AABC Commissioning Group

AIA Provider Number 50111116

GSA Project Nets $48 Million Savings: A Case Study

Course Number: CXENERGY1715

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Course Description

The GSA needed to replace aging building systems and regulate energy use in its Southern California portfolio. By utilizing an energy savings performance contract that leveraged future savings for financing this comprehensive energy retrofit, GSA expects to reduce energy consumption by over 50%, yielding more than $50 million in savings to taxpayers.

Learning Objectives

At the end of the this course, participants will be able to:

1. Understand how leveraging performance contracting with capital improvement dollars can create a deep energy retrofit.

2. Learn how to take feedback from building operators to guide energy retrofit solutions.

3. Utilize the power of interval data to quantify actual building operating parameters.

4. Learn how IoT is changing how Measurement and Verification are performed… Monitoring based commissioning!

Owner’s Project Requirements

Driver:

1. Decouple and upgrade central chiller plant serving 300 NLA and Roybal Buildings
2. Leverage fast payback ECMs to offset cost of new chiller plant
3. Attempt Deep Energy Retrofit

Timeline:

2011 Design completed for chiller plant upgrade at GSA’s request
2012 Bridge from Design, Spec, Bid to Energy Savings Performance Contract
2013 RFP Process for ESPC
2014 Start construction on Phase 1
2015 Finish Phase 1 Construction, start construction on Phase 2A
2017 Finish Phase 2A Construction, start construction on Phase 2B

What is a Deep Energy Retrofit?

In August 2011, the General Services Administration (GSA) launched the National Deep Energy Retrofit Program to demonstrate deep energy savings delivered through energy savings performance contracts (ESPCs). Aggressive program objectives include:

- Move federal facilities towards net zero energy consumption
- Reduce water consumption at federal facilities
- Implement cost-effective retrofits with payback periods of 25 years or less
- Complete associated construction work without major tenant disruption
- Use innovative technologies
- Use renewable energy technologies
- Use comprehensive and integrated whole building approaches to determine ECMs

Source: http://www.rmi.org/gsaretrofits

GSA LA ESPC – The Buildings

North LA

Glenn Anderson

Ronald Reagan

Roybal

Social Security

Energy Baseline

Building / Facility	Building SF	Elec Usage (kWh/yr)	Elec Cost ($/yr)	Nat'l Gas (MMBtu/yr)	Gas Cost ($/yr)	Water Use (kGal/yr)	Water Cost ($/yr)
NLA	1,057,130	10,606,916	$1,697,653	18,788	$105,593	20,857	$216,589
Roybal	1,296,873	12,782,644	$2,045,882				
Reagan	601,475	5,119,653	$703,132	1,888	$12,962	2,994	$13,982
Anderson	306,255	2,221,639	$306,330	7,452	$40,849	2,506	$9,648
Social Security	26,880	324,465	$43,461	223	$1,937		

Buildings average $1.58/SF based on these bills
Total spend is $5,198,017 per year

- *300 NLA has an additional 281,599 kWh of roof mounted PV*
- *300 NLA central boiler plant feeds both Roybal and 300 NLA*
- *Anderson Gas Bill includes 6,511 MMBtu to CoGen installed on roof*
- *Anderson CoGen created 502,723 kWh and 126,280 tons of cooling running 1,804 hours in the baseline year*

Phase 1 ECMs

Building	Measure	Description
Glen Anderson	LB-1	VFD for Primary CHW Pumps
Glen Anderson	LB-2	Cooling Tower VFDs
Ronald Reagan	RG-4	VFDs on CWPs
Ronald Reagan	RG-1	Parking Deck CO Control
Ronald Reagan	RG-2	Water Side Economizer
Roybal	NLA-1	Chiller Plant and Associated Controls
Roybal	NLA-1	Install VFD on Chillers
300 NLA	NLA-2	Demand Control Ventilation
Social Security Building	HP-2	DHW Heaters
Social Security Building	HP-3	Temperature Setback
Ronald Reagan	RG-ALT	Cooling Tower VFD - Alt

Phase 1, Year 1 results

ECM	Contracted Cost Saving	Expected Cost Savings	Difference (Positive means more savings than expected, Negative means savings shortfall)	Percent Difference in Savings (Positive means more savings than expected, Negative means savings shortfall)
NLA-1	$531,607	$587,276	$55,669	10%
NLA-2	$7,550	Not Determined	Not measured	Not measured
LB-1	$10,023	$805	($9,218)	-92%
LB-2	$9,691	$1,734	($7,957)	-82%
RG-1	$9,051	$8,792	($259)	-3%
RG-2	$6,862	Not Determined	Not measured	Not measured
RG-4	$32,341	$13,750	($18,591)	-57%
RG-ALT	$10,722	$8,419	($2,303)	-21%
HP-2	$1,459	$592	($867)	-59%
HP-3	$2,026	$765	($1,261)	-62%
Total savings	$621,332	$622,133	$801	0%

What did Phase 1 teach us?

- No ECM will achieve savings reality without working controls
- We need more granular data to focus on actionable ECMs
- We must data log, trend, and measure key plant variables
- We must have an open discussion about O&M with GSA
- We need to look outside the box for deep energy retrofit ECMs
- Commissioning is key
- Monitoring based commissioning is the only way to ensure success!

Phase 2 becomes 2A and 2B

- Interval data shows us what is really going on
- Need more time to investigate contract possibilities
- Need more time for new technology ECMs like battery storage
- Apply savings overages to fund other building needs (DHW)

Phase 2A ECMs
Glenn Anderson Federal Building – Long Beach, CA

ECM	Annual Cost Savings ($)	SPB
Anderson ECM 02.01 Chiller Replacements	$ 75,964	13.70
Anderson ECM 02.02 Motorized Isolation Valves for Cooling Towers	$ 8,017	17.08
Anderson ECM 03.02 DDC Retrofit	$ 1,652	964.22
Anderson ECM 05.00 Lighting Retrofit and Controls Upgrades	$ 39,739	6.45
Anderson ECM 12.01 Electric Transformer Upgrade	$ 15,090	10.54
Anderson ECM 13.02 Low Flow Plumbing Equipment	$ 2,463	5.83
Anderson ECM 17.01 Monitoring Based Commissioning	$ 371	
Anderson ECM 17.10 Retrocommissioning	$ 7,360	1.08
Anderson ECM 20.01 Dyson Hand Driers	$ 9,050	5.24

