

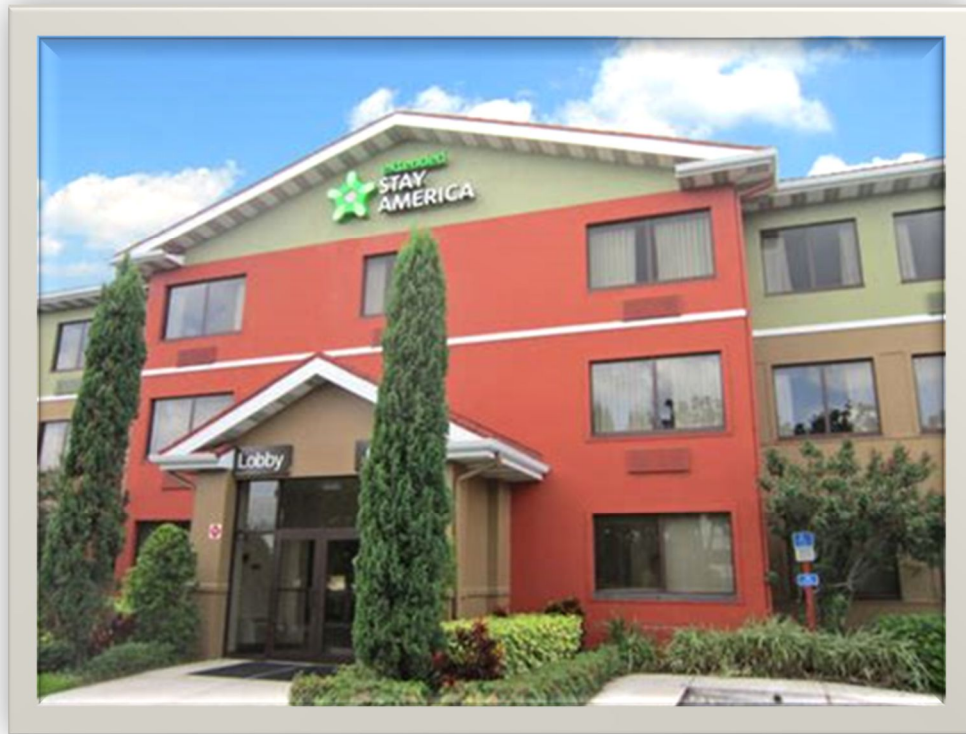
# RPM

Energy Consulting LLC

## PTAC Cleaning Energy Analysis

---

For



**Extended Stay America – Cypress Creek**

**Ft. Lauderdale, FL**

**October 7, 2020**

---

**Extended Stay America  
Cypress Creek, Ft Lauderdale, Florida**

**Evaluation of Hotel Guestroom PTAC cleaning  
on  
PTAC Energy Usage**

By: Robert Mapleton, EE, CEA  
Title: Owner, Engineer  
Company: RPM Energy Consulting LLC  
Date: September 9-10, 2020

## **Extended Stay America – Cypress Creek, Ft Lauderdale**

### **Evaluation of Fibercare Hotel Cleaning Services Cleaning hotel guestroom PTAC units**

The ESA Cypress Creek hotel located at 5851 N. Andrews Avenue Extension in Ft Lauderdale, FL conducted a test on September 9-10, 2020 to determine the effect of cleaning the coils of the hotel's guestroom PTAC units on cooling energy usage. The test was used to determine whether Fibercare PTAC cleaning service results in lower energy costs. The test was performed on four guestrooms cleaned by the Fibercare cleaning inspector. Fibercare cleaned PTAC units for guestrooms 102, 103, 114, and 121.

Measurements were performed to determine the impact on the guestroom PTAC cooling energy usage as a result of cleaning the PTAC unit. The reasoning for the test is that the cleaned PTAC condenser should result in increased supply airflow (CFM) and return air flow that would satisfy the thermostat quicker and thereby reduce energy costs. The test consisted of measuring the amount of time required to satisfy a three degree decrease on the guestroom package terminal air conditioner (PTAC).

#### **Guestroom Fan Coil Unit**

The guestroom HVAC unit is an Amana PTC093G package terminal air conditioner. This is a 310 maximum nominal cfm unit using 785 watts for cooling at 208 volts.

#### **Methodology**

A HOBO data logger, HOBO UX100 External Temp/RH, that uses an external sensor was placed at a location in the middle of the guestroom approximately 10 to 12 feet from the guestroom PTAC unit. The HOBO Logger was held in place by a tripod. The HOBO logger external sensor response time is 3 minutes, 45 seconds in air moving 1 m/s (2.2 mph).

The data logger was programmed to measure the room air temperature every second. The room temperature was monitored while the PTAC operated to satisfy the guestroom PTAC thermostat that was lowered three degrees typically from 73° F to 70°F. Another HOBO data logger, MX1101 wireless Temp/Humidity, was placed either on a table or dresser that was located either ten feet away or three feet away from the guestroom PTAC unit to also measure the temperature drop when the PTAC operated to meet the thermostat setting. The response time for the MX1101 data logger is 7:30 minutes in air moving 1 m/s (2.2 mph). The slower response time for the MX1101 was the reason the logger was placed closer to the PTAC units for the final three PTAC units. The RPM Energy engineer tried to use the identical process for each room during the test. An Extech EN510 10-in-1 Environmental meter anemometer was used to measure the air flow from the PTAC supply register before and after cleaning the PTAC unit.

The test was performed before and after the guestroom PTAC units were cleaned by the Fibercare cleaning inspector. The HOBO data loggers were allowed to stabilize to the room temperature before the PTAC thermostat setpoint was lowered. The HOBO data loggers

measured and recorded the guestroom temperatures while the pre-cleaned and post-cleaned PTAC units were operating. When the PTAC thermostat was satisfied, which turned off the PTAC unit, the HOBO UX100 data logger was allowed to stabilize the logged temperature. The data was then downloaded to a PC or the HOBO MX1101 data logger data was e-mailed to the engineer's PC. After the PTAC pre-clean test was completed the Fibercare cleaning inspector removed the PTAC unit from the wall and cleaned it. The post-cleaning testing for each PTAC unit was done at least a minimum of four hours after cleaning the unit up to overnight before the post-clean test.

