
CampusEnergy2021
BRIDGE TO THE FUTURE
Feb. 16-18 | CONNECTING VIRTUALLY
WORKSHOPS | Thermal Distribution: March 2 | Microgrid: March 16

Thermal Energy Corporation (TECO) – the Energy Behind What's Next

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TECO THERMAL ENERGY CORPORATION

OPTIMUMENERGY

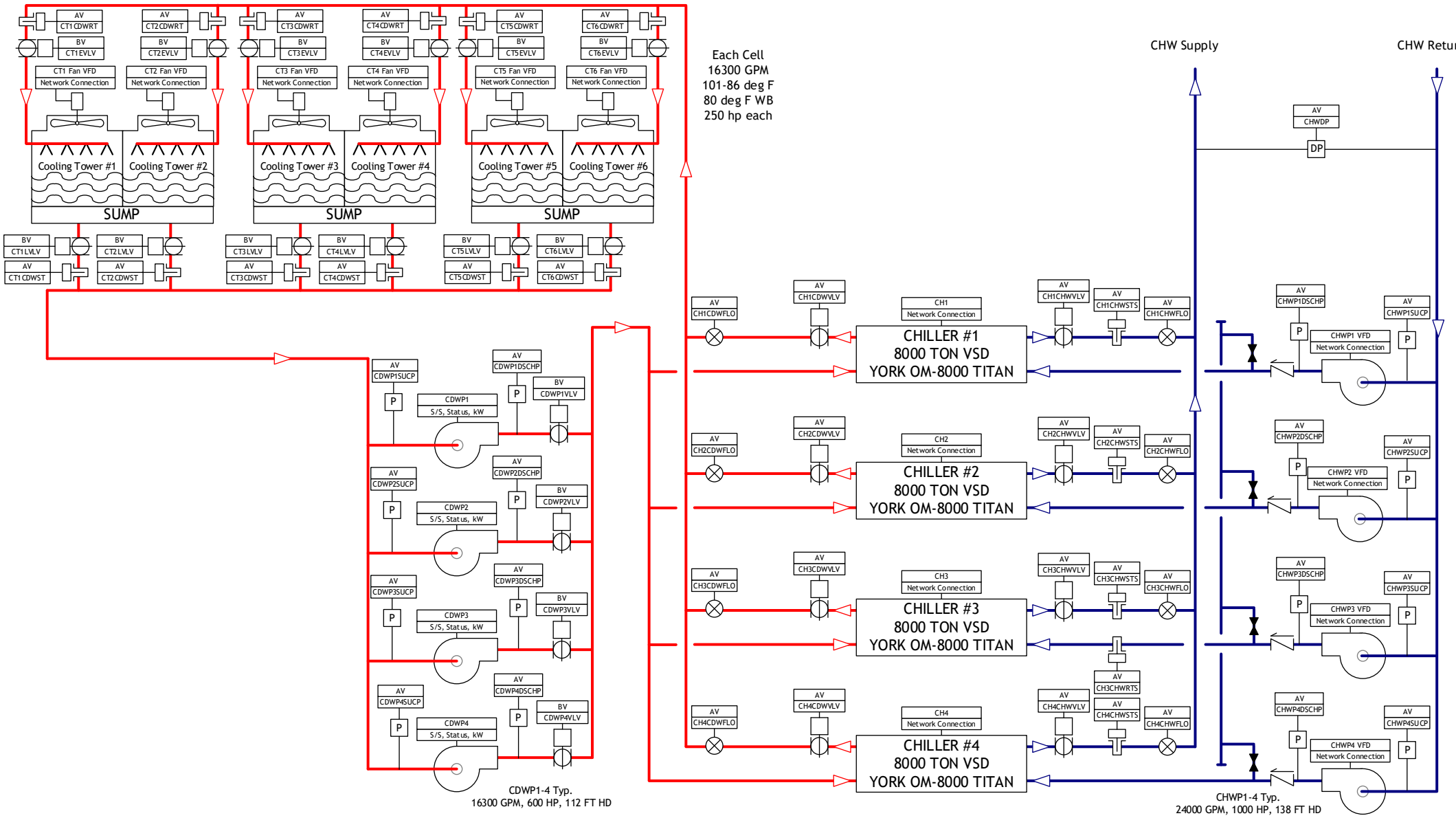
INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Q&A Will Not Be Answered Live

Please submit questions in the Q&A box.
The presenters will respond to questions off-line.