Phase 2A ECMs
300 NLA Federal Building – Los Angeles, CA

ECM	Annual Cost Savings ($)	SPB
NLA ECM 02.01 Low Load Chiller	$ 43,860	17.74
NLA ECM 02.02 Motorized Isolation Valves for Cooling Towers	$ 3,720	110.04
NLA ECM 02.03 Centrifugal Separators	$ 26,573	21.55
NLA ECM 03.02 Replace Controls with Tridium	$ 15,114	96.00
NLA ECM 04.02 Pressure Independent Control Valves	$ 66,719	6.17
NLA ECM 04.03 Demand Controlled Ventilation	$ 109,573	11.05
NLA ECM 04.06 Fan Wall Retrofit	$ 119,657	24.47
NLA ECM 04.10 Replace Cooling Coils	$ 25,632	18.15
NLA ECM 05.00 Lighting Retrofit and Controls Upgrades	$ 407,445	10.09
NLA ECM 06.04 Reflective Solar Window Tinting	$ 32,225	12.91
NLA ECM 12.01 Electric Transformer Upgrade	$ 58,563	9.48
NLA ECM 13.02 Low Flow Plumbing Equipment	$ 42,728	6.98
NLA ECM 14.01 Phase Change Thermal System	$ 2,223	187.20
NLA ECM 17.01 Monitoring Based Commissioning	$ 2,051	
NLA ECM 17.10 Retrocommissioning	$ 93,008	0.53
NLA ECM 20.01 Dyson Hand Driers	$ 27,868	6.58

Phase 2A ECMs
Ronald Reagan Federal Building – Santa Ana, CA

ECM	Annual Cost Savings ($)	SPB
Reagan ECM 02.01 Low Load Chiller	$ 35,733	21.00
Reagan ECM 02.02 Motorized Isolation Valves for Cooling Towers	$ 5,035	29.71
Reagan ECM 03.02 DDC Retrofit	$ 2,406	936.57
Reagan ECM 04.02 Pressure Independent Control Valves	$ 27,096	11.68
Reagan ECM 05.00 Lighting Retrofit and Controls Upgrades	$ 180,569	10.83
Reagan ECM 06.02 Building Envelope Weatherization	$ 4,012	2.70
Reagan ECM 08.01 Premium Efficiency Motors - CWP	$ 1,662	36.97
Reagan ECM 12.01 Electric Transformer Upgrade	$ 33,567	9.37
Reagan ECM 13.02 Low Flow Plumbing Equipment	$ 3,700	12.12
Reagan ECM 17.01 Monitoring Based Commissioning	$ 689	
Reagan ECM 17.10 Retrocommissioning	$ 27,925	0.18
Reagan ECM 20.01 Dyson Hand Driers	$ 7,873	12.51

Phase 2A ECMs
Roybal Federal Building and USCH – Los Angeles, CA

ECM	Annual Cost Savings ($)	SPB
Roybal ECM 02.01 Low Load Chiller	$ 43,003	21.93
Roybal ECM 03.02 DDC Retrofit	$ 6,258	286.55
Roybal ECM 04.02 Pressure Independent Control Valves	$ 13,339	34.03
Roybal ECM 05.00 Lighting Retrofit and Controls Upgrades	$ 255,394	12.43
Roybal ECM 08.01 Premium Efficiency Motors - AHUs	$ 12,113	25.94
Roybal ECM 08.02 VFD Replacement	$ 1,573	424.75
Roybal ECM 12.01 Electric Transformer Upgrade	$ 33,450	7.69
Roybal ECM 14.01 Phase Change Thermal System	$ 1,314	187.15
Roybal ECM 17.01 Monitoring Based Commissioning	$ 401	
Roybal ECM 17.10 Retrocommissioning	$ 88,281	0.07
Roybal ECM 20.01 Dyson Hand Driers	$ 30,126	6.09

Phase 2A ECMs
Social Security Building – Huntington Park, CA

ECM	Annual Cost Savings ($)	SPB
Social Security ECM 04.01 RTU Replacement	$ 12,716	17.72
Social Security ECM 06.04 Reflective Solar Window Tinting	$ 401	26.70
Social Security ECM 13.02 Low Flow Plumbing Equipment	$ 2,327	2.36
Social Security ECM 17.01 Monitoring Based Commissioning	$ 215	
Social Security ECM 20.01 Dyson Hand Driers	$ 1,172	5.38

Expected Utility Savings from ESPC

2013 Baseline =	**$5,198,017**	
Phase 1 Savings =	$ 620,165	12%
Phase 2A Savings =	$1,855,957	36%
Phase 2B Savings =	$ 476,022	9%
Total Savings =	**$2,952,144**	**57%**

Chiller Plant Performance Roybal and 300 NLA

GSA-stipulated Baseline for Roybal/300 NLA Chiller Plant

Average Tons	2500
Plant Efficiency	1.05 kW/ton
Total ton-hours	7,960,000
Annual Chiller Plant kWh	8,358,000

Snapshot of Post Phase 1 Actual Baseline for Roybal/300 NLA Chiller Plants

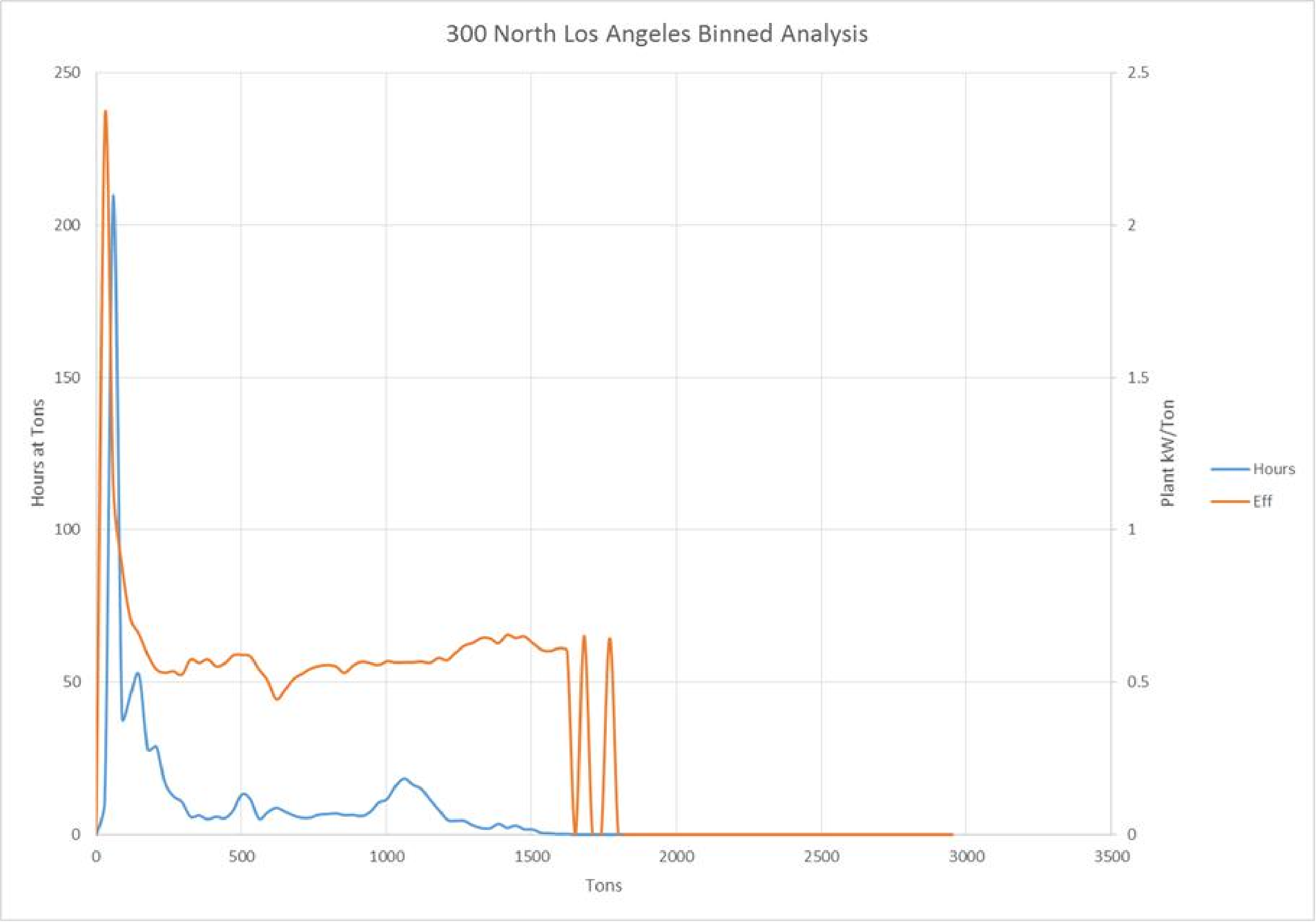
Building	Ton-hours	kWh	kW/ton
300 NLA	708,044	407,600	0.576
Roybal	708,044	368,567	0.521