**Issues impacting the test and evaluation**

The test had several variables that may have impacted the results. These variables included:

- 1) The HOBO UX100 external temperature sensor was more sensitive to ambient temperature changes therefore it was used for the analysis to determine the cooling energy savings from Fibercare cleaning the PTAC unit.
- 2) Residual moisture on the PTAC coils, after cleaning, may have caused the PTAC unit to run longer to remove the moisture. Two PTAC units operated overnight after cleaning therefore drying out all the moisture completely. One unit set in a guestroom overnight without operating.
- 3) Some of the PTAC units pre-clean and post-clean did not shut off even when the HOBO logger showed that the room temperature dropped three degrees. This required turning up the thermostat in one degree (1°F) intervals for a couple minutes to cause the PTAC unit to turn off.

**ESA Guestroom PTAC pre-clean and post-clean kWh usage and costs**

Room	Pre-clean		Post-clean		Annual savings		
	annual kWh	Cost <sup>1</sup>	annual kWh	Cost	kWh	Cost	Percentage
<b>103</b>	5995	\$ 406.48	2127	\$ 144.22	3868	\$ 262.26	64.52%
<b>114</b>	10761 <sup>2</sup>	\$ 729.62	3142	\$ 213.05	7619	\$ 516.57	70.80%
<b>121</b>	4246	\$ 287.91	1201	\$ 81.39	3046	\$ 206.51	71.73%
<b>102</b>	4817	\$ 326.58	2259	\$ 153.19	2557	\$ 173.39	53.01%
<b>Total</b>	25819	\$ 1750.59	8729	\$ 591.85	17090	\$1,185.74	67.73%

<sup>1</sup> The cooling costs and savings are based on the hotel energy cost of \$0.0678 per kWh.

<sup>2</sup> The kWh usage is high due to the PTAC not shutting off.

### ESA Guestroom PTAC pre-clean and post-clean supply air flow in FPM

Guestroom	Pre-Clean average	Post-Clean average	Air flow increase
103	545	662.6	21.5%
114	467.6	603.0	28.9%
121	458.7	607.3	32.4%
102	673	698.6	3.8%
Average			21.65%

#### Interpretation of Table data

All the guestroom PTAC units showed large improvements after cleaning by Fibercare. **The average for the four guestroom PTAC units is 67.73%.** The benefit is that having clean PTAC units will result in lower energy cost to the facility. **The anemometer readings show an average improvement in air flow of 21.65% from the cleaned PTAC units.** This validates the improvement in °F temperature/time measurements showing that the guestroom will be cooled quicker after cleaning.

Note:

The estimated annual kWh and estimated cost savings is for relative comparison. The proper way to calculate the exact savings is to perform a heat gain analysis and model the operation of the entire hotel which requires more extensive engineering. However, the methodology used in this study proves that a clean PTAC speeds the cooling of the guestroom and reduces the energy to provide cooling to the guestroom.

#### Evaluation

The test data was evaluated to determine the energy savings that would be achieved from having a clean PTAC (Package Terminal Air Conditioner) cleaned by FiberCare. There are two tables that compare the energy usage for the pre-cleaned and post-cleaned guestroom PTAC units. The PTAC rated wattage of 785 watts was used for determining the kWh and cost savings for the PTAC units. The temperature bins method, using the Energy Information Administration CBECS Climate Zone number 5, was used to determine the kWh usage and savings.

The formula for the calculation is as follows:

Energy usage = (PTAC kW \* Time(hours) for °F thermostat drop) / total temperature drop \* BIN hours above 70°F.

Note: To normalize BIN hours to the equivalent full load cooling hours (EFLCH) in Ft Lauderdale the resulting kWh usage from the formula was multiplied by 0.632. Equivalent full load cooling hours in Climate Region 5 (3400 hours) ÷ BIN hours above 70°F (5377 hours) = .632

There are 3400 equivalent full load cooling hours in the Ft. Lauderdale area (Climate Zone 5). The idea is that as the outside temperature increases the temperature in the room will increase resulting in the PTAC unit turning on. A cleaner PTAC coil with improved air flow and colder temperatures will cool the room faster, satisfy the thermostat set point faster and turn off the PTAC using less kWh energy. What is not taken into consideration are the internal heat gains from people and equipment that will also cause the PTAC to turn on more often.

Temperature BIN hours for EIA CBECS Climate Zone 5

Temperature BIN (°F)	Hours
90 - 95	157
85 - 90	778
80 - 85	1523
75 - 80	1780
70 - 75	1139
Total	5377

# Data Tables for Extended Stay America- Cypress Creek

## Guestroom PTAC unit testing

Extended Stay America - Cypress Creek  
Guestroom 103

Room 103 was tested twice for thermostat setpoint satisfaction. The first time was the pre-clean measurement. The second time was the Fibercare post-clean measurement. The HOBO UX100 External Temp/RH data logger was stabilized to the room temperature. The data logger was located twelve feet from the PTAC unit. The PTAC thermostat was started at 73 °F and was lowered to 70 °F

HOBO data logger temperatures/ Time to satisfy the thermostat

Pre-Clean data	Begin	End	Difference	Hours	Degree/minute
Date/Start/End time	9/9/20 6:19:16pm	9/9/20 7:00:57pm	41'-41"	.695	
HOBO logger temp (°F)	72.307	69.294	3.013		.0723

kW	time (hrs)	kwh	degrees	kwh/degree
0.785	0.695	0.545357	3.013	0.1810

Post Clean data	Begin	End	Difference	Hours	Degrees/minute
Date/Start/End time	9/10/20 9:31:38pm	9/10/20 9:50:46pm	19'-08"	.319	
HOBO logger temp (°F)	72.307	69.294	3.898		.181

kW	time (hrs)	kwh	degrees	kwh/degree
0.785	0.319	0.2503	3.898	0.0642

**Guestroom 103 PTAC supply Anemometer readings  
Air Speed in Feet Per Minute (FPM)**

Condition	Left side	Middle	Right	Average
Pre-clean	813	417	405	545.0
Post-clean	724	576	688	662.6
				<b>21.5% increase</b>