TECO and the Texas Medical Center

- 120,000 tons of chilled water (300,000,000+ ton-hrs /yr)
- 27 chillers, 35+ miles of thermal piping
- 48 MW combined heat and power plant
- 23.7 million sq ft of conditioned space
- 50 buildings
- 10 million patient encounters annually
- 180,000+ surgeries annually
- 9,200 patient beds



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"ECHB"

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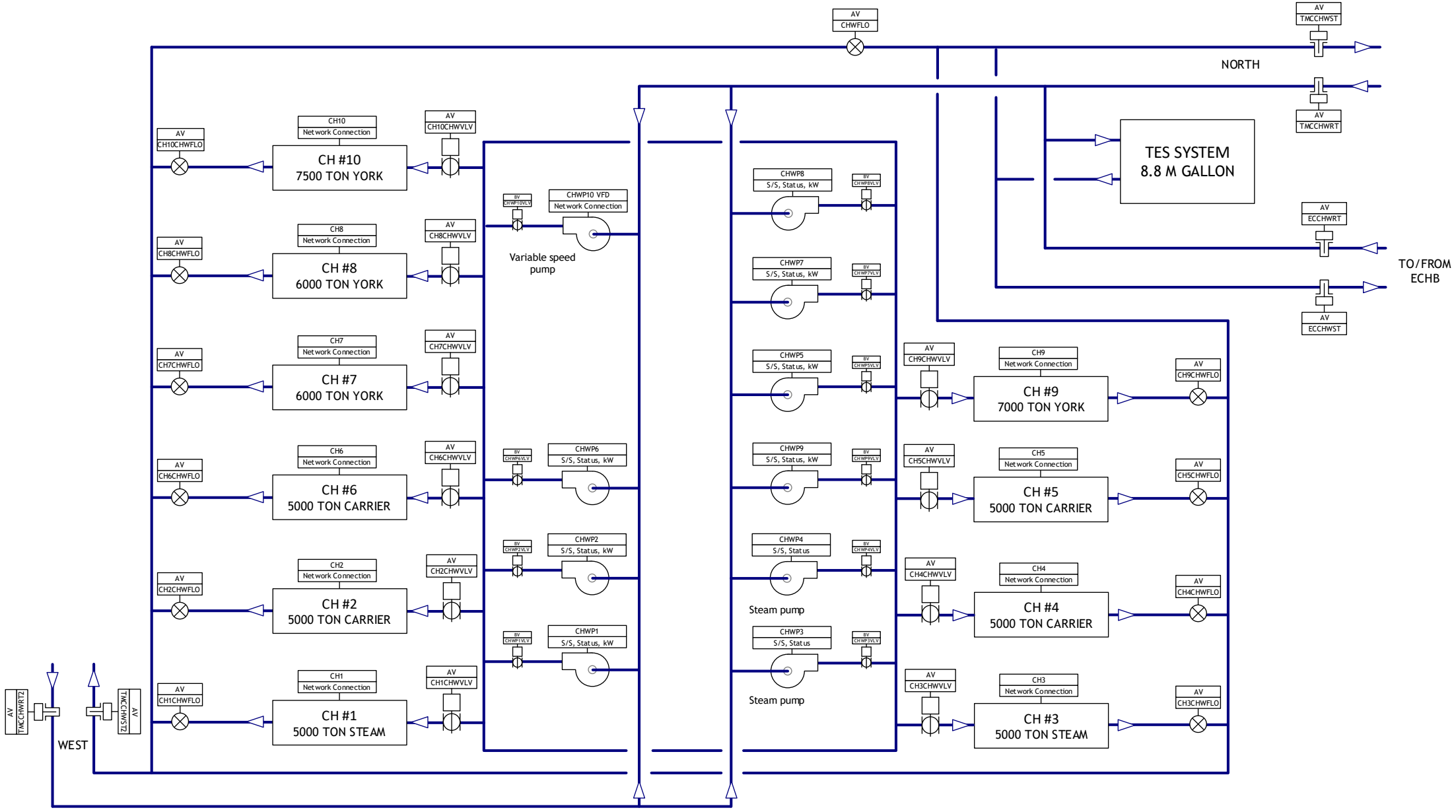
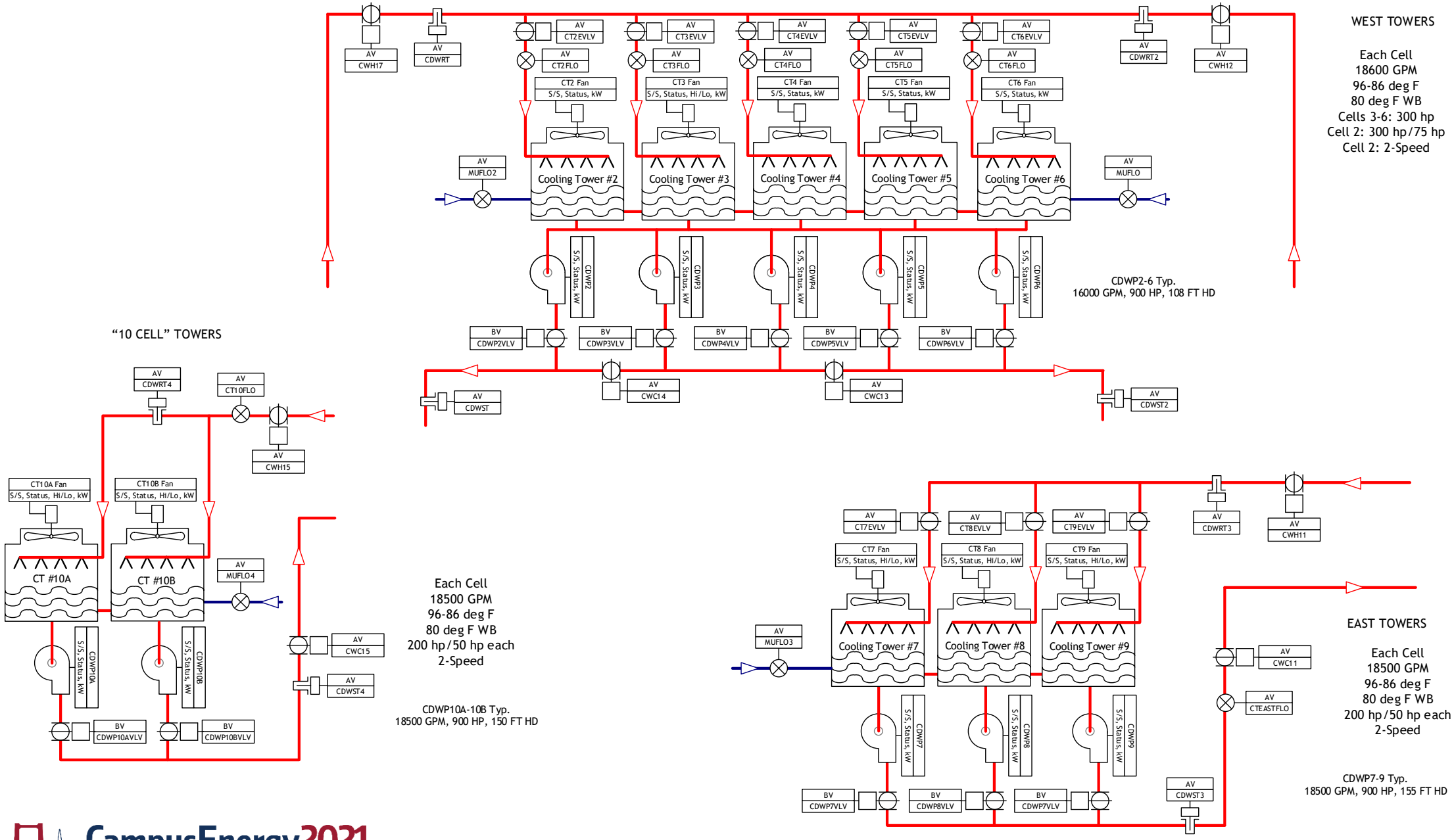