Chiller Plant Changes at 300 NLA

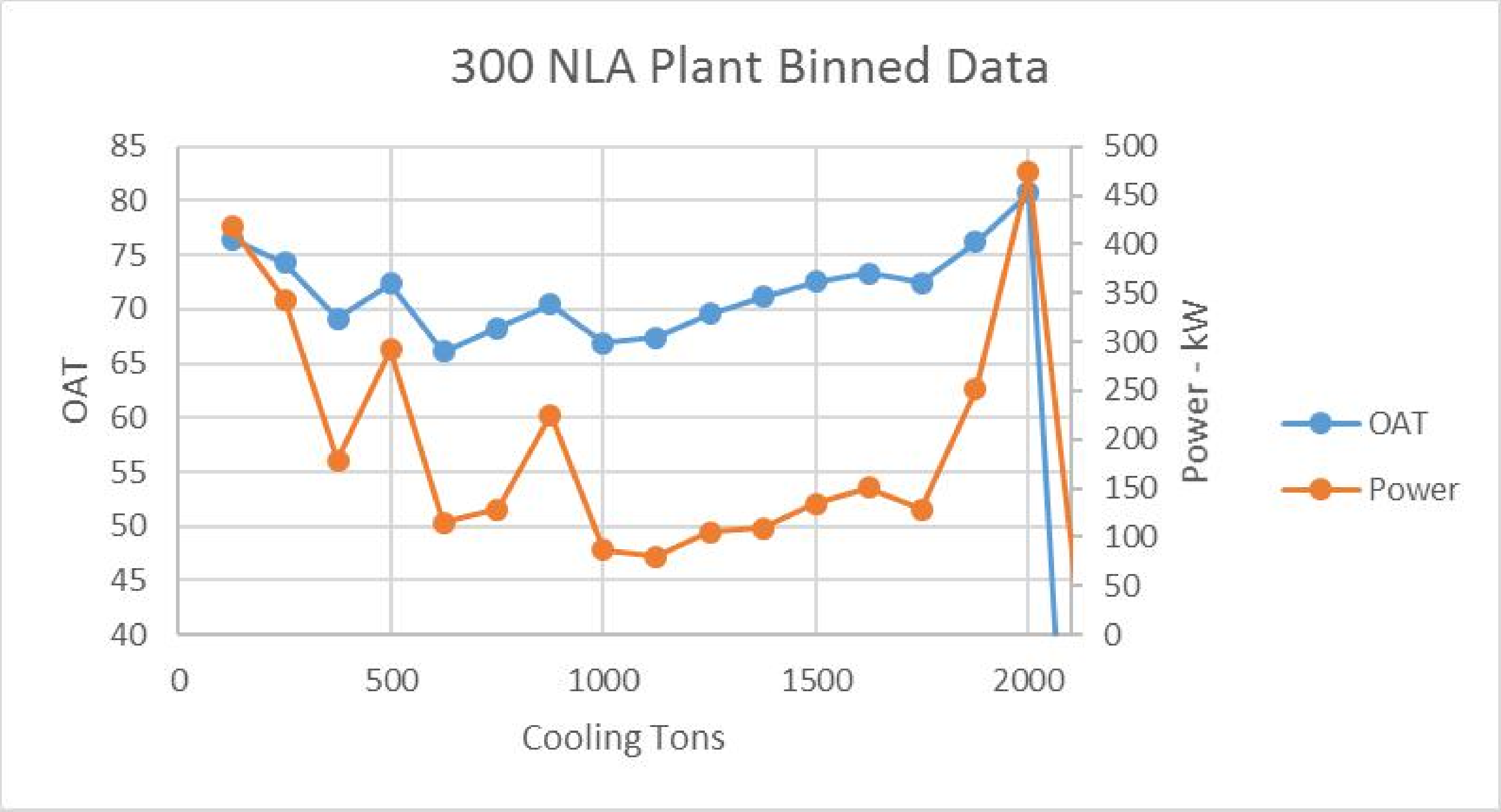
Unit ID	Serves	Make	Total Capacity (tons)	Chiller Type	Condenser Type	Speed Control	Scope	Phase
CH-1	300 NLA and Roybal	Trane	1600	Centrifugal	Water-Cooled	Constant	To Remain	Phase 1
CH-2	300 NLA and Roybal	Trane	900	Centrifugal	Water-Cooled	Constant	To Remain	Phase 1
CH-3	300 NLA and Roybal	Trane	450	Centrifugal	Water-Cooled	Constant	To Remain	Phase 1
CH-4	300 NLA and Roybal	York	900	Centrifugal	Water-Cooled	Constant	Demo	Phase 1
CH-5	300 NLA and Roybal	York	900	Centrifugal	Water-cooled	Constant	Demo	Phase 1
Unit ID	**Serves**	**Make**	**Total Capacity (tons)**	**Chiller Type**	**Condenser Type**	**Speed Control**	**Scope**	**Phase**
CH-1	300 NLA	Trane	1600	Centrifugal	Water-Cooled	Variable	Retrofit VFD	Phase 1
CH-2	300 NLA	Trane	900	Centrifugal	Water-Cooled	Variable	Retrofit VFD	Phase 1
CH-3	300 NLA	Trane	450	Centrifugal	Water-Cooled	Variable	Retrofit VFD	Phase 1
CH-4	*Roybal*	*York*	*900*	*Centrifugal*	*Water-Cooled*	*Variable*	*New Machine*	*Phase 1*
CH-5	*Roybal*	*York*	*900*	*Centrifugal*	*Water-cooled*	*Variable*	*New Machine*	*Phase 1*
CH-6	*Roybal*	*York*	*900*	*Centrifugal*	*Water-cooled*	*Variable*	*New Machine*	*Phase 1*
CH-7	*300 NLA*	*Multi Stack*	*450*	*Magnetic*	*Water-cooled*	*Variable*	*New Machine*	*Phase 2A*
CH-8	*Roybal*	*York*	*250*	*Magnetic*	*Water-cooled*	*Variable*	*New Machine*	*Phase 2A*