Extended Stay America - Cypress Creek  
Guestroom 114

Room 114 was tested twice for thermostat setpoint satisfaction. The first time was the pre-clean measurement. The second time was the Fibercare post-clean measurement. The HOBO UX100 External Temp/RH data logger was stabilized to the room temperature. The data logger was located 8'-8" from the PTAC unit. The PTAC thermostat was started at 73 °F and was lowered to 70 °F

HOBO data logger temperatures/ Time to satisfy the thermostat

<b>Pre-Clean data</b>	Begin	End	Difference	Hours	Degree/minute
Date/Start/End time	9/9/20 1:51:56pm	9/10/20 2:38:55pm	46'-59"	.783	
HOBO logger temp (°F)	75.202	73.31	1.892		.0403

<b>Post-Clean data</b>	Begin	End	Difference	Hours	Degree/minute
Date/Start/End time	9/10/20 8:30:27pm	9/10/20 8:48:56pm	18'-29"	.308	
HOBO logger temp (°F)	70.299	67.75	2.549		.138

**Guestroom 114 PTAC supply Anemometer readings  
Air Speed in Feet Per Minute (FPM)**

Condition	Left side	Middle	Right	Average
Pre-clean	429	419	555	467.6
Post-clean	588	588	633	603.0
				<b>28.9% increase</b>

Guestroom 114 PTAC unit did not shutoff for the pre-clean test. The unit cycled on and off for four and five minute periods. There were also times where the fan cycled on and off for a two minute period without the compressor running. The post clean PTAC shut off when the thermostat was satisfied.

Extended Stay America - Cypress Creek  
Guestroom 121

Room 121 was tested twice for thermostat setpoint satisfaction. The first time was the pre-clean measurement. The second time was the Fibercare post-clean measurement. The HOBO UX100 External Temp/RH data logger was stabilized to the room temperature. The data logger was located 8'-8" from the PTAC unit. The PTAC thermostat was started at 70 °F and was lowered to 67 °F

HOBO data logger temperatures/ Time to satisfy the thermostat

<b>Pre-Clean data</b>	Begin	End	Difference	Hours	Degree/minute
Date/Start/End time	9/9/20 7:24:00pm	9/10/20 7:52:45pm	28'-45"	.479	
HOBO logger temp (°F)	73.233	70.299	2.934		.102

<b>kW</b>	<b>time (hrs)</b>	<b>kwh</b>	<b>degrees</b>	<b>kwh/degree</b>
0.785	0.479	0.376	2.934	0.1282

<b>Post-Clean data</b>	Begin	End	Difference	Hours	Degree/minute
Date/Start/End time	9/10/20 10:15:55 am	9/10/20 10:26:11 am	10'-16"	.171	
HOBO logger temp (°F)	71.843	68.137	3.706		.361

<b>kW</b>	<b>time (hrs)</b>	<b>kwh</b>	<b>degrees</b>	<b>kwh/degree</b>
0.785	0.171	0.134	3.706	0.0362

**Guestroom 121 PTAC supply Anemometer readings  
Air Speed in Feet Per Minute (FPM)**

Condition	Left side	Middle	Right	Average
Pre-clean	555	440	381	458.7
Post-clean	600	622	600	607.3
				<b>32.4% increase</b>

Guestroom 121 PTAC unit did not shut off for the pre-clean test. The ending time stamp was chosen to be when the temperature flattened out and the relative humidity was at its lowest at 7:53:55 pm. The post clean PTAC unit did not shut off. The ending time stamp was chosen to be when the temperature flattened out at 10:26:11 am.

Extended Stay America - Cypress Creek  
Guestroom 102

Room 102 was tested twice for thermostat setpoint satisfaction. The first time was the pre-clean measurement. The second time was the Fibercare post-clean measurement. The HOBO UX100 External Temp/RH data logger was stabilized to the room temperature. The data logger was located 10 feet from the PTAC unit. The PTAC thermostat was started at 70 °F and was lowered to 67 °F

HOBO data logger temperatures/ Time to satisfy the thermostat

<b>Pre-Clean data</b>	Begin	End	Difference	Hours	Degree/minute
Date/Start/End time	9/9/20 12:46:00 pm	9/9/20 1:00:35 pm	14'-35"	.243	
HOBO logger temp (°F)	71.303	69.991	1.312		.090

<b>kW</b>	<b>time (hrs)</b>	<b>kwh</b>	<b>degrees</b>	<b>kwh/degree</b>
0.785	.243	.1908	1.312	.1454

<b>Post-Clean data</b>	Begin	End	Difference	Hours	Degree/minute
Date/Start/End time	9/9/20 4:59:16 pm	9/9/20 5:04:06 pm	4'-50"	.081	
HOBO logger temp (°F)	71.458	70.491	.967		.200

<b>kW</b>	<b>time (hrs)</b>	<b>kwh</b>	<b>degrees</b>	<b>kwh/degree</b>
0.785	.081	.06324	.967	.0682

Guestroom 102 PTAC unit operated in an abnormal way in the pre-clean test. The unit cycled on and off for five to seven minute periods. There were also times where the fan cycled on and off for a two minute period without the compressor running. The pre-clean temperatures charted abnormally where the temperature went higher each time from its lower temperature at 1:00 pm. The post clean PTAC cycled properly with: fan on first, compressor on, fan off, compressor off. The post-clean temperature went lower each time the PTAC cycled through its operation.

**Guestroom 102 PTAC supply Anemometer readings  
Air Speed in Feet Per Minute (FPM)**

Condition	Left side	Middle	Right	Average
Pre-clean	643	633	743	673.0
Post-clean	667	672	757	698.6
				<b>3.8% increase</b>

## Appendix for Calculations

### Extended Stay America - Cypress Creek Guestroom 103

Sample calculation using Guestroom 103 to show how the kWh savings are arrived at using the measured data and temperature BIN for Climate Zone 5.