Central Pant, “CP” Chilled Water Side



Central Pant, "CP" Condenser Water Side

Growth

Peak chilled water demand has increased ~ 9000 tons over last 4 years

Projected chilled water demand to increase ~9000 tons over next 3 years

2020 Peak Load at 78,600 tons

Solution – it is much more cost effective to be more efficient than to add power production capacity

Through energy efficiency, reduce 2 Megawatts of load during Peak Grid days

1. Lower kW allowing entire plant to stay within load capacity of Co-Gen
2. Avoid spot purchasing of kW
3. Avoid unreliable grid power
4. kWh savings every day of year with < 2 year simple payback
5. Avoid demand charges associated with Coincident Peak Days $14,350/MW

Optimization

- Phase 1
  - ECHB chiller panel tuning
  - ECHB lift optimization
  - ECHB – cooling tower fan speed and staging optimization

Lift = Leaving condenser water temperature minus the leaving chilled water supply temperature

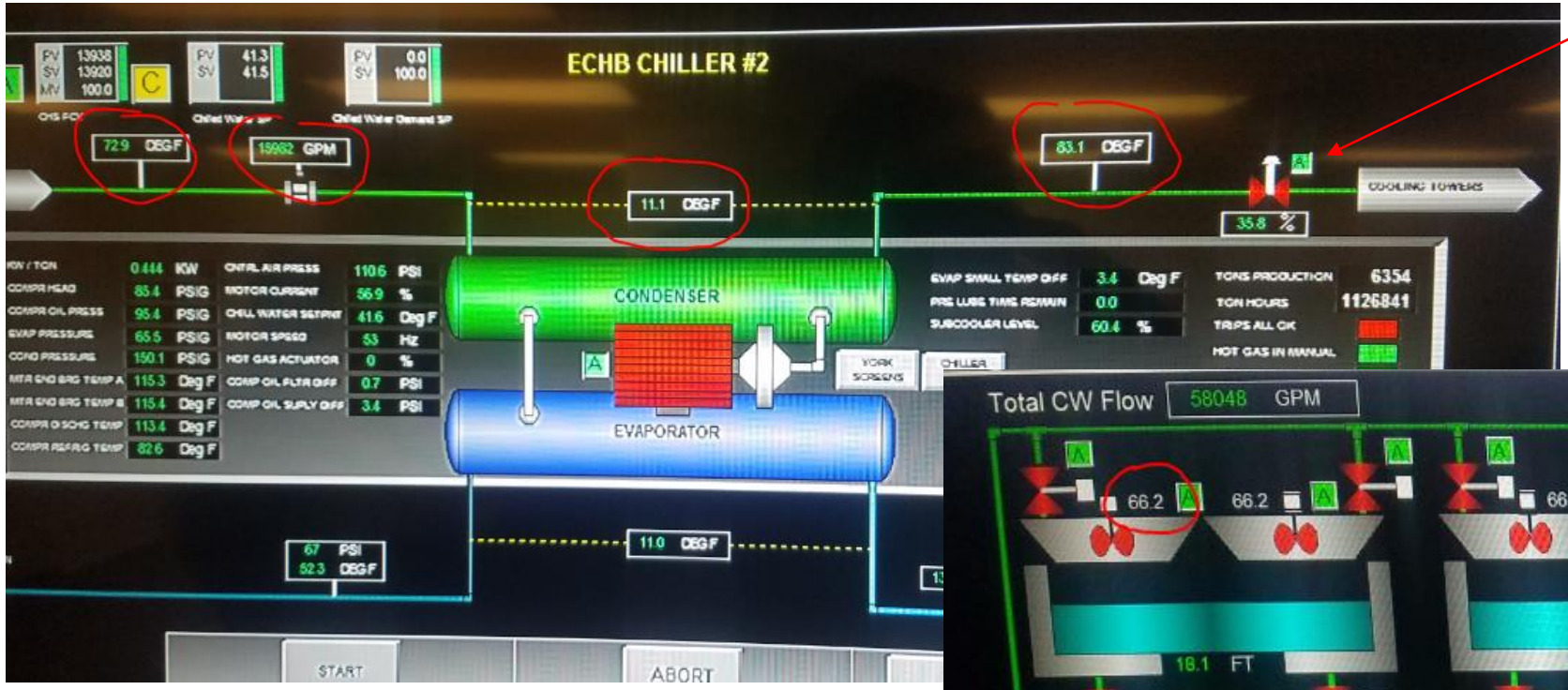
For example, a chiller selected at 40 deg F at 85-95 deg F would have a design lift calculated as 95 - 40 = 55 deg F

Optimization

- Phase 2
  - CP lift optimization
  - Updated chiller staging
  - Update chilled water pump control
  - Updated tower and condenser water pump staging
  - Compliance and Health Reporting

Reducing Lift – lowering condenser water delta T

Maintaining a 16,000 gpm CDW flow set point



Before (11.1 deg F delta T)

After (9.1 deg F delta T)