- All pumps are variable speed
- Plant is optimized with condenser water as control variable

Chiller Plant Analysis at 300 NLA

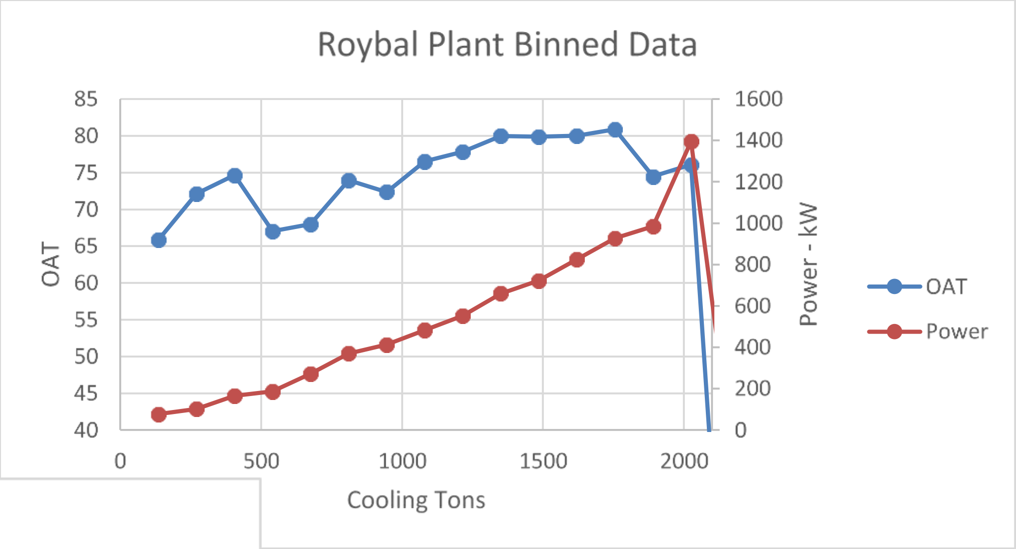


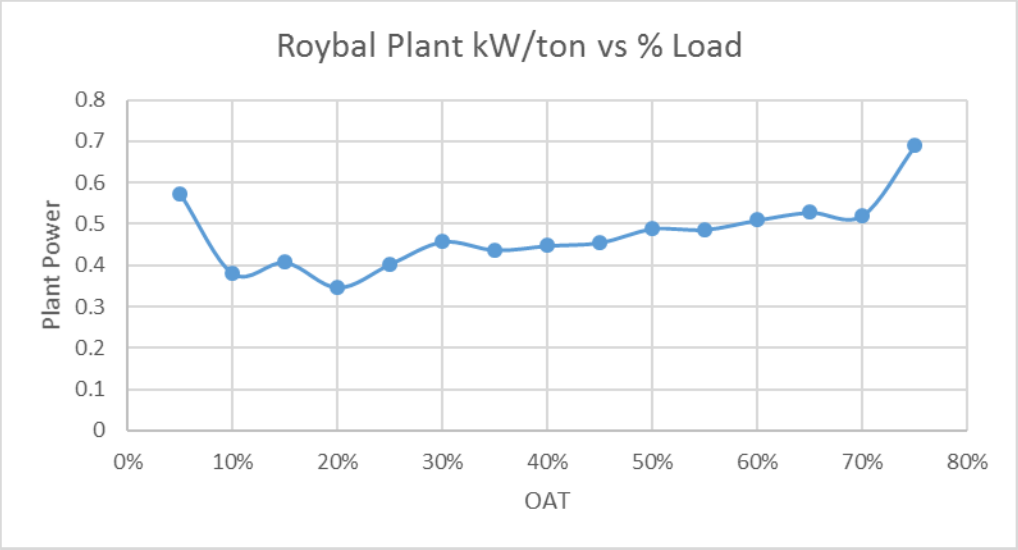
Chiller Plant Analysis at 300 NLA



Chiller Plant Analysis at Roybal

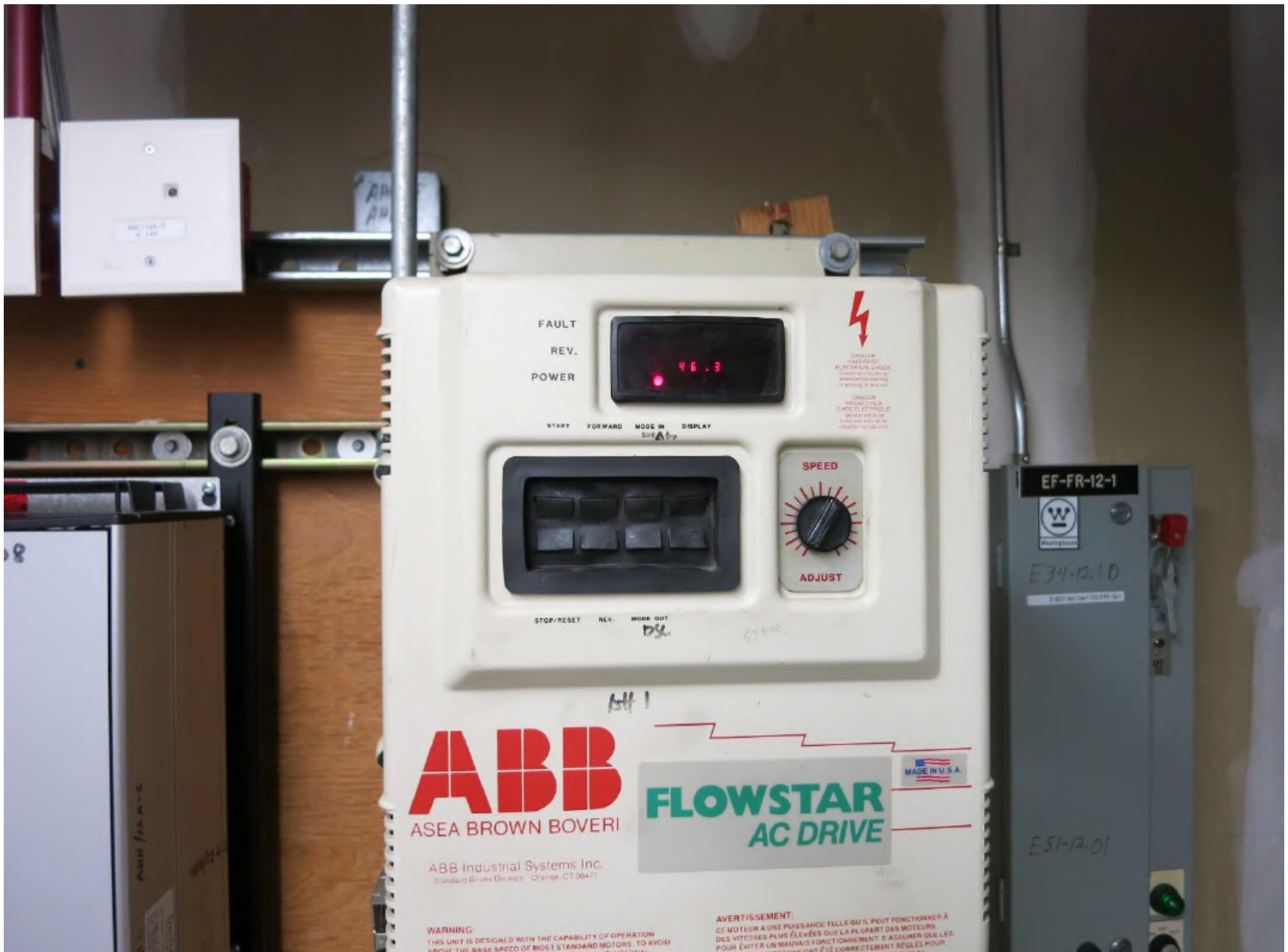
Plant unloads smoothly as expected