<b>Pre-clean PTAC</b>				
41:41:00 Time in minutes/seconds to meet 3°F PTAC reduction				
<b>kW<sup>1</sup></b>	<b>time (hours)<sup>2</sup></b>	<b>kwh<sup>3</sup></b>	<b>Degrees<sup>4</sup></b>	<b>kwh/degree<sup>5</sup></b>
0.785	0.695	0.545	3.013	0.1810

- 1) .785 kW PTAC power rating
- 2) Time in hours =  $(41+41/60)/60 = .695$
- 3) kWh = kW \* Time (hours) =  $.785 * .695$
- 4) Degrees are the reduction from HOBO logger measurement for PTAC operation
- 5) kWh/Degrees =  $.545/3.013 = .181$

DB Temp BINs <sup>1</sup>	Hours <sup>2</sup>	Total BIN hours above 70°F	Cooling equivalent full load hours (EFLH)	EFLH / Total BIN hours <sup>3</sup>
92.5	157	5377	3400	63.23%
87.5	778			
82.5	1523			
77.5	1780			
72.5	1139			
67.5	1190			

- 1) CBECS temp bins for Climate Zone 5
- 2) Number of hours in each temperature BIN
- 3) EFLH/BIN hours =  $3400 / 5377 = .6323$

**PTAC pre-clean calculation of cooling season kWhs and cost**

Temp Diff <sup>1</sup>	kWh <sup>2</sup>	kWh <sup>3</sup>
22.5	4.07	639
17.5	3.17	2464
12.5	2.26	3446
7.5	1.36	2416
2.5	0.45	515
	11.31	9481.3
0.6323		5995 <sup>4</sup>
		\$0.0678 <sup>5</sup>
		<b>\$406.48<sup>6</sup></b>

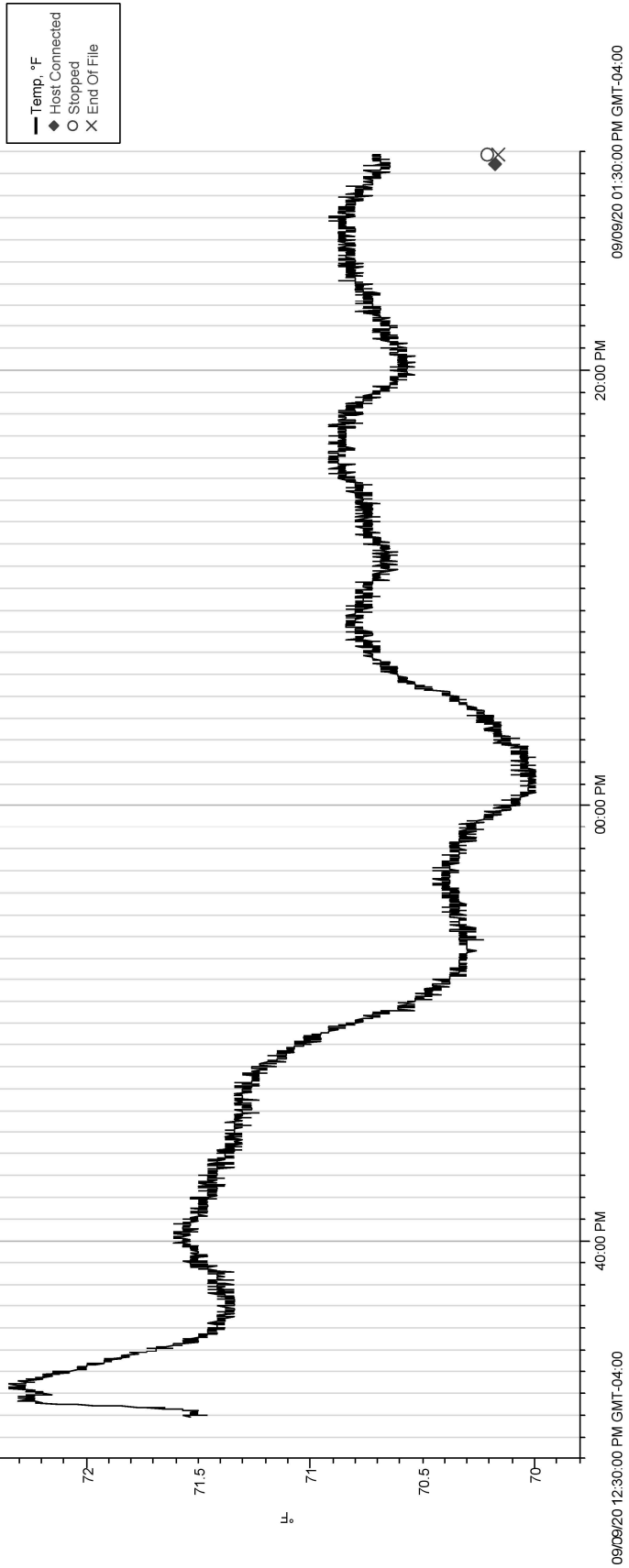
- 1) Temperature difference between temperature BIN and 70°F
- 2) kWh/degree \* temp difference =  $.181 * 22.5 = 4.07$  kWh
- 3) hour in Temp BIN \* kWh =  $157 * 4.07 = 639$  kWh
- 4) Normalize BIN kWh to cooling EFLH =  $.6323 * 9481.3 = 5995$  kWh
- 5) Hotel average electric cost per kWh
- 6) Cost to operate PTAC unit for cooling season.