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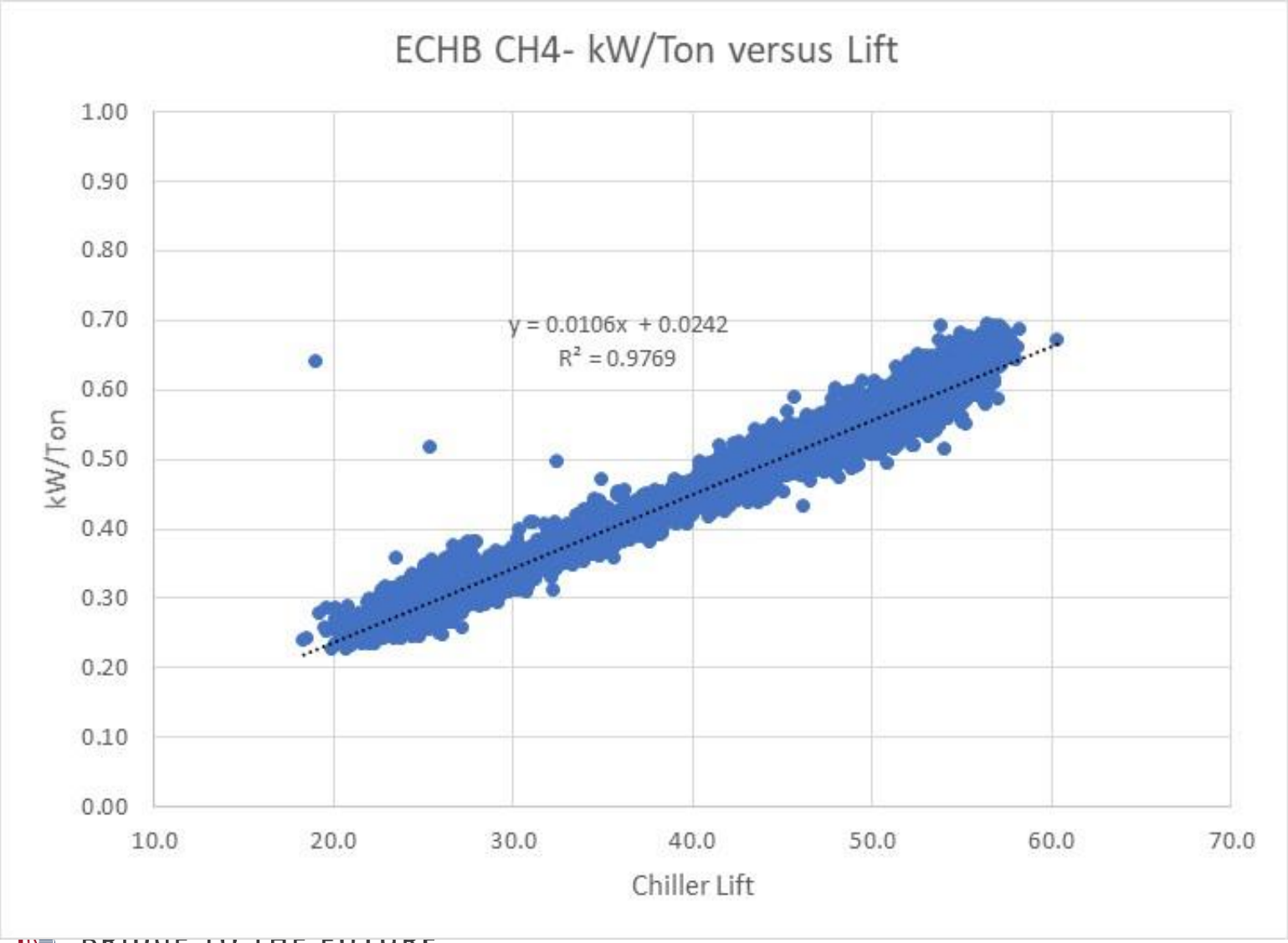
Reducing Lift



Reduction in Lift by 2 deg F

kW/ton savings = 0.0106 x 2 = 0.0212 kW/ton

3 x 6000-tons x 0.0212 kW/ton = 382 kW

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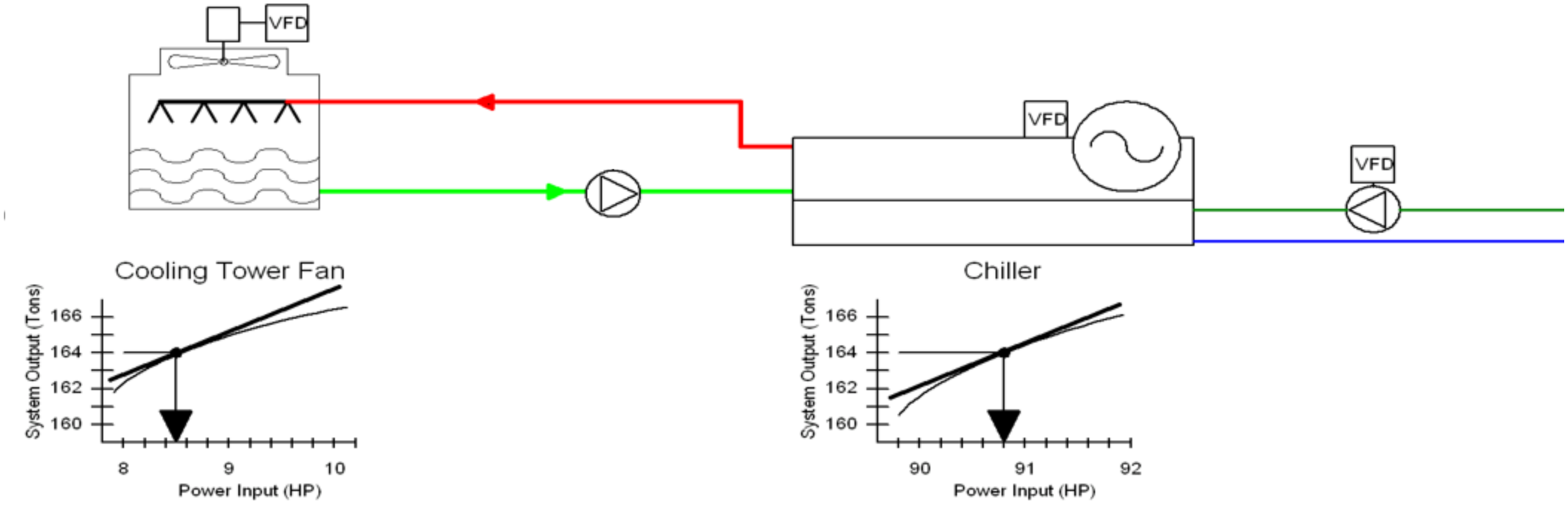
Optimization of Tower Fan Speed Using Power Relationships