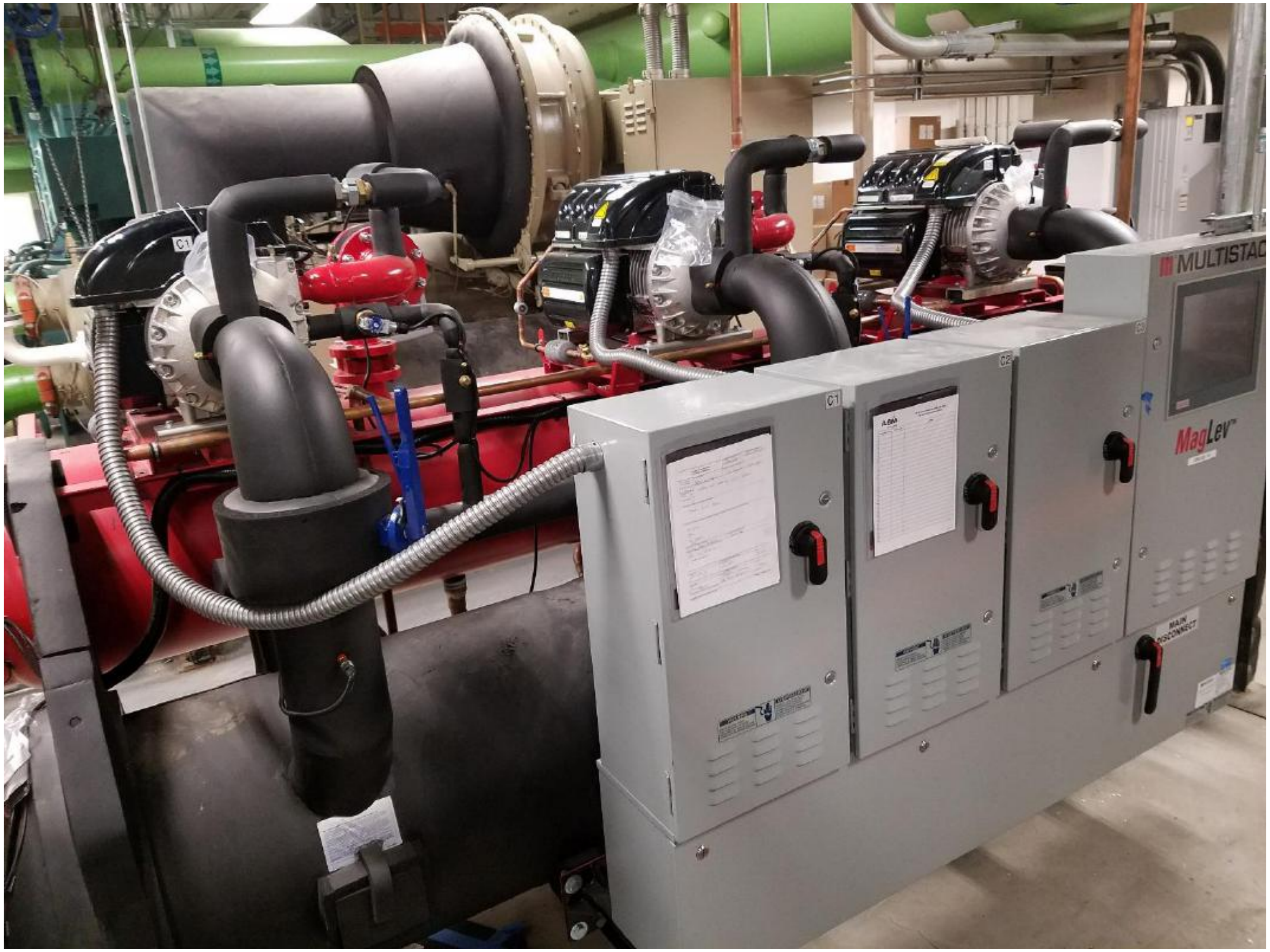


Plant low load performance is unacceptable

AHU VFDs at Roybal



Chiller Plant 300 NLA

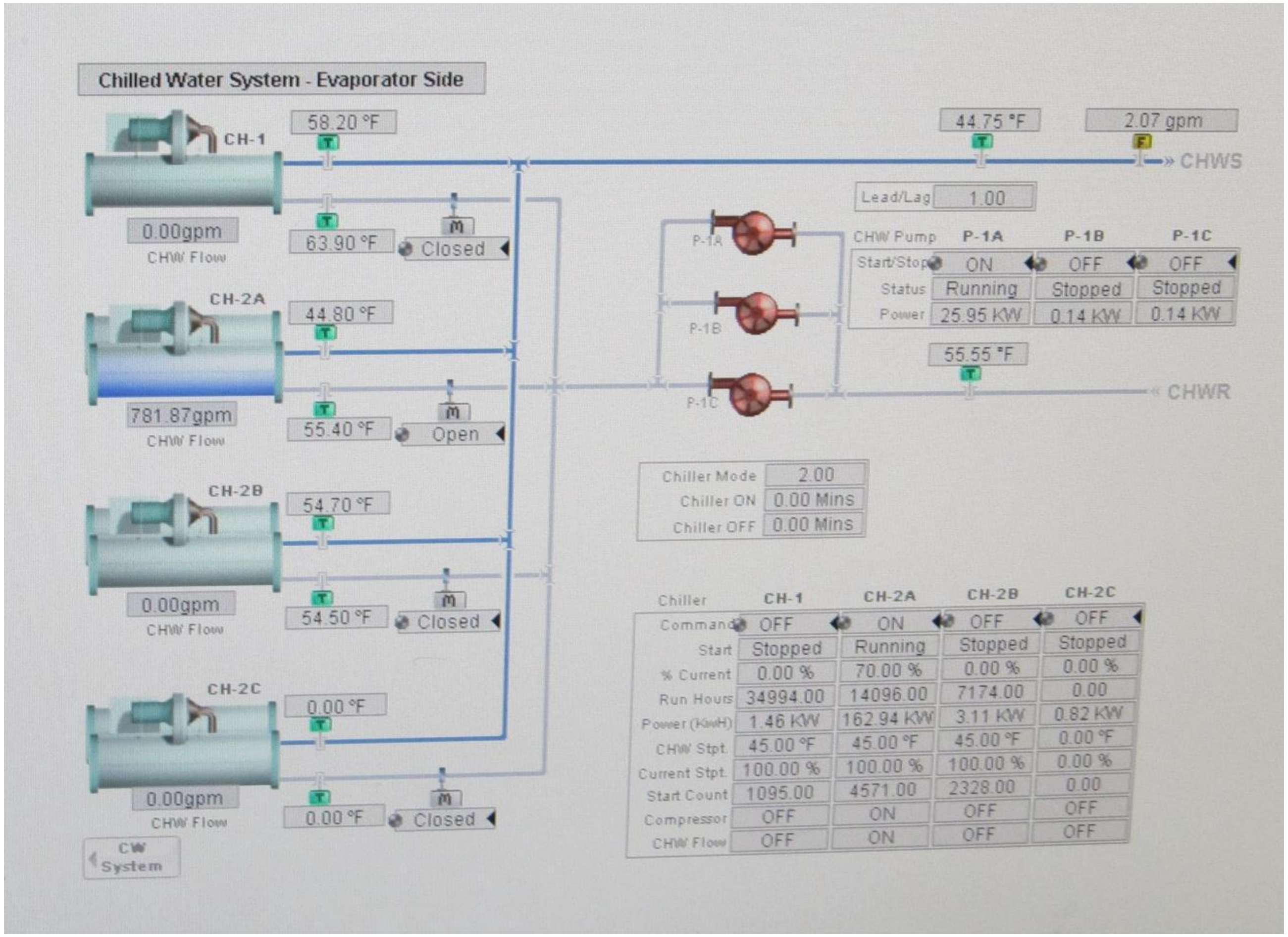


Chiller Plant Roybal

300 NLA Domestic Water Skid

300 NLA Fan Walls

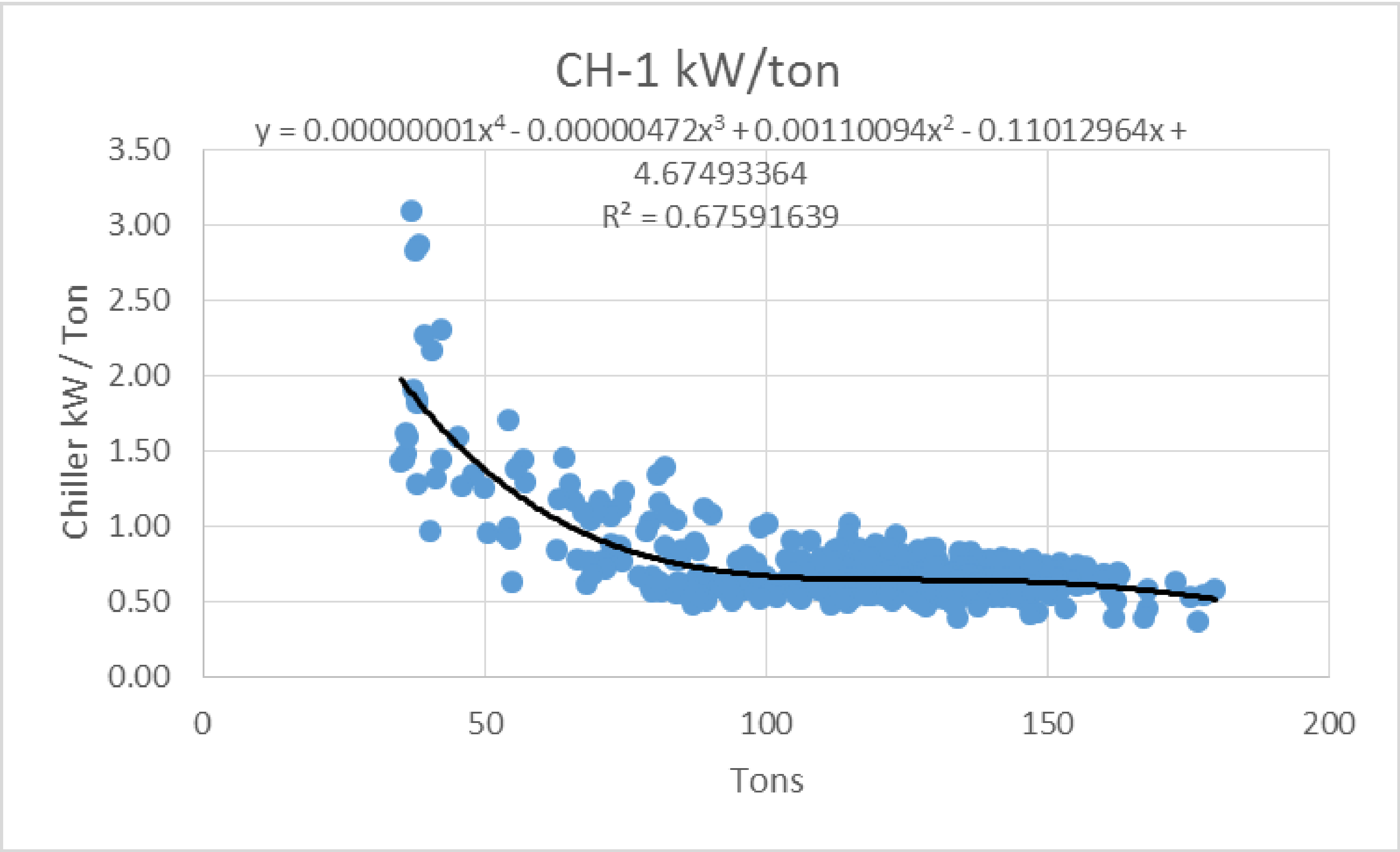
Chiller Plant Reagan



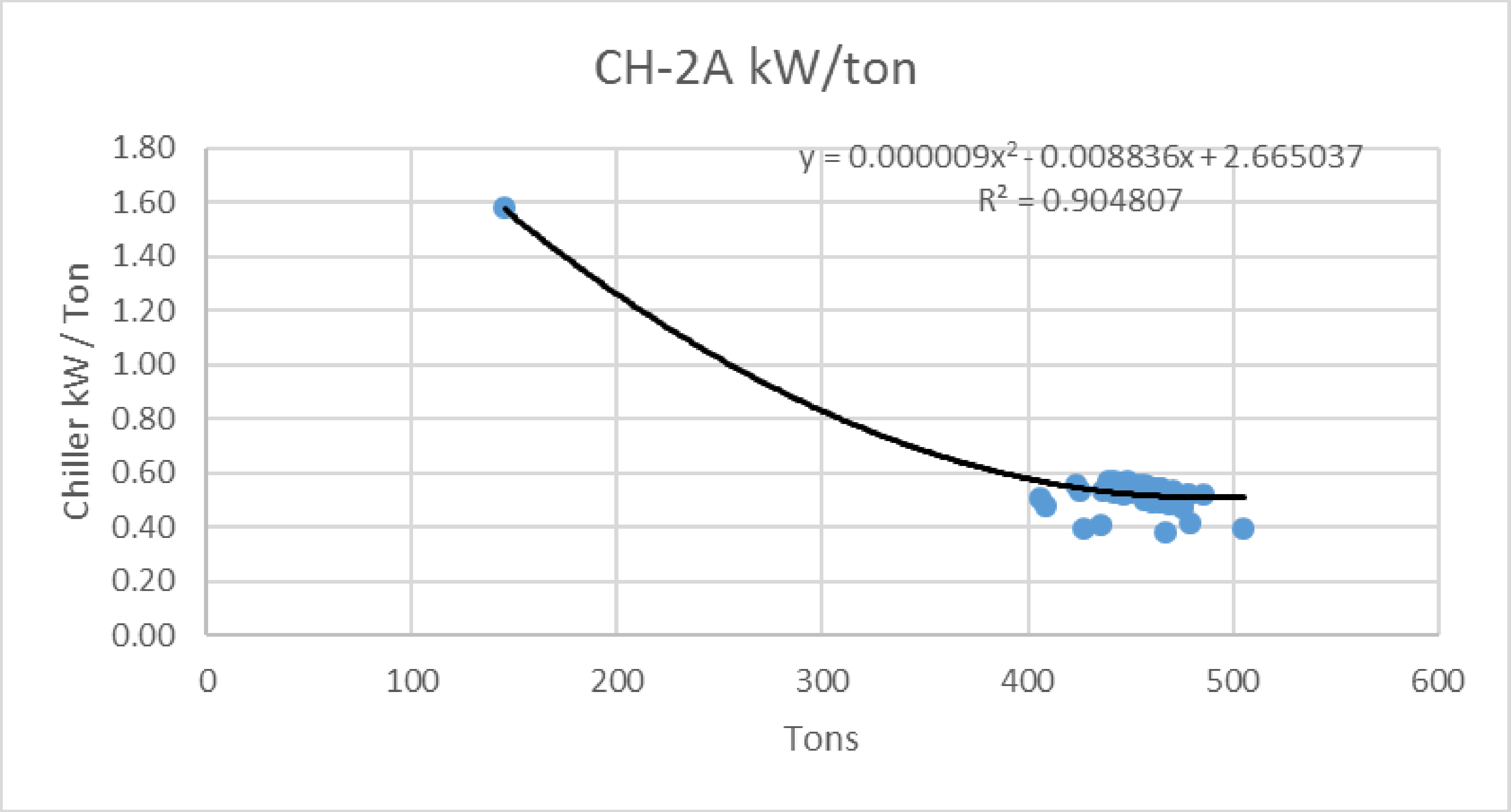
Chiller Plant Reagan

Unit ID	Serves	Make	Total Capacity (tons)	Chiller Type	Condenser Type	Speed Control	Scope	Phase
CH-1	Reagan	York	175	Centrifugal	Water-Cooled	Variable	Demo	Phase 2A
CH-2A	Reagan	York	450	Centrifugal	Water-Cooled	Variable	To Remain	
CH-2B	Reagan	York	450	Centrifugal	Water-Cooled	Variable	To Remain	
CH-2C	Reagan	York	450	Centrifugal	Water-Cooled	Variable	To Remain	
Unit ID	**Serves**	**Make**	**Total Capacity (tons)**	**Chiller Type**	**Condenser Type**	**Speed Control**	**Scope**	**Phase**
CH-1	*Reagan*	*York*	*250*	*Magnetic*	*Water-Cooled*	*Variable*	*New*	*Phase 2A*
CH-2A	Reagan	York	450	Centrifugal	Water-Cooled	Variable	Sequence	Phase 2A
CH-2B	Reagan	York	450	Centrifugal	Water-Cooled	Variable	Sequence	Phase 2A
CH-2C	Reagan	York	450	Centrifugal	Water-Cooled	Variable	Sequence	Phase 2A