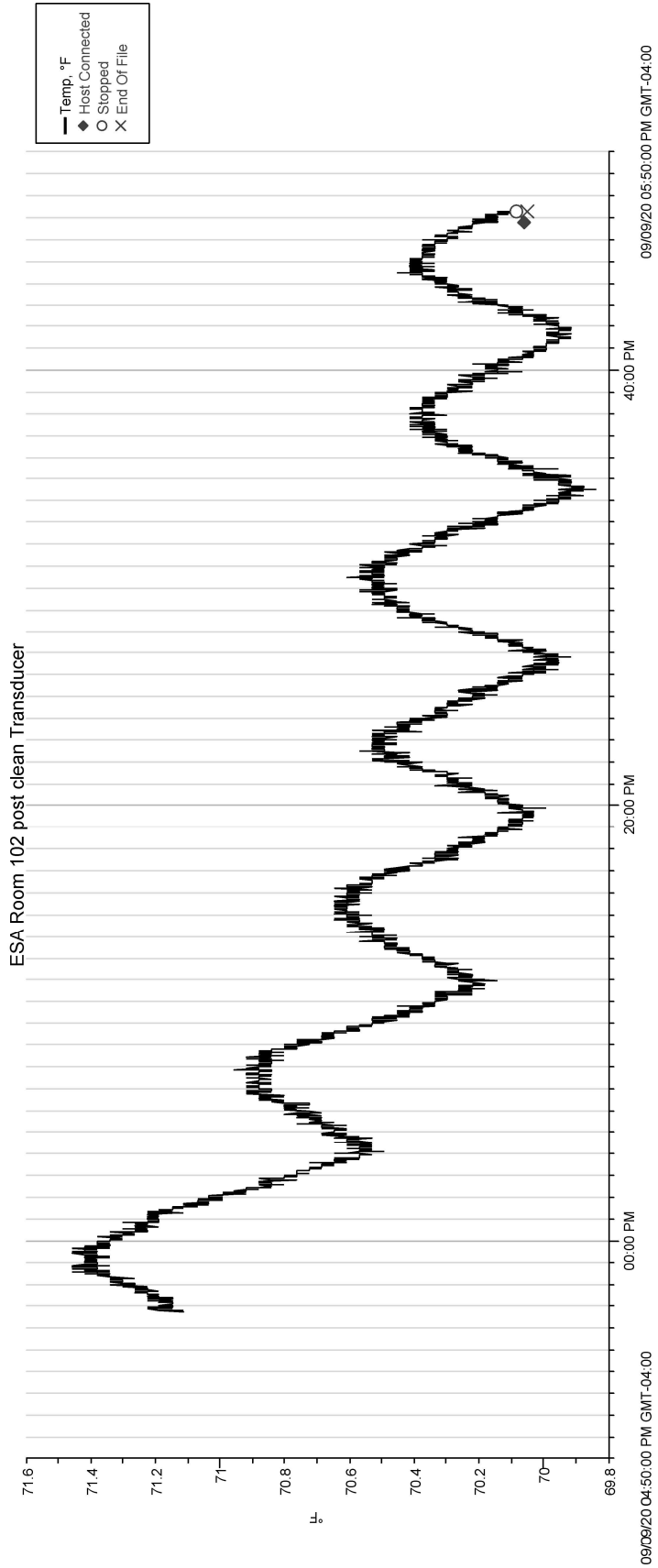
The same methodology is used for the PTAC post-clean data. The savings is the difference between the pre-clean cost and the post clean cost for each guestroom PTAC units for Rooms 102, 103, 114, 121.

Extended Stay America Cypress Creek  
Ft Lauderdale, Florida

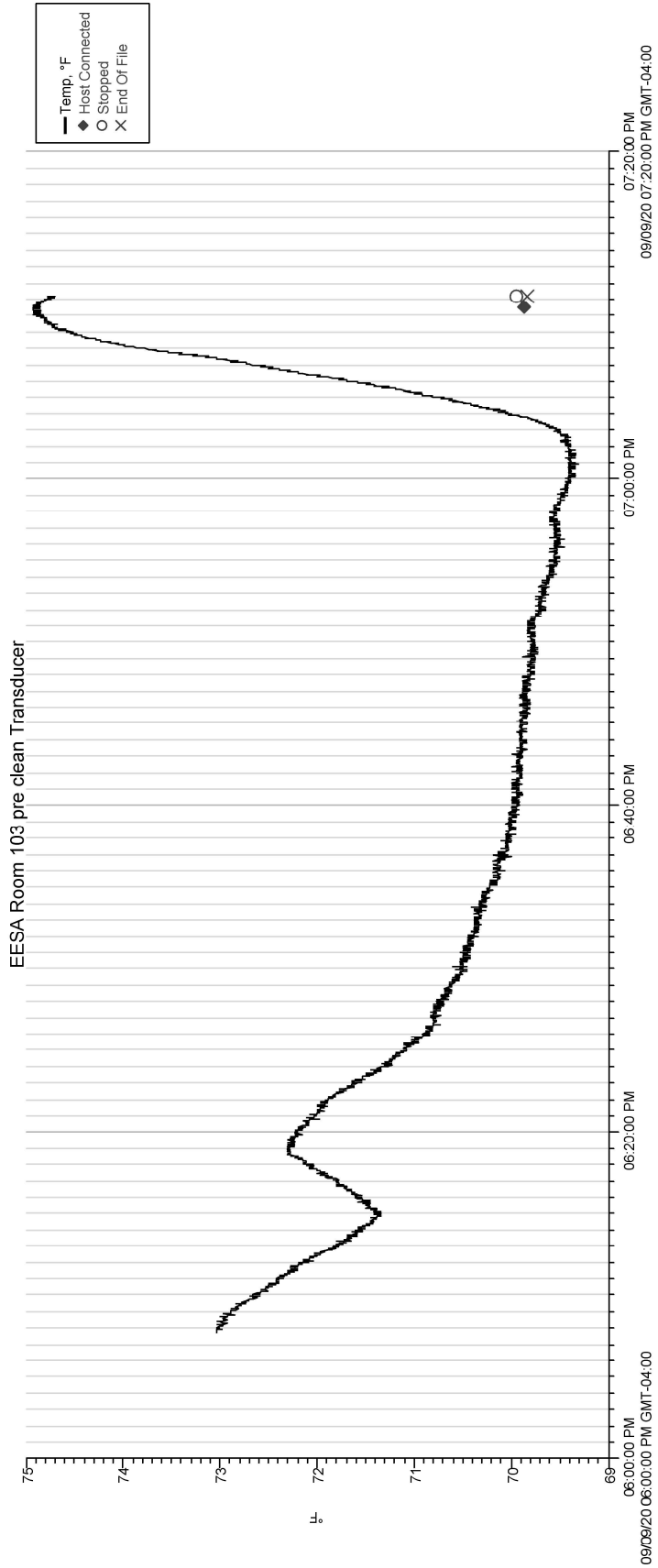
HOBO Plotted Datafiles

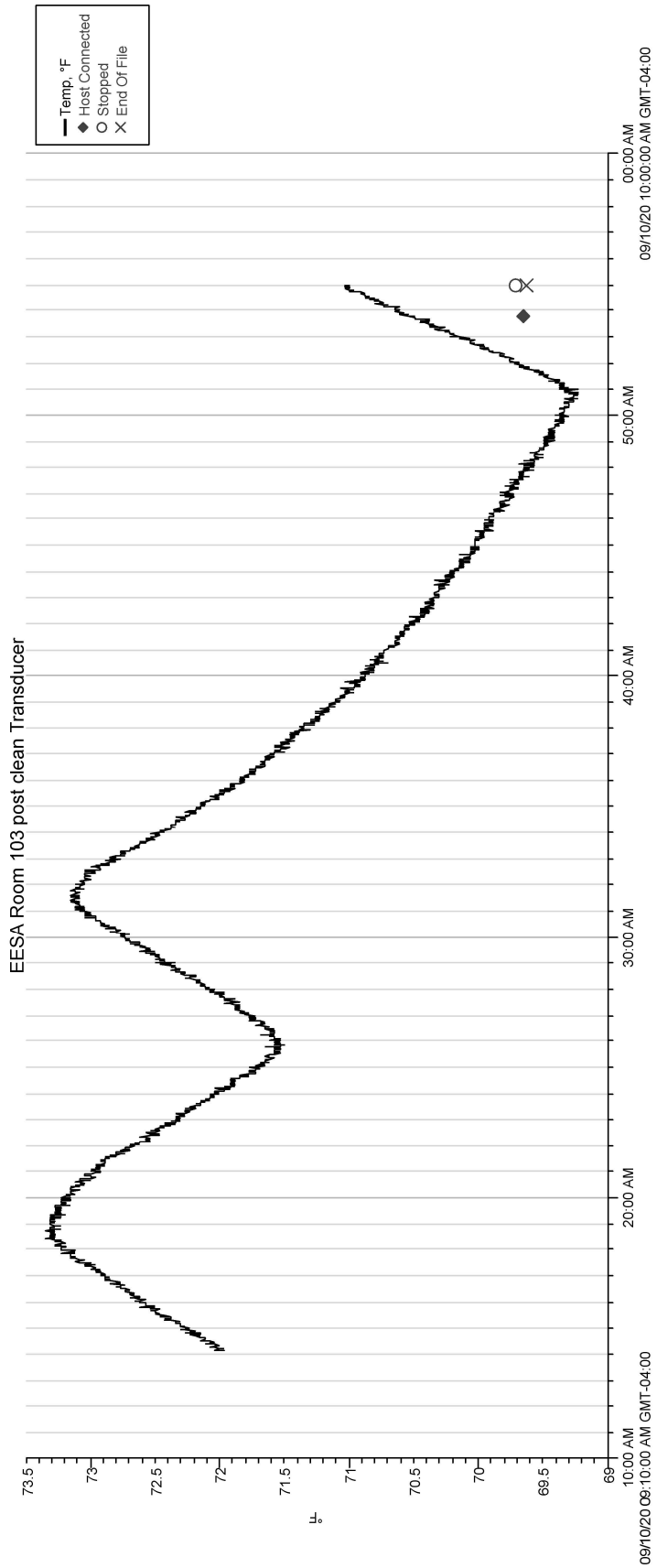
ESA Room 102 Transducer



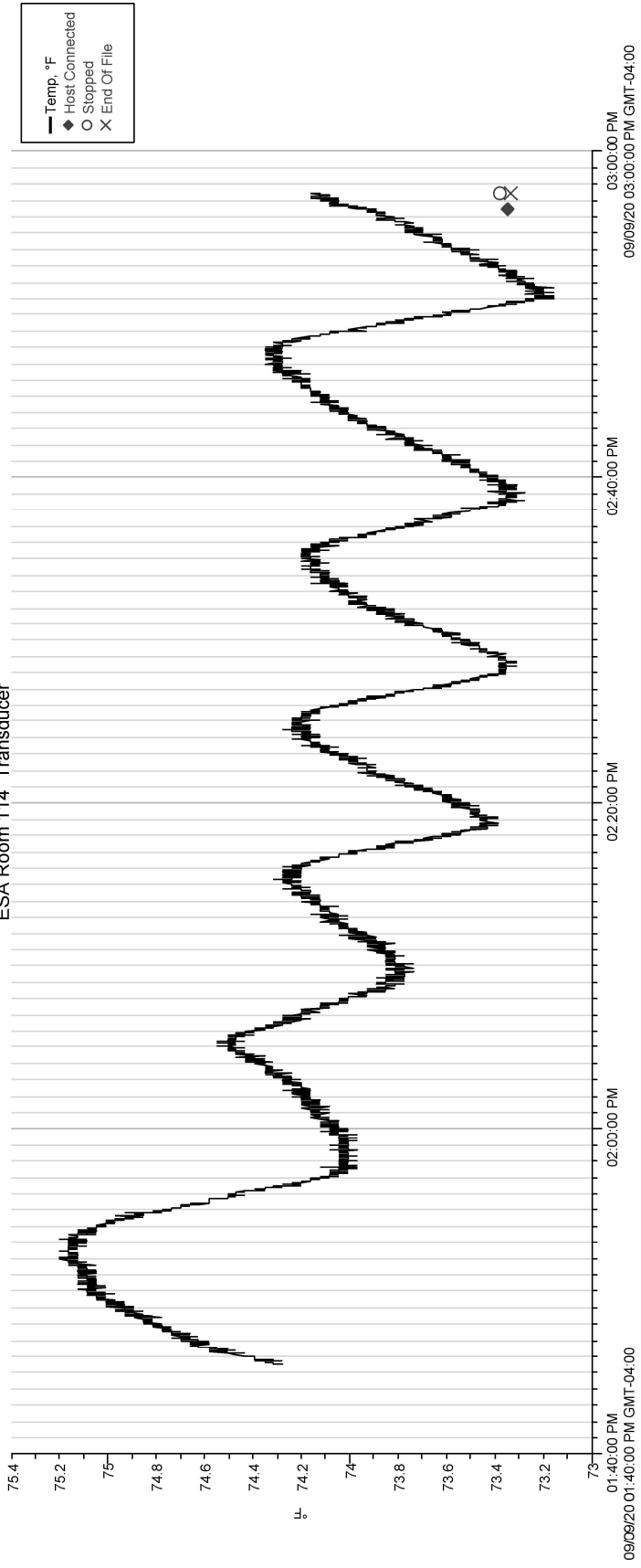


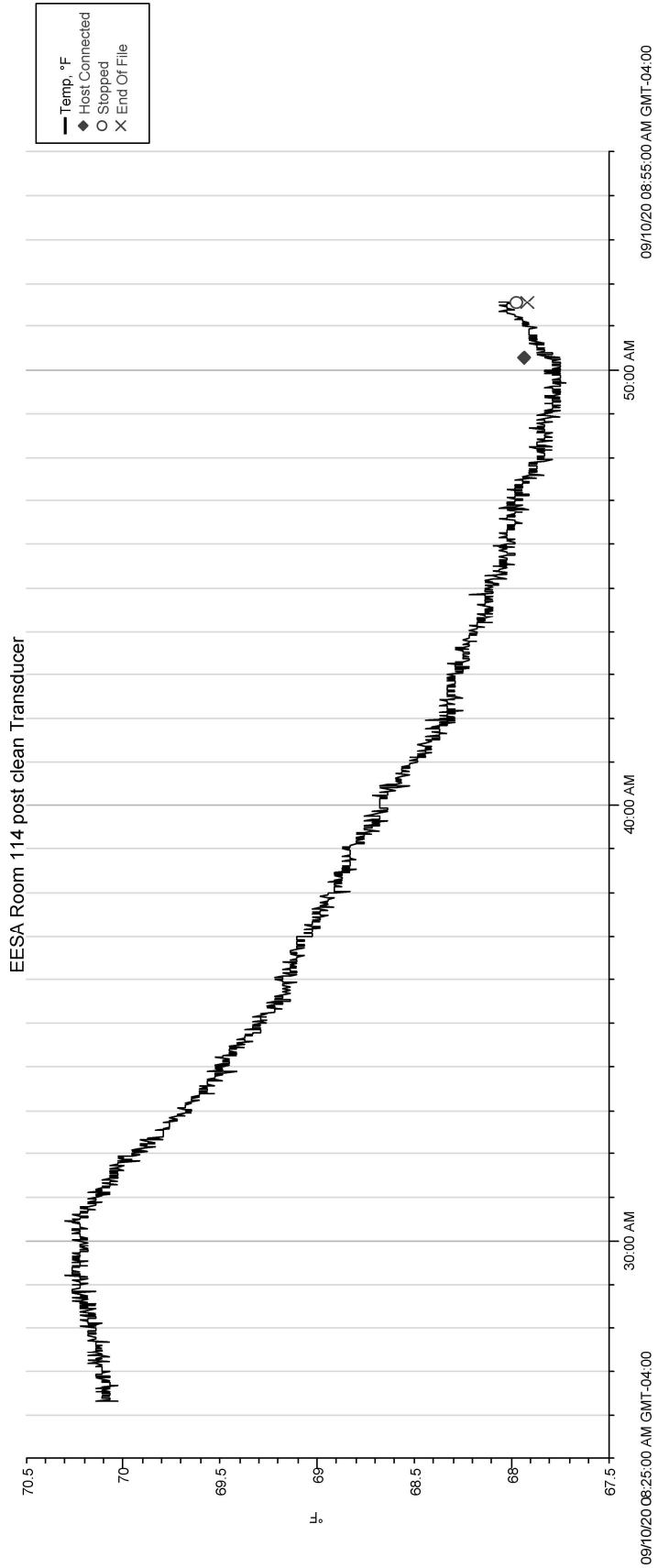


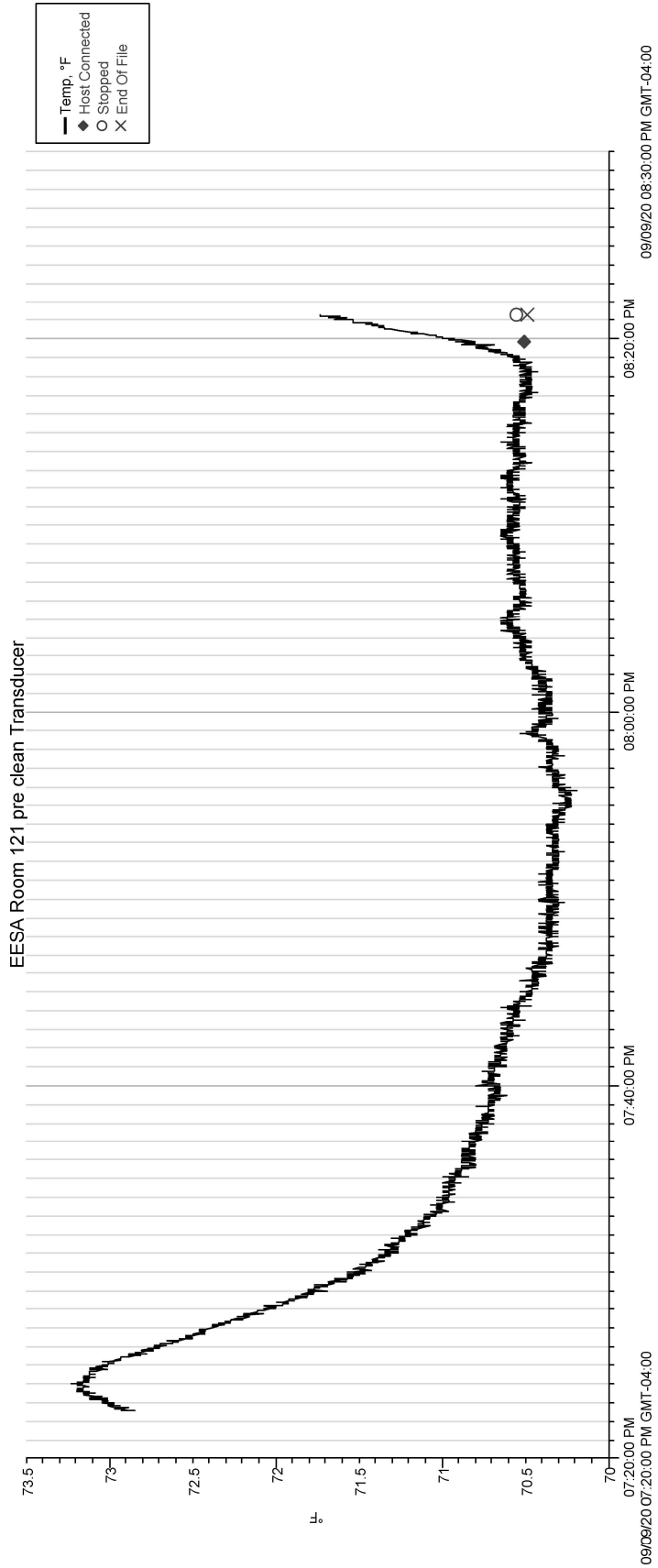


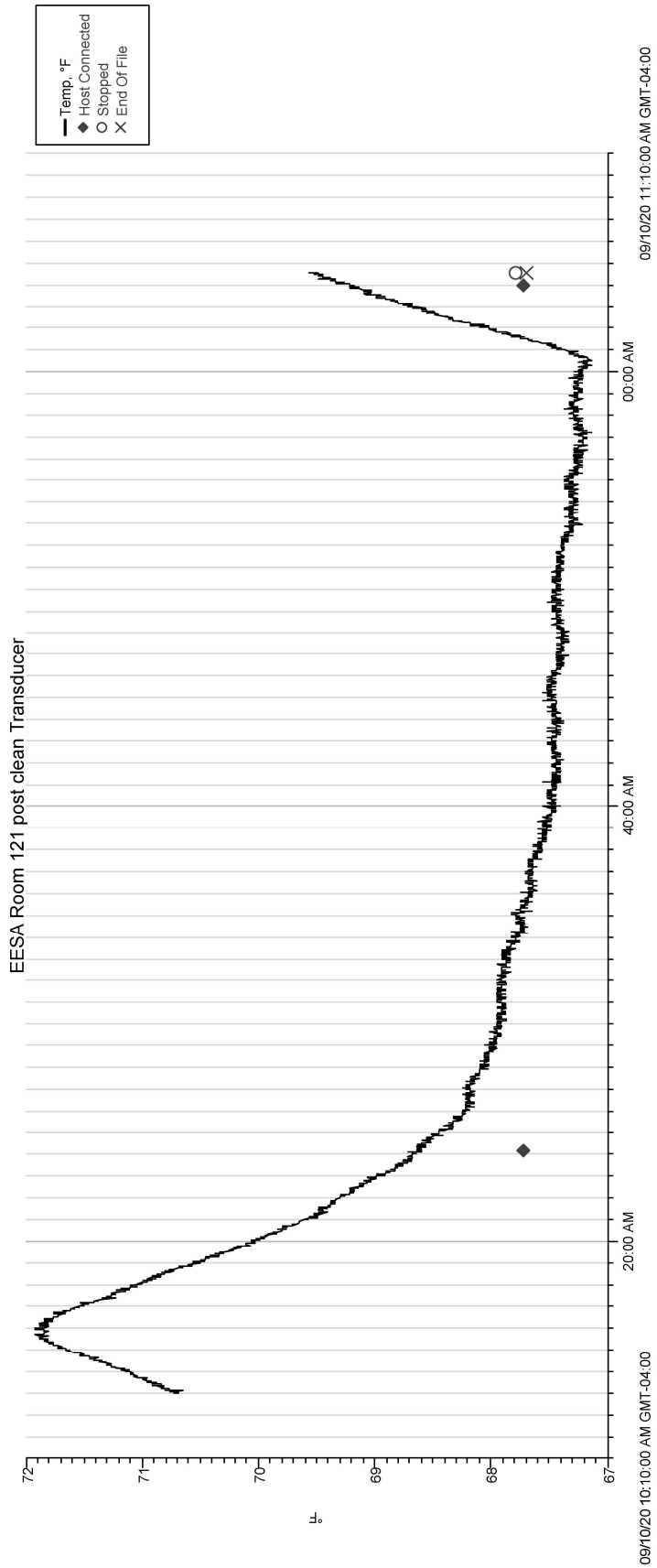


ESA Room 114 Transducer









## Robert P Mapleton

Mr. Mapleton is a 1978 graduate engineer with a Bachelor of Science in Electrical Engineering from Pennsylvania State University, State College, Pennsylvania. Mr. Mapleton was employed as an electrical engineer for 21-1/2 years at First Energy Corp – Pennsylvania Power Company and over 14 years as a senior electrical engineer at the Eric Ryan Corporation in Ellwood City, PA. Mr. Mapleton started his own business, RPM Energy Consulting LLC, in October 2014. Mr. Mapleton is a Certified Energy Auditor.

Mr. Mapleton's experiences include conducting site visits for ASHRAE 2nd and 3rd level energy audits and present audit report for clients in the Hospitality, Healthcare, Educational, Retail, Municipal and Manufacturing markets. Research and recommend energy efficient equipment and alternative fuels and energy systems (solar, wind, co-generation, distributive generation) to produce energy costs savings for clients. Conduct site visits for determining sales tax exemption for qualified clients and prepare supporting documentation for refund petition. Analyze, design, engineer and install power factor correction equipment to reduce client electric penalties. Executed load profiling services for national and regional clients. Perform electric and natural gas procurement services.