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Phase 1 Energy Savings – spot reading

Running 6 cells at 70% speed instead of 3 cells at 100% speed to achieve the same or better approach temperature (~ 5 deg F)

6 x 70 kW fans = 420 kW

3 x 185 kW fans = 555 kW

Tower Fan Savings = 555 – 420 = 135 kW

Previous slide (reducing throttling) = 382 kW

Condenser Pumps' Savings = -15 kW x 3 = -45 kW

Total savings = 135 + 382 - 45 = 472 kW

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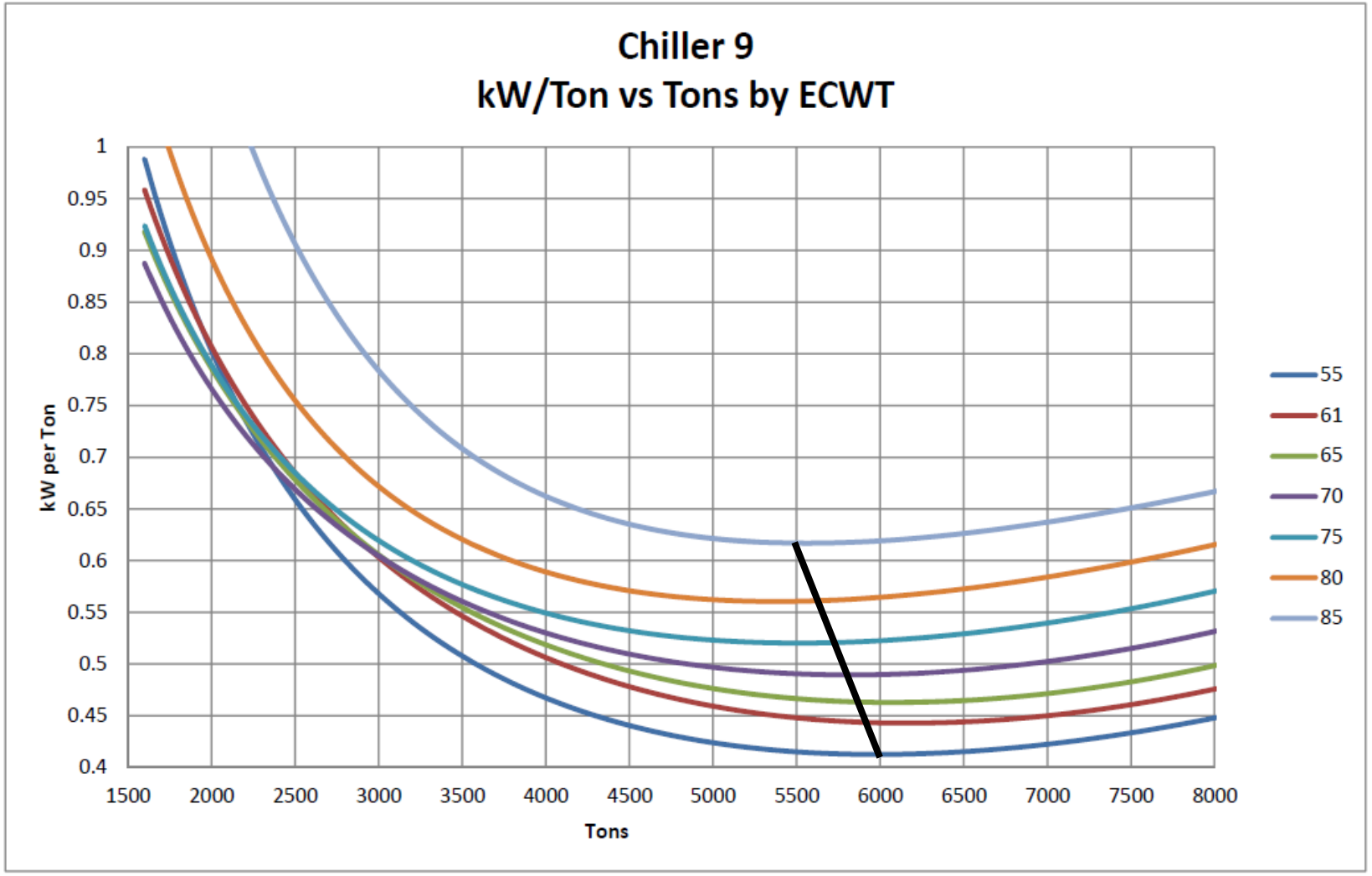
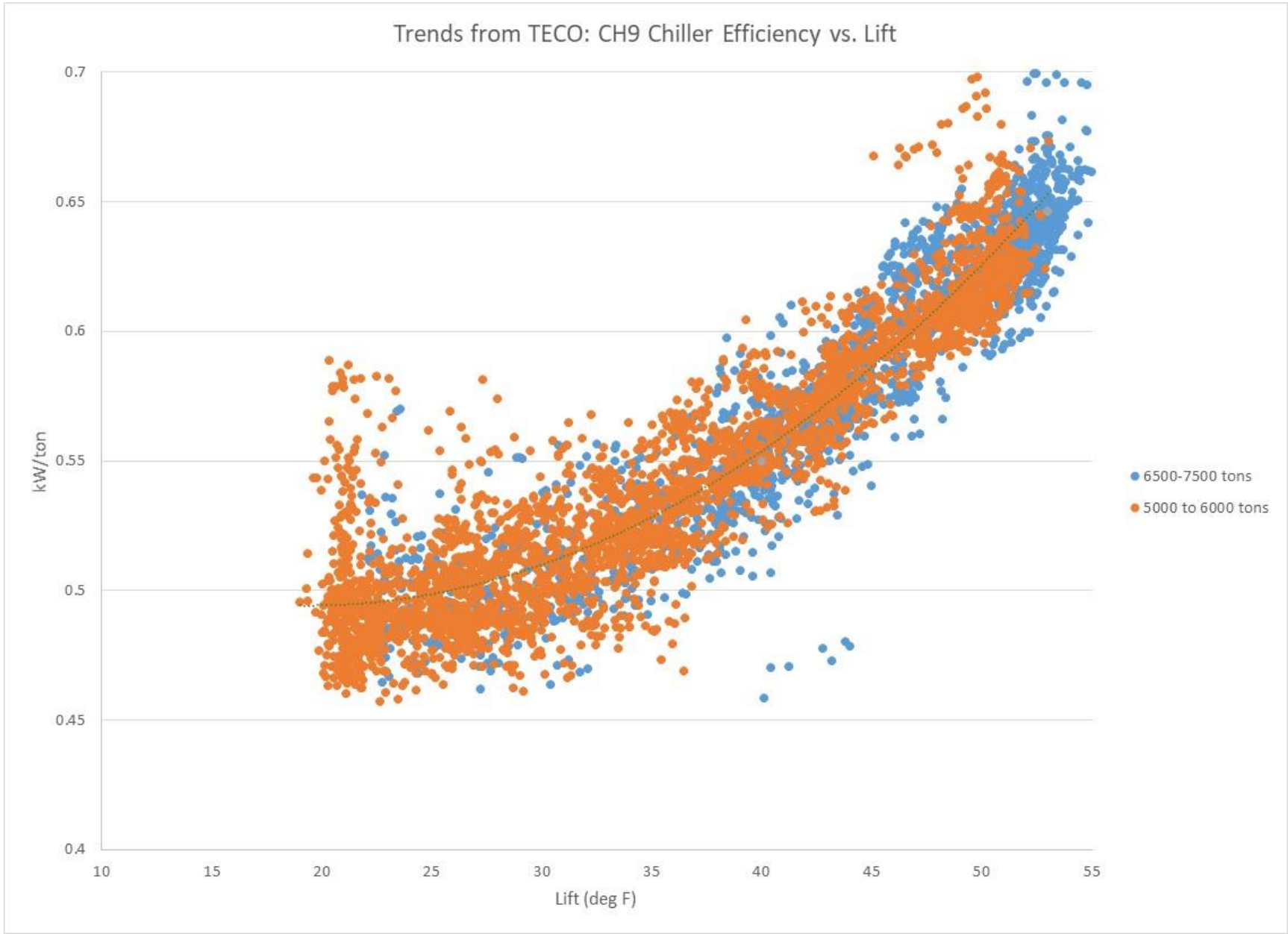
Staging Chillers