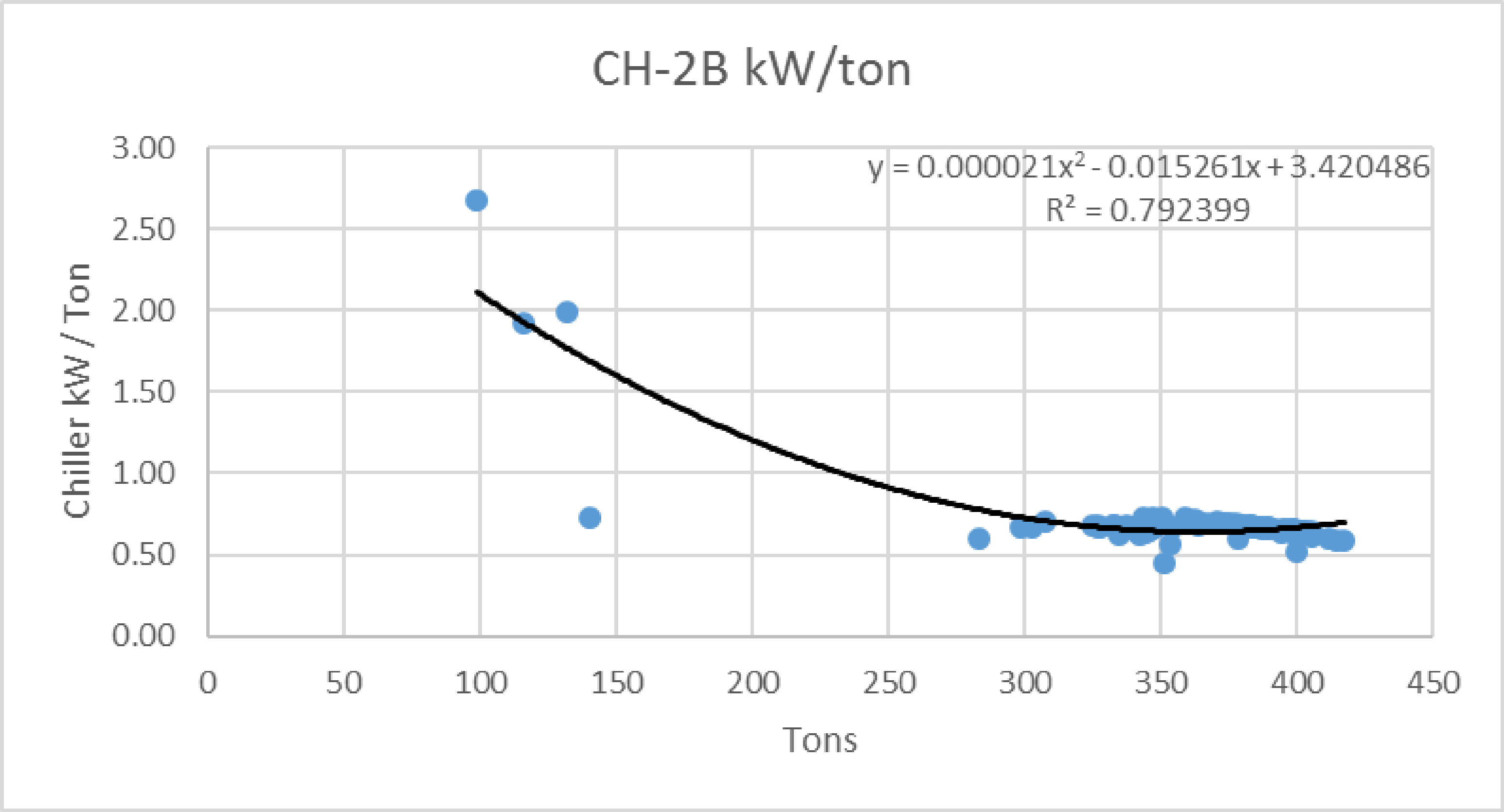
Chiller Plant Reagan CH-1 kW/ton



Chiller Plant Reagan CH-2A kW/ton



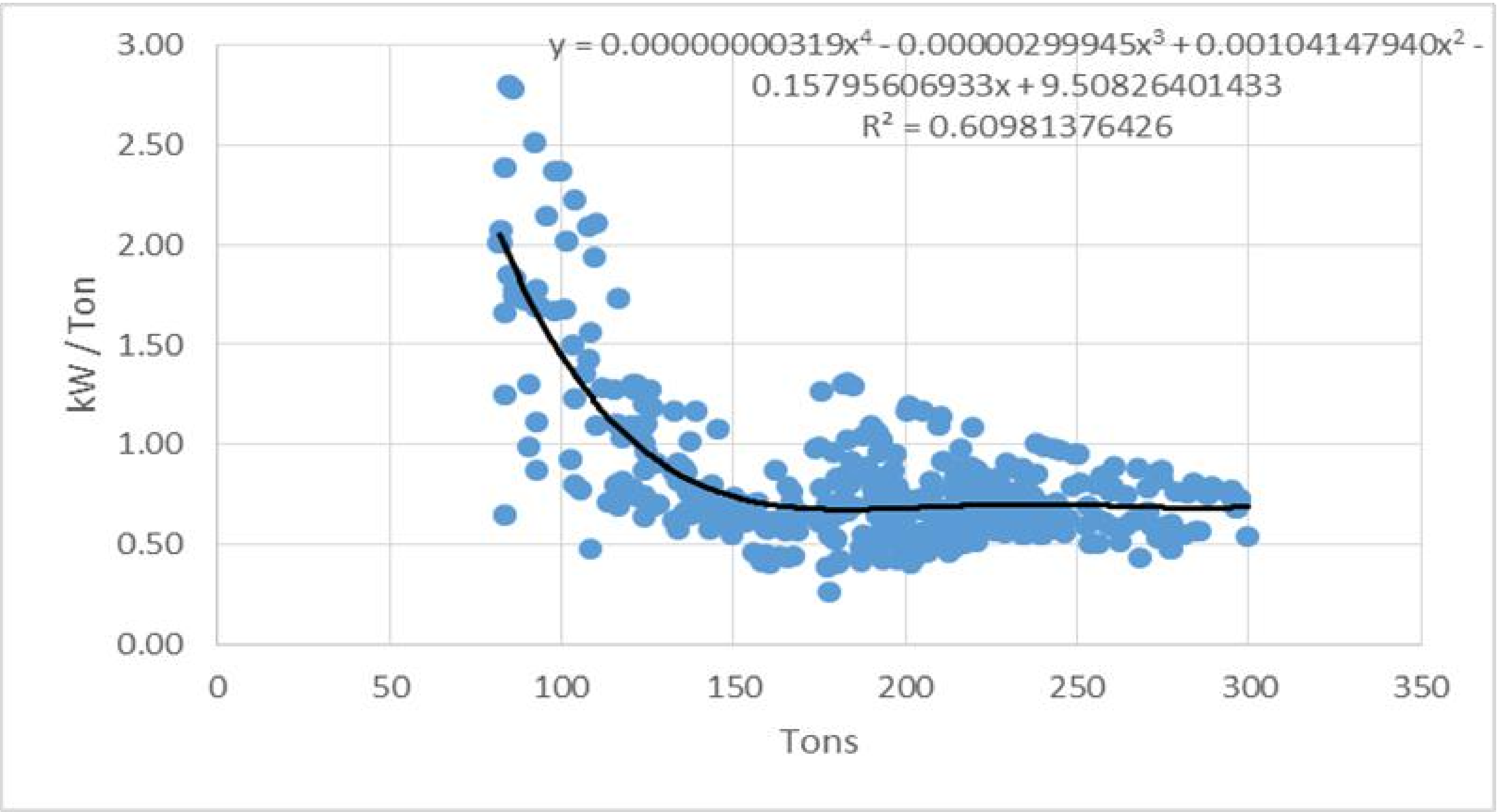
Chiller Plant Reagan CH-2B kW/ton



Chiller Plant Anderson

Unit ID	Serves	Make	Total Capacity (tons)	Chiller Type	Condenser Type	Speed Control	Scope	Phase
CH-1	Anderson	Carrier	300	Centrifugal	Water-Cooled	Variable	Demo	Phase 2A
CH-2	Anderson	Carrier	400	Centrifugal	Water-Cooled	Constant	To Remain	
CH-3	Anderson	Carrier	400	Centrifugal	Water-Cooled	Constant	Demo	Phase 2A
CH-4	Anderson	Cention	75	Absorption	Water-Cooled	Constant	Demo	Phase 2B
Unit ID	**Serves**	**Make**	**Total Capacity (tons)**	**Chiller Type**	**Condenser Type**	**Speed Control**	**Scope**	**Scope**
CH-1	*Anderson*	*York*	*425*	*Magnetic*	*Water-Cooled*	*Variable*	*New*	*Phase 2A*
CH-2	Anderson	York	400	Centrifugal	Water-Cooled	Constant	Backup Chiller	
CH-3	*Anderson*	*York*	*442*	*Magnetic*	*Water-Cooled*	*Variable*	*New*	*Phase 2A*
CH-4	Anderson	Cention	75	Absorption	Water-Cooled	Variable	Removed	Phase 2B

Chiller Plant Anderson



This concludes The American Institute of Architects Continuing Education Systems Course

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