 170 | 9 | Mammoth |

**Table 2 Air Conditioning Units Schedule**

The purpose of the pre-inspection was to perform the following tasks:

- Verify that the majority of units were not treated;
- Visit the existing site to review current operations; and
- Meet with the applicant to discuss program processes, expectations, and next steps.

## 3.2. Pre-inspection

The following images were taken on the pre-inspection that took place on October 17, 2016. TRC verified all 35 air conditioning units, six of which will not be treated. There were no discrepancies observed regarding manufacturer and unit sizes. TRC also confirmed that aside from ACU-10, ACU-11, and ACU-14, no other units were treated.

**Figure 2 Entrance to New York Times**

**Figure 3 Mammoth ACU 2, 7, & 9 - 150 tons each**

**Figure 4 Mammoth ACU-14 Condenser Face, Untreated**

**Figure 5 Mammoth ACU-14, Condenser Face, Untreated**


**Figure 6 Mammoth ACU-10, 150 tons**


**Figure 7 Mammoth ACU-10 Nameplate**

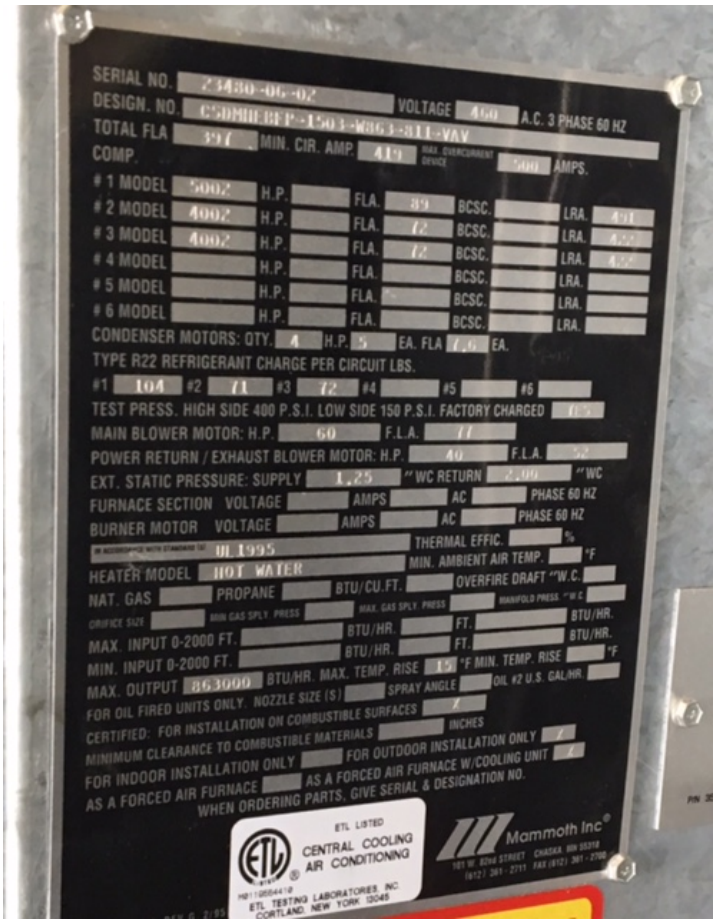


**Figure 8 Mammoth ACU-9 Nameplate**


**Figure 9 Mammoth ACU-34, 170 tons**


**Figure 10 Mammoth ACU-34 VFD, 57.89 Hz, 96.5% speed**

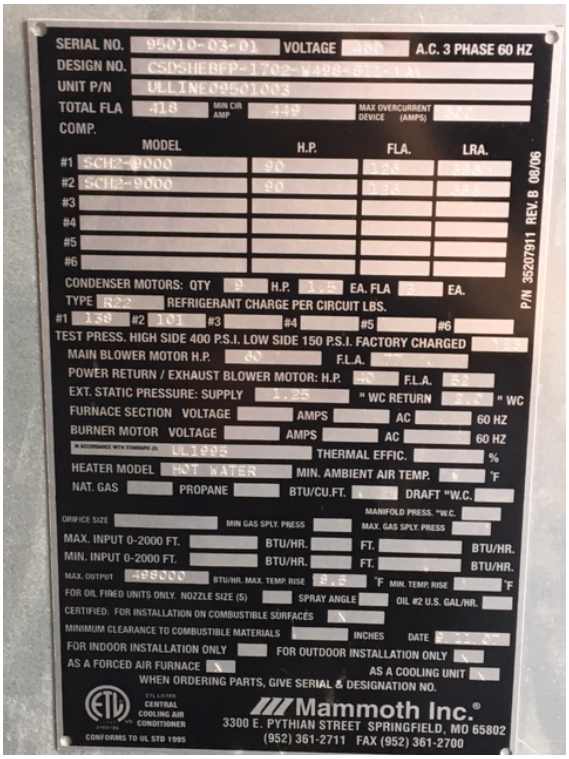


**Figure 11 Mammoth ACU-34 Nameplate**


**Figure 12 Mammoth ACU-35, 170 tons, Nameplate**


**Figure 13 Aaon ACU-16, 40 tons**

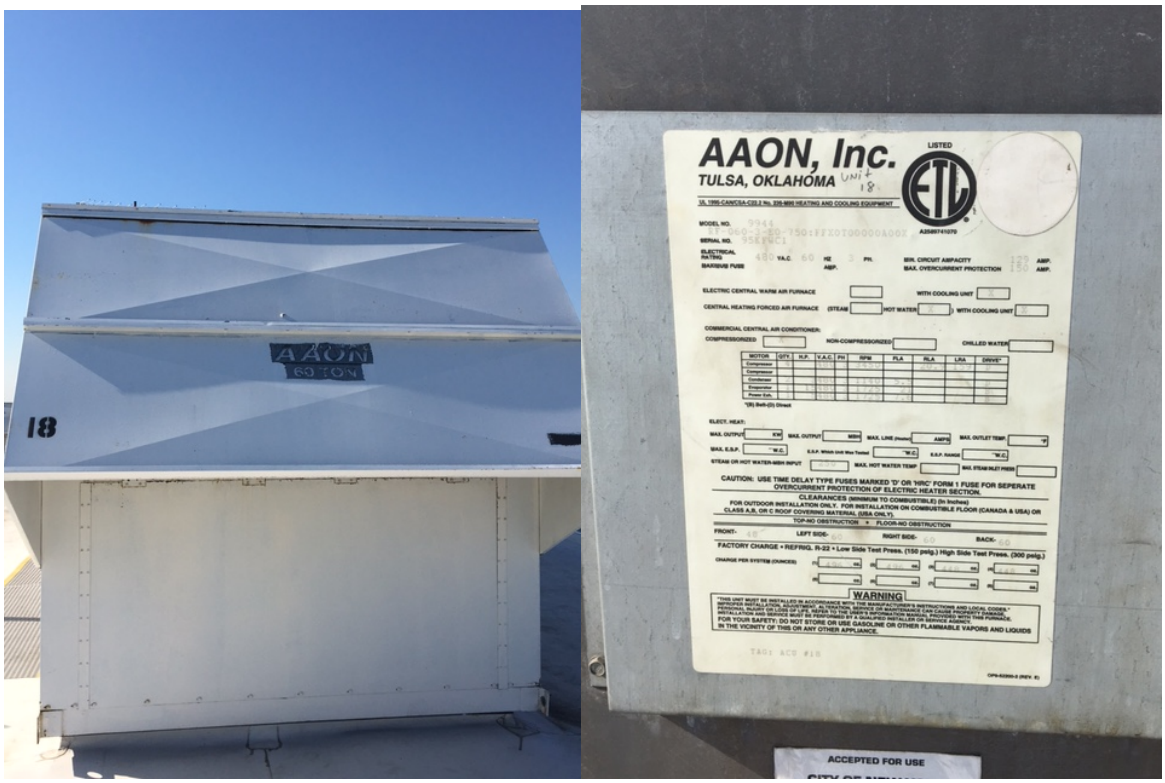


**Figure 14 Aaon ACU-18, 60 tons, Nameplate**


**Figure 15 Aaon ACU-33, 40 tons**


**Figure 16 Mammoth ACU-32, 110 tons**


**Figure 17 Mammoth ACU-15, 160 tons**


**Figure 18 Mammoth ACU-14, Nameplate**


**Figure 19 Mammoth ACU-11, 90 tons, Nameplate**


**Figure 20 Mammoth ACU-31, 110 tons, Nameplate**

## 3.3. Measurement and Verification (M&V) – EA Revised Phase

### 3.3.1. ACU-10 Measurement and Verification

Existing M&V for ACU-10, a 150 ton Mammoth unit took place from July 15 through July 17, 2016. Proposed M&V for ACU-10 took place from August 26 through September 6, 2016.

During these periods, the following components of ACU-10 were measured and calculated:

- Compressors 1-3 (kW)
- Fans 1-5 (kW)
- Evaporator Coil Humidity and Temperature
- Relative Humidity
- Cooling Capacity (Tons)
- Efficiency (EER)

The following figure presents a plot of EER as a function of outside drybulb temperature for the existing and proposed cases. As observed below, the efficiency of the unit is significantly improved from approximately 2.9 EER in the existing case to 8.6 EER in the proposed case.

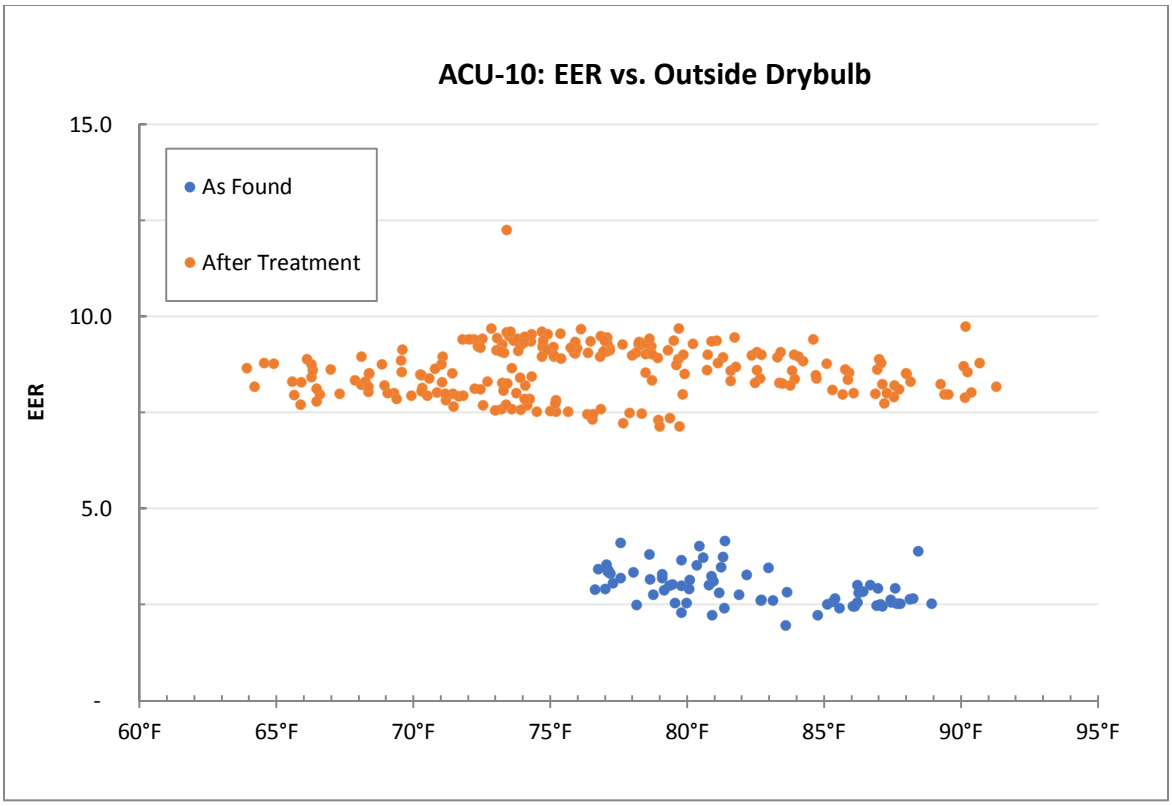


**Figure 21 ACU-10, EER vs. Outside Drybulb**

The table below summarizes the daily average kW and kWh for each day in which M&V took place. The values highlighted in pink represent existing M&V results.

| Date | CDD | ACU-10 Daily Average kW | ACU-10 Daily kWh |
|---|---|---|---|
| 7/15/2016 | 22.2 | 25.7 | 616 |
| 7/16/2016 | 17.8 | 24.8 | 596 |
| 7/17/2016 | 19.2 | 25.4 | 609 |
| 8/27/2016 | 16.8 | 50.9 | 1,220 |
| 8/28/2016 | 15.3 | 50.3 | 1,206 |
| 8/29/2016 | 17.9 | 50.8 | 1,219 |
| 8/30/2016 | 13.2 | 48.8 | 1,170 |
| 8/31/2016 | 16 | 50.7 | 1,217 |
| 9/1/2016 | 10.9 | 32.6 | 782 |
| 9/2/2016 | 10.1 | 38.4 | 922 |
| 9/3/2016 | 7.4 | 51.1 | 1,226 |
| 9/4/2016 | 7.9 | 51.4 | 1,233 |
| 9/5/2016 | 9.9 | 29.9 | 718 |

**Figure 22 ACU-10, M&V, Average Daily kW and kWh**

### 3.3.2. ACU-11 Measurement and Verification

Existing M&V for ACU-11, a 90 ton Mammoth unit took place from October 21 through October 25, 2015, and November 19 through November 20. Proposed M&V for ACU-11 took place from May 27 through June 6, 2016.

During these periods, the following components of ACU-11 were measured and calculated:

- Compressors 1-2 (kW)
- Fans 1-6 (kW)
- Evaporator Coil Humidity and Temperature
- Relative Humidity
- Cooling Capacity (Tons)
- Efficiency (EER)

The following figure presents a plot of EER as a function of outside drybulb temperature for the existing and proposed cases. As observed below, the efficiency of the unit is slightly improved from approximately 9.7 EER in the existing case to 10.0 EER in the proposed case.

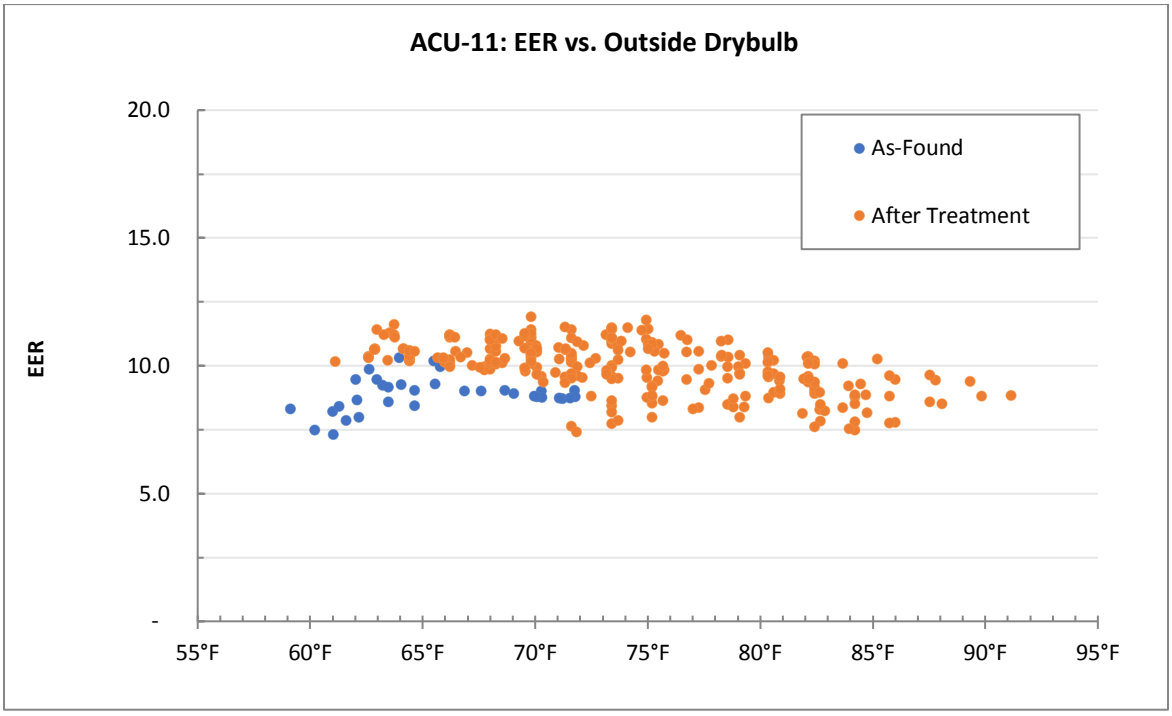


**Figure 23 ACU-11, EER vs. Outside Drybulb**

The following table summarizes the daily average kW and kWh for each day in which M&V took place. The values highlighted in pink represent existing M&V results.

| Date | CDD | ACU-11 Daily Average kW | ACU-11 Daily kWh |
|---|---|---|---|
| 10/21/2015 | 2.3 | 26.1 | 627 |
| 10/22/2015 | 3.6 | 26.6 | 638 |
| 10/23/2015 | 0.1 | 24.5 | 587 |
| 10/25/2015 | 0.2 | 26.6 | 639 |
| 11/19/2015 | 0 | 27.0 | 202 |
| 11/20/2015 | 0 | 26.8 | 201 |
| 5/27/2016 | 11.5 | 38.2 | 916 |
| 5/28/2016 | 16.3 | 41.6 | 999 |
| 5/29/2016 | 13 | 39.3 | 943 |
| 5/30/2016 | 8.9 | 40.2 | 965 |
| 5/31/2016 | 11.8 | 43.7 | 1,048 |
| 6/1/2016 | 10.3 | 36.2 | 870 |
| 6/2/2016 | 3.3 | 31.7 | 760 |
| 6/3/2016 | 2 | 32.3 | 774 |
| 6/4/2016 | 8.4 | 38.4 | 921 |
| 6/5/2016 | 4.2 | 36.0 | 864 |
| 6/6/2016 | 12.4 | 37.7 | 905 |

**Figure 24 ACU-11, M&V, Average Daily kW and KWh**

### 3.3.3. ACU-14 Measurement and Verification

Existing M&V for ACU-14, a 160 on Mammoth unit took place from October 21 through October 22, 2015. Proposed M&V for ACU-14 took place from November 16-20, 2015 and June 7-20 2016.

During these periods, the following components of ACU-11 were measured and calculated:

- Compressors 1-3
- Fans 1-5
- Temperature
- Relative Humidity

The following figure presents a plot of EER as a function of outside drybulb temperature for the existing and proposed cases. As observed below, the efficiency of the unit is significantly improved from approximately 3.5 EER in the existing case to 11.5 EER in the proposed case.

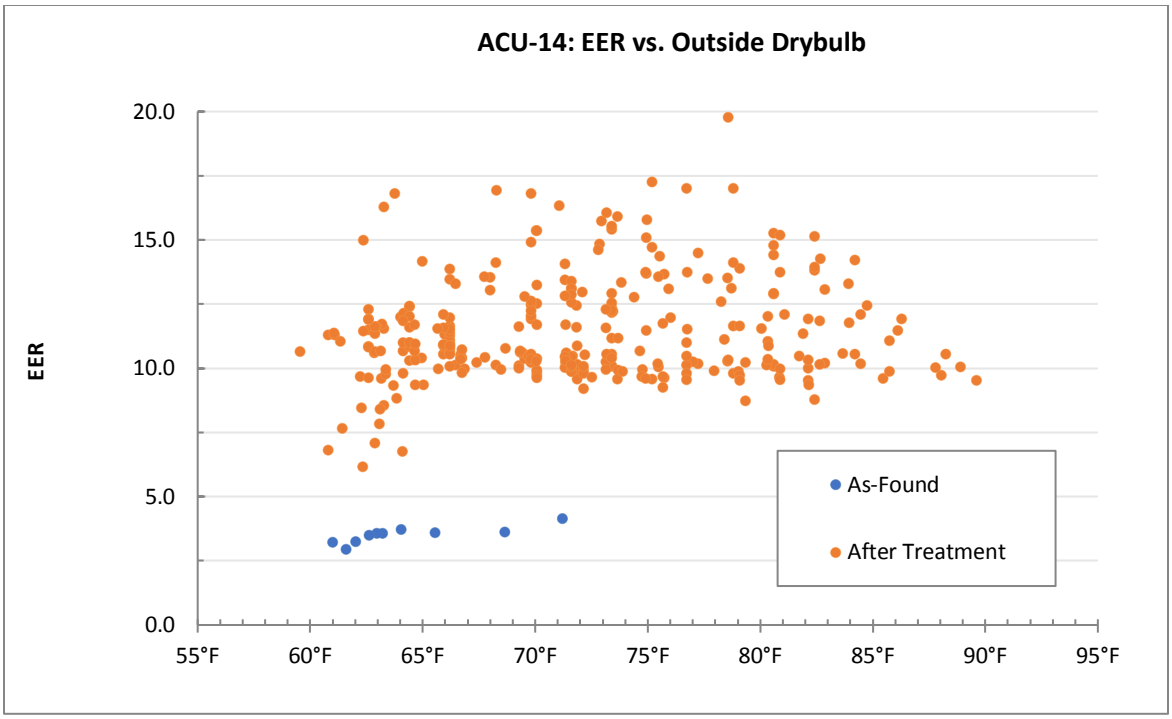


**Figure 25 ACU-14, EER vs. Outside Drybulb**

The following table summarizes the daily average kW and kWh for each day in which M&V took place. The values highlighted in pink represent existing M&V results.

| Date | CDD | ACU-14 Daily Average kW | ACU-14 Daily kWh |
|---|---|---|---|
| 10/21/2015 | 2.3 | 65.1 | 1,562 |
| 10/22/2015 | 3.6 | 62.1 | 1,492 |
| 11/16/2015 | 0.3 | 54.5 | 491 |
| 11/19/2015 | 0 | 51.5 | 464 |
| 11/20/2015 | 0 | 45.8 | 412 |
| 6/7/2016 | 12.2 | 101.4 | 2,435 |
| 6/8/2016 | 0.5 | 73.6 | 1,473 |
| 6/9/2016 | 2.5 | 71.1 | 996 |
| 6/10/2016 | 4.9 | 73.1 | 1,535 |
| 6/11/2016 | 11.8 | 90.4 | 2,170 |
| 6/12/2016 | 12 | 95.6 | 2,295 |
| 6/13/2016 | 2.7 | 73.9 | 1,404 |
| 6/14/2016 | 6.3 | 76.6 | 1,609 |
| 6/15/2016 | 10.8 | 86.1 | 2,066 |
| 6/16/2016 | 7.3 | 101.6 | 2,439 |
| 6/17/2016 | 5.5 | 83.3 | 1,416 |
| 6/18/2016 | 9.2 | 81.9 | 1,720 |
| 6/19/2016 | 9.5 | 86.6 | 346 |

**Table 3 ACU-14, M&V, Average Daily kW and kWh**

### 3.3.4. Summary of M&V – EA Revised

The table below presents the summarized M&V data provided by the applicant.

| | ACU-10 | ACU-11 | ACU-14 |
|---|---|---|---|
| Nominal Tonnage | 150 | 90 | 160 |
| Maximum Tonnage | 42.5 | 63.9 | 137.1 |
| EFLH | 2,380 | 2,358 | 2,417 |
| Existing EER | 2.94 | 9.68 | 3.5 |
| Proposed EER | 8.61 | 9.97 | 11.5 |
| Existing kWh | 413,402 | 186,787 | 1,127,560 |
| Existing kWh per Ton | 2,756 | 2,075 | 7,047 |
| Proposed kWh | 140,910 | 181,487 | 346,874 |
| Proposed kWh per Ton | 939 | 2,017 | 2,168 |
| Annual Savings (kWh) | 272,492 | 5,300 | 780,686 |
| Annual kWh Savings per Ton | 1,817 | 59 | 4,879 |
| 2015 CDD | 1,544 | 1,544 | 1,544 |

**Table 4 Summary of M&V Results**

Using this data, savings were applied for all other units in the building summarized in the table below.

Overall, the results were problematic and savings appeared to be aggressive

- Compared to the typical year, 2015 was significantly hotter than average[1]. 2015 had 1,544 cooling degree days compared to the average of 1,142 for New York City.
- The existing case M&V data for AC units ranges from 2-5 days, which is generally not a long enough time to develop meaningful trends.
- The existing case M&V data for two of the three units took place in the fall compared to the summer for the proposed case.
- As with many O&M projects, there is no consistency in savings. For example, ACU-11 saves 59 kWh/ton per ton while ACU-14 saves 4,879 kWh/ton based on the data provided.
- For two of the units, the calculated EER is extremely low (2.9 to 3.5 EER). Applying this to all units may result in exaggerated savings.
- The analysis uses weather to estimate existing consumption for three units. However, a utility bill analysis was not performed to estimate existing cooling consumption for the facility.

Due to the uncertainties in the analysis, savings projected must be conservative. The following section addresses the approaches we used to estimate conservative savings.

[1] http://www.nyserda.ny.gov/About/Publications/EA-Reports-and-Studies/Weather-Data/Monthly-Cooling-and-Heating-Degree-Day-Data

# 4. Review of the Savings Calculation

The energy savings calculations included in this analysis were performed by TRC based on documentation provided by the applicant. To establish baseline consumption, TRC reviewed utility bills, determined consumption associated with cooling, and weather-normalized cooling consumption to reflect typical consumption.

## 4.1. Utility Bill Analysis

TRC collected one year of utility bills to review the utility spend for the facility. The average baseload during this period was approximately 1,900,000 kWh. TRC then estimated the consumption from May through September that was associated with cooling. During this period, approximately 2,500,000 kWh was associated with cooling. 2015 and 2016 were much hotter than the typical area. Therefore, cooling consumption was weather normalized and adjusted lower to reflect typical year consumption. TRC assumed that weather-normalized cooling consumption is proportional to cooling degree days. As a result, weather-normalized cooling consumption is estimated to be 1,900,000 kWh.

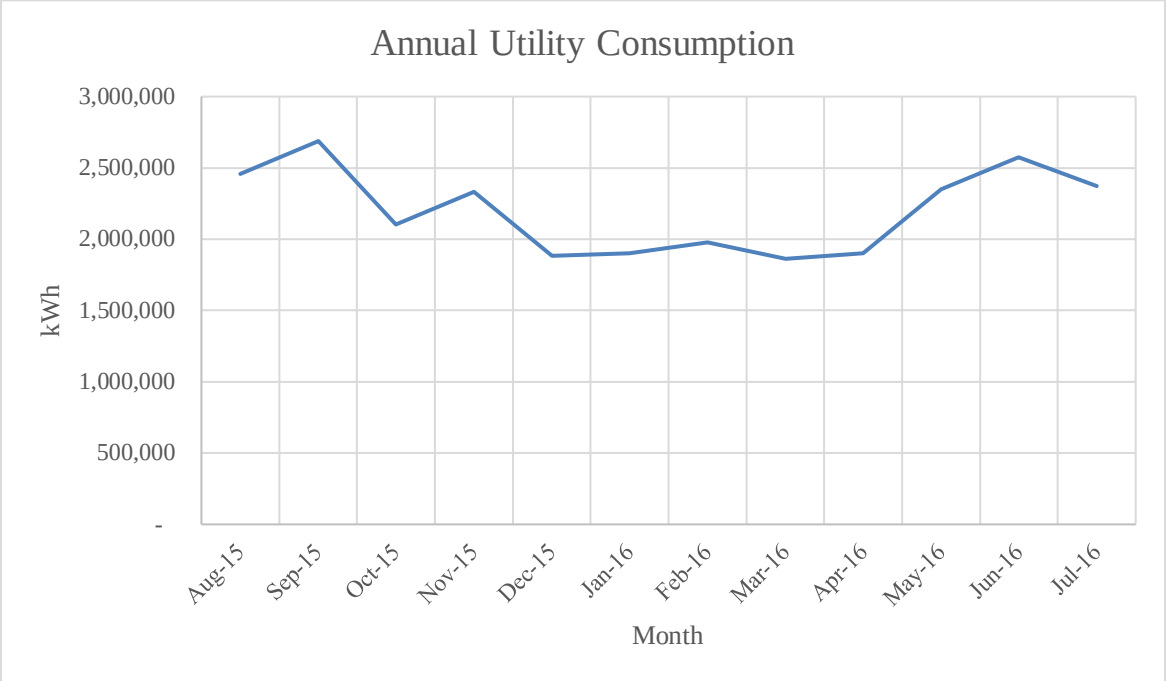


**Table 5 New York Times Annual Utility Consumption**

# New York City

(La Guardia Airport)

**Cooling Degree Day**

| | 2016 | 2015 | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | Normal |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **January** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **February** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **March** | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **April** | 8 | 2 | 0 | 0 | 18 | 1 | 13 | 31 | 5 | 10 | 6 | 6 |
| **May** | 106 | 119 | 49 | 87 | 102 | 72 | 124 | 51 | 30 | 129 | 67 | 54 |
| **June** | 269 | 226 | 230 | 278 | 254 | 239 | 337 | 131 | 325 | 276 | 267 | 209 |
| **July** | 506 | 445 | 380 | 505 | 484 | 486 | 557 | 301 | 470 | 401 | 492 | 377 |
| **August** | 519 | 451 | 322 | 340 | 430 | 346 | 428 | 403 | 318 | 385 | 414 | 336 |
| **September** | 271 | 281 | 178 | 129 | 184 | 195 | 232 | 117 | 184 | 251 | 137 | 141 |
| **October** | | 14 | 24 | 49 | 31 | 24 | 21 | 7 | 14 | 114 | 31 | 17 |
| **November** | | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **December** | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **TOTAL** | | 1544 | 1183 | 1388 | 1503 | 1363 | 1712 | 1041 | 1346 | 1566 | 1414 | 1142 |

**Table 6 NYSERDA Cooling Degree Days**

| | Start | End | Days | kWh | Demand (kW) | Actual CDD | Typical | Baseload (kWh) | Cooling (kWh) | Cooling Adjustment |
|---|---|---|---|---|---|---|---|---|---|---|
| Jan-16 | 1/6/16 | 2/5/16 | 30 | 1,900,801 | 5690.8 | 0 | 0 | 1,965,972 | | |
| Feb-16 | 2/5/16 | 3/8/16 | 32 | 1,977,601 | 5713.9 | 0 | 0 | 2,097,037 | | |
| Mar-16 | 3/8/16 | 4/6/16 | 29 | 1,862,400 | 5771.5 | 5 | 1 | 1,900,440 | | |
| Apr-16 | 4/6/16 | 5/5/16 | 29 | 1,900,800 | 6382 | 8 | 6 | 1,900,440 | | |
| May-16 | 5/5/16 | 6/6/16 | 32 | 2,352,000 | 6422.4 | 106 | 54 | 2,097,037 | 254,963 | 129,887 |
| Jun-16 | 6/6/16 | 7/6/16 | 30 | 2,572,800 | 6750.7 | 269 | 209 | 1,965,972 | 606,828 | 471,476 |
| Jul-16 | 7/6/16 | 8/4/16 | 29 | 2,371,200 | 6560.6 | 506 | 377 | 1,900,440 | 470,760 | 350,744 |
| Aug-15 | 8/5/15 | 9/3/15 | 29 | 2,457,600 | 6595.2 | 519 | 336 | 1,900,440 | 557,160 | 360,705 |
| Sep-15 | 9/3/15 | 10/5/15 | 32 | 2,688,000 | 6981.1 | 141 | 141 | 2,097,037 | 590,963 | 590,963 |
| Oct-15 | 10/5/15 | 11/3/15 | 29 | 2,102,400 | 6295.6 | 17 | 17 | 1,900,440 | | |
| Nov-15 | 11/3/15 | 12/7/15 | 34 | 2,332,800 | 6888.9 | 1 | 1 | 2,228,102 | | |
| Dec-15 | 12/7/15 | 1/6/16 | 30 | 1,881,601 | 5731.2 | 0 | 0 | 1,965,972 | | |
| Total | | | | 26,400,003 | | | | | 2,480,674 | 1,903,775 |

**Table 7 New York Times Weather Normalized Cooling Consumption**

The weather-normalized cooling consumption of 1,900,000 kWh was used to establish the baseline cooling consumption.

## 4.2. EA – Final Analysis

To establish the baseline energy consumption per system, the following approach was used:

- Estimate existing cooling efficiency using M&V results or a derating approach described below, whichever is greater.
- Use the proposed EER calculated through M&V and determine a percent improvement per unit. For example, if the proposed EER verified through M&V is 8.6 EER and the baseline EER is equal to 7.7, the percent improvement is 10%.
- Calculate post-kWh per nominal ton per M&V data.
- Calculate proposed kWh by multiplying post-kWh per ton by the nominal tonnage of the units.
- Calculate baseline-kWh per nominal ton by applying the percent improvement (e.g. if efficiency is improved by 10%, the baseline kWh per ton is increased by 10%).
- Calculate baseline kWh by multiplying baseline-kWh per ton by nominal tonnage of the units.
- Calculate kWh savings per unit by subtracting proposed kWh consumption from baseline consumption.
- Reduce post-kWh per ton by a factor so that the baseline kWh consumption is equal to the weather normalized cooling consumption calculated through the utility bill analysis. Recall that baseline kWh per ton is calculated as a function of post-kWh per ton.

Efficiency of existing air conditioners is de-rated as follows due to age:

$$\textbf{Efficiency}_{\textbf{derated}} = \textbf{Efficiency}_{\textbf{original}} * (1-M)^{\textbf{age}}$$

Where:

- **Efficiency** $_{\textbf{original}}$ = nameplate efficiency
  - For equipment in which nameplate efficiency is unavailable, ASHRAE 90.1-2007 is used.
- **Age** = equipment age if nameplate efficiency is known or 15 years, whichever is less.
- **M** = Maintenance factor
  - $\mathbf{M_a}$ = Maintenance factor for equipment that received annual professional maintenance
  - $\mathbf{M_b}$ = Maintenance factor for equipment that was seldom or never maintained

| Equipment Type | $M_a$ | $M_b$ |
|---|---|---|
| Air Conditioners | 0.010 | 0.015 |

For example, a 20 year old, 150 ton Mammoth unit would have a baseline efficiency equal to 7.7 Assuming the Mammoth units are well maintained, the baseline efficiency is estimated to be 69.7% (**7.7 EER = 9.0 EER *(1-0.010)** $^{\mathbf{15}}$).

The following table presents the estimated savings per unit. In general, savings are much lower than originally projected for two primary reasons:

- Baseline consumption was significantly higher than actual utility consumption. For example, the original analysis was showing over 1.5 million kWh saved for a 10-12% improvement in efficiency. This would mean than the baseline cooling consumption would be over 15 million kWh for cooling alone, or 58% of the annual energy

consumption. Utility bills show that cooling consumption in the summer contributes to approximately 2 million kWh per year. In addition, M&V data shows that during cooling months such as November, the units do not operate as frequently. There were multiple days in which units did not turn on at all.

- Energy consumption was not weather-normalized. Weather-normalizing energy consumption reduces savings by 25% alone.

| Unit Tag | Tons | Age | EFLH per M&V | Updated EFLH | Baseline EER | Baseline kWh per ton | Baseline kWh Consumption | Proposed EER | Percent Better | Post-kWh per Ton | Proposed kWh | Year 1 kWh Savings | Year 1 Savings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACU-01 | 150 | 20 | 2380 | 1095 | 7.7 | 355 | 53,250 | 8.6 | 10% | 319 | 47,886 | 5,364 | $622 |
| ACU-02 | 150 | 20 | 2380 | 1095 | 7.7 | 355 | 53,250 | 8.6 | 10% | 319 | 47,886 | 5,364 | $622 |
| ACU-03 | 150 | 20 | 2380 | 1095 | 7.7 | 355 | 53,250 | 8.6 | 10% | 319 | 47,886 | 5,364 | $622 |
| ACU-04 | 150 | 20 | 2380 | 1095 | 7.7 | 355 | 53,250 | 8.6 | 10% | 319 | 47,886 | 5,364 | $622 |
| ACU-05 | 150 | 20 | 2380 | 1095 | 7.7 | 355 | 53,250 | 8.6 | 10% | 319 | 47,886 | 5,364 | $622 |
| ACU-06 | 150 | 20 | 2380 | 1095 | 7.7 | 355 | 53,250 | 8.6 | 10% | 319 | 47,886 | 5,364 | $622 |
| ACU-07 | 150 | 20 | 2380 | 1095 | 7.7 | 355 | 53,250 | 8.6 | 10% | 319 | 47,886 | 5,364 | $622 |
| ACU-08 | 150 | 20 | 2380 | 1095 | 7.7 | 355 | 53,250 | 8.6 | 10% | 319 | 47,886 | 5,364 | $622 |
| ACU-09 | 150 | 20 | 2380 | 1095 | 7.7 | 355 | 53,250 | 8.6 | 10% | 319 | 47,886 | 5,364 | $622 |
| ACU-10 | 150 | 20 | 2380 | 1095 | 7.7 | 355 | 53,250 | 8.6 | 10% | 319 | 47,886 | 5,364 | $622 |
| ACU-11 | 90 | 20 | 2358 | 1085 | 7.7 | 883 | 79,470 | 10.0 | 22% | 686 | 61,727 | 17,743 | $2,058 |
| ACU-12 | 90 | 20 | 2358 | 1085 | 7.7 | 883 | 79,470 | 10.0 | 22% | 686 | 61,727 | 17,743 | $2,058 |
| ACU-13 | 130 | 20 | 2380 | 1095 | 7.7 | 355 | 46,150 | 8.6 | 10% | 319 | 41,501 | 4,649 | $539 |
| ACU-14 | 160 | 20 | 2417 | 1112 | 7.7 | 1,092 | 174,720 | 11.5 | 32% | 737 | 117,981 | 56,739 | $6,582 |
| ACU-15 | 160 | 20 | 2417 | 1112 | 7.7 | 1,092 | 174,720 | 11.5 | 32% | 737 | 117,981 | 56,739 | $6,582 |
| ACU-16 | 40 | 20 | 2358 | 1085 | 9.7 | 705 | 28,200 | 10.0 | 3% | 686 | 27,434 | 766 | $89 |
| ACU-18 | 60 | 20 | 2358 | 1085 | 9.7 | 705 | 42,300 | 10.0 | 3% | 686 | 41,152 | 1,148 | $133 |
| ACU-23 | 50 | 20 | 2358 | 1085 | 9.7 | 705 | 35,250 | 10.0 | 3% | 686 | 34,293 | 957 | $111 |
| ACU-24 | 70 | 20 | 2358 | 1085 | 9.7 | 705 | 49,350 | 10.0 | 3% | 686 | 48,010 | 1,340 | $155 |
| ACU-25 | 25 | 20 | 2358 | 1085 | 9.7 | 705 | 17,625 | 10.0 | 3% | 686 | 17,147 | 479 | $56 |
| ACU-27 | 150 | 20 | 2380 | 1095 | 7.7 | 355 | 53,250 | 8.6 | 10% | 319 | 47,886 | 5,364 | $622 |
| ACU-28 | 150 | 20 | 2400 | 1104 | 7.7 | 355 | 53,250 | 8.6 | 10% | 319 | 47,886 | 5,364 | $622 |
| ACU-29 | 150 | 20 | 2400 | 1104 | 7.7 | 355 | 53,250 | 8.6 | 10% | 319 | 47,886 | 5,364 | $622 |
| ACU-30 | 50 | 9 | 2400 | 1104 | 9.7 | 705 | 35,250 | 10.0 | 3% | 686 | 34,293 | 957 | $111 |
| ACU-31 | 110 | 9 | 2400 | 1104 | 8.2 | 387 | 42,570 | 10.0 | 17% | 319 | 35,116 | 7,454 | $865 |
| ACU-32 | 110 | 9 | 2400 | 1104 | 8.2 | 387 | 42,570 | 10.0 | 17% | 319 | 35,116 | 7,454 | $865 |
| ACU-33 | 40 | 9 | 2400 | 1104 | 9.7 | 705 | 28,200 | 10.0 | 3% | 686 | 27,434 | 766 | $89 |
| ACU-34 | 170 | 9 | 2417 | 1112 | 8.2 | 1,028 | 174,760 | 11.5 | 28% | 737 | 125,355 | 49,405 | $5,731 |
| ACU-35 | 170 | 9 | 2417 | 1112 | 8.2 | 1,028 | 174,760 | 11.5 | 28% | 737 | 125,355 | 49,405 | $5,731 |
| **Total** | **3,475** | | | | | | **1,917,615** | | **18%** | | **1,574,141** | **343,474** | **$39,843** |

**Table 8 Final Energy Savings per Unit**

# 5. Post-Installation Conditions

The project consists of treating air-cooled condenser coils for twenty-nine (29) air conditioning units located at the facility with a total cooling capacity of 3,475 tons. The treatment includes the following:

- Mechanical and chemical cleaning (removal of corrosion and loose dirt, detergent cleaning)
- Restoration of the coil assembly
- Re-alignment of fins, if necessary
- Coating of the coil assembly (application of thinner, primer, and topcoat)

## 5.1. Post-inspection Verification (1 of 2)

Chris DeAlmagro met with the following personnel at New York Times on Tuesday, October 18, 2016 at 10:00 a.m.:

Tony Garbacki, New York Times

During this post-inspection, which took place at the same time as the pre-inspection, TRC confirmed that ACU-10, ACU-11, and ACU-14 were treated. The following images represent treated units at the time of inspection.

**Figure 26 ACU-10, 150 tons, Condenser Face, Treated**

**Figure 27 ACU-10, Condenser Face, Treated**

**Figure 28 ACU-14, 160 tons, Condenser Face, Treated**

**Figure 29 ACU-14, 160 tons, Condenser Face, Treated**

**Figure 30 ACU-14, 160 tons, Condenser Face, Treated Close-up**

## 5.2. Post-inspection Verification (2 of 2)

At the time of the original post-inspection, only 3 units were treated. Chris DeAlmagro met with the following personnel at New York Times on Thursday, March, 2, 2017 at 10:00 a.m.:

Tony Garbacki, New York Times

TRC confirmed that the following units were treated:

- ACU-01 through ACU-16
- ACU-18,
- ACU-23 through ACU-25
- ACU-27 through ACU-35

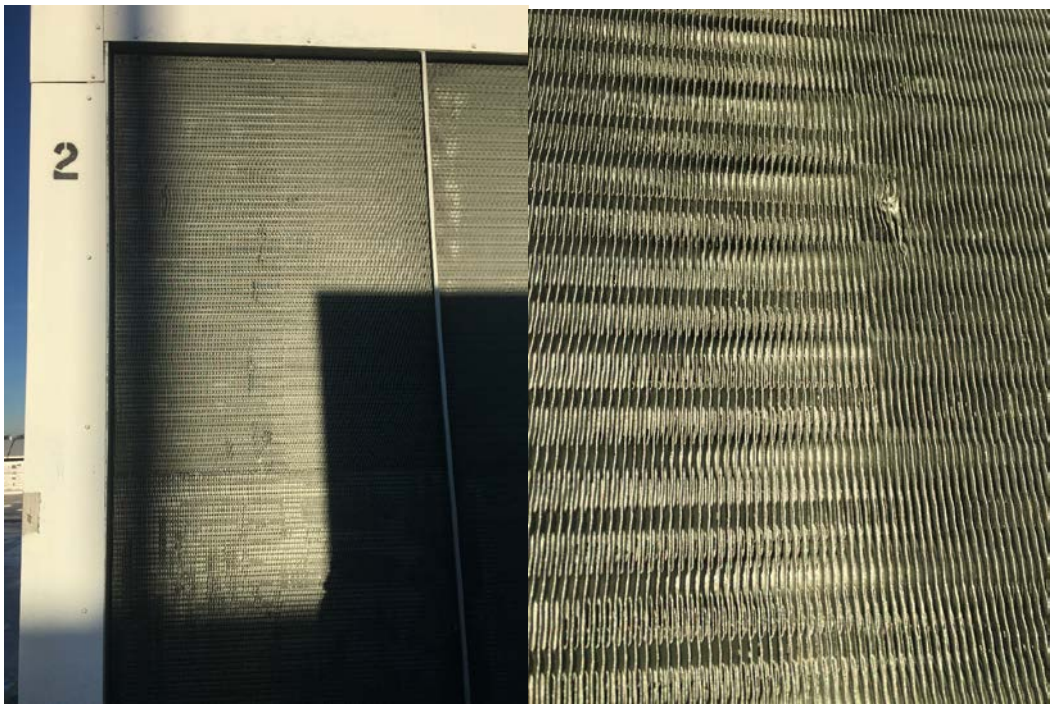


**Figure 31 ACU-2, 150 tons, Condenser Face, Treated**

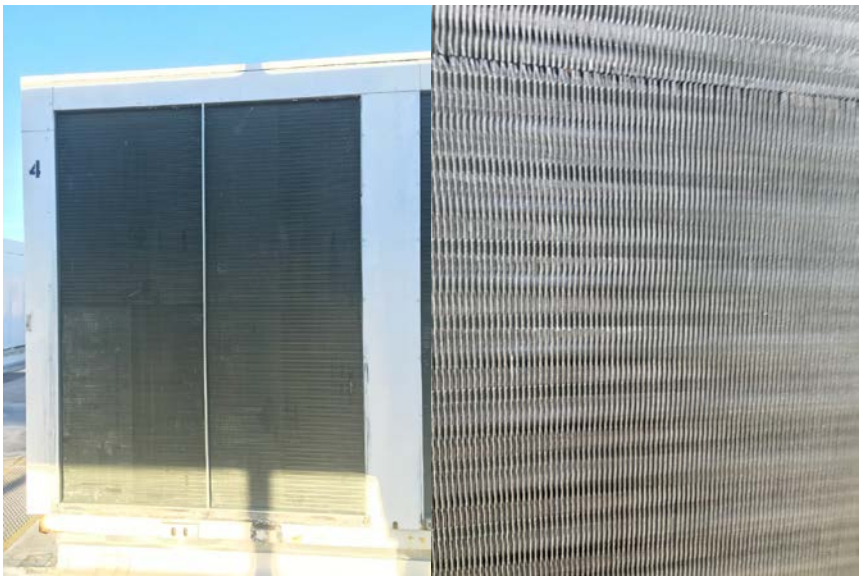


**Figure 32 ACU-4, 150 tons, Condenser Face, Treated**

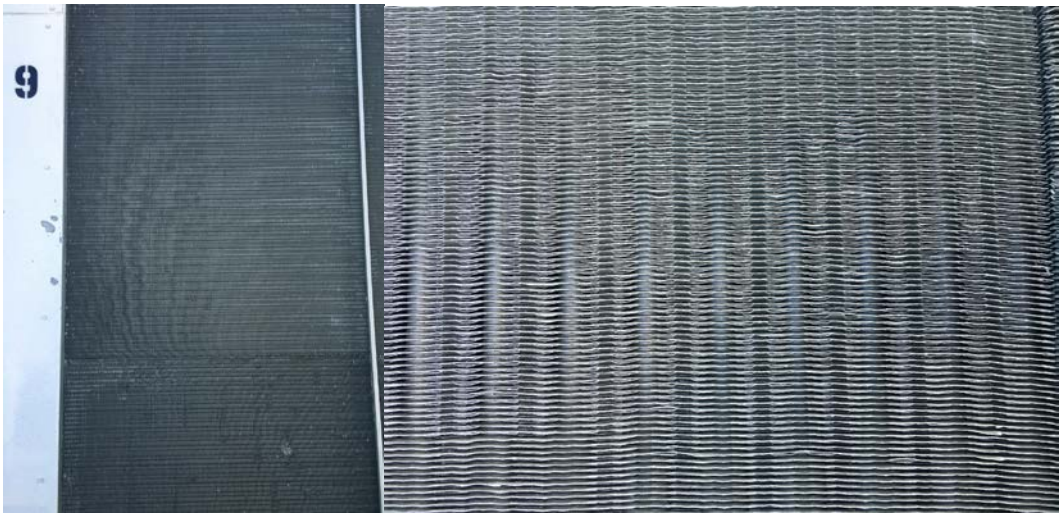


**Figure 33 ACU-9, 150 tons, Condenser Face, Treated**

**Figure 34 ACU-9, 150 tons, Coils, Treated**


**Figure 35 ACU-15, 160 tons, Condenser Face, Treated**

**Figure 36 ACU-16, 40 tons, Condenser Face, Treated**


**Figure 37 ACU-23, 50 tons, Condenser Face, Treated**


**Figure 38 ACU-24, 70 tons, Condenser Face, Treated**


**Figure 39 ACU-29, 150 tons, Condenser Face, Treated**


**Figure 40 ACU-34, 170 tons, Condenser Face, Treated**

**Figure 41 ACU-34 (cont'd), 170 tons, Condenser Face, Treated**


**Figure 42 ACU-35, 170 tons, Condenser Face, Treated**

# 6. Required Project Documentation

| Required Project Documentation | | | | | | Notes |
|---|---|---|---|---|---|---|
| 1 | Application | X | Included | | Not Included | Included with submittals. |
| 2 | Utility Bill | X | Included | | Not Included | See Appendix E of EA report. |
| 3 | Equipment Cut Sheets | X | Included | | Not Included | See Appendix B of EA report. |
| 4 | Engineering Analysis | X | Included | | Not Included | See Appendix A. |
| 5 | Lighting Form (Required for lighting projects) | | Included | X | Not Included | Not required for this application. |
| 6 | M&V Plan | | Included | X | Not Included | Savings are less than 500,000 kWh |
| 7 | Cost Invoice | X | Included | | Not Included | Will be included with the PIR report |

## 7. Breakdown of Project Costs and Project Cost Cap

The customer submitted the project invoice of $300,000, which was identical to the project cost estimate of the EA phase. The expected net energy savings are 343,474 kWh and incentive is $17,173.70. Therefore, based on the project cost, the anticipated performance incentive amount will not exceed the cap of 50% of the total estimated project costs.

## 8. Overall Assessment and Recommendations

Based on the analysis performed by TRC, this project is expected to save 343,474 kWh/yr compared to the existing case, and TRC recommends an incentive of $17,173.70.

TRC recommends 100% of the total calculated incentive to be paid based on this Post-Installation Review (PIR) report as the savings for this project do not warrant additional measurement and verification.

## 9. Additional Attachments

- Appendix A: Energy Savings Calculation
- Appendix B: Utility Bills
- Appendix C: Application
- Appendix D: Invoice

# Appendix A.
# Energy Savings Calculation

# Appendix B.
# Utility Bills

# Appendix C.
# Application

# Appendix D.
# Invoice