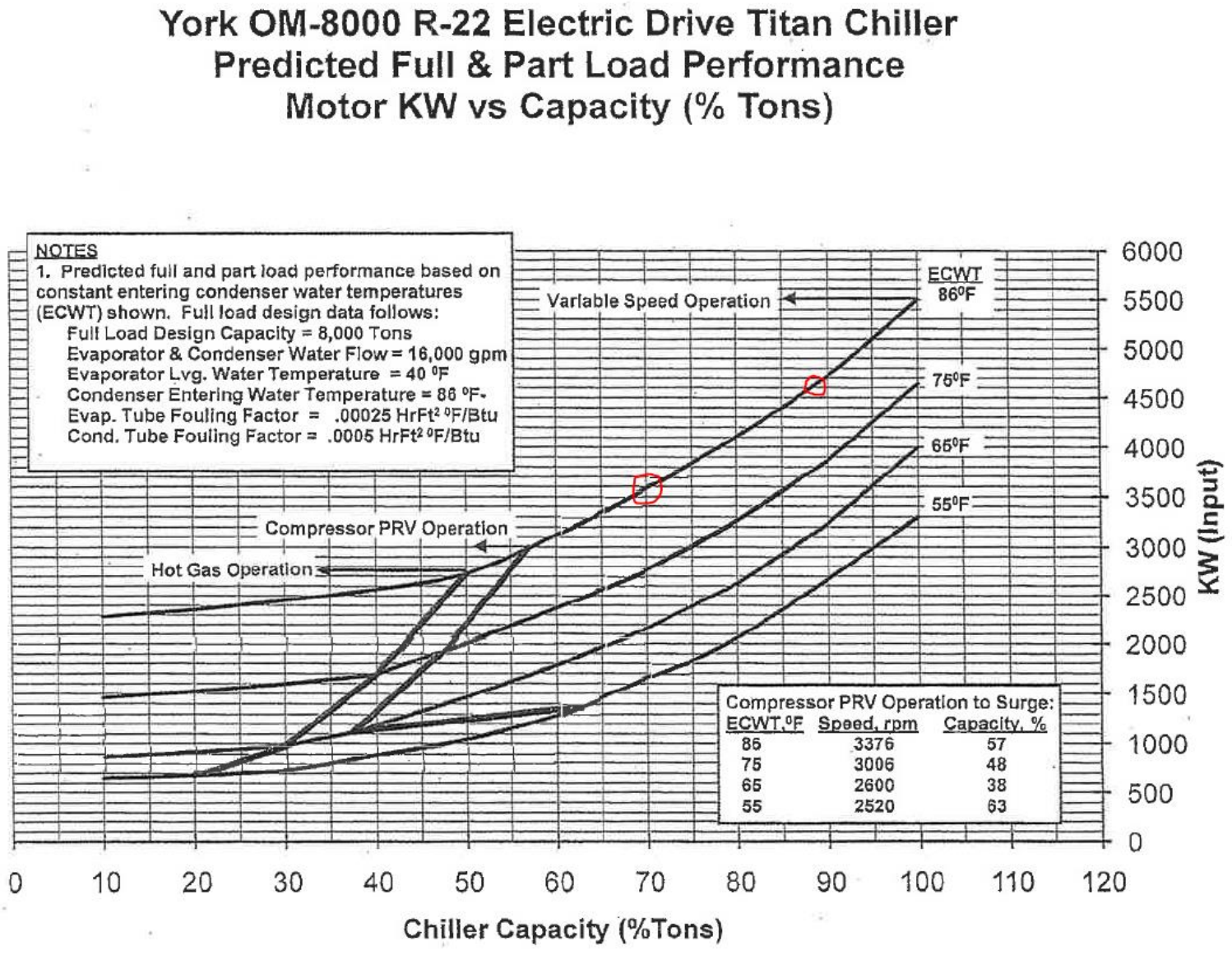


Staging Chillers

- Efficiency at low vs. higher loads is nearly identical per deg F of lift



Run 4 ECHB chillers at 7050 tons instead of 4 ECHB chillers at 5600 tons and CH8 at 5800 tons (86 deg F ECWT).



ECHB chiller at 7050 tons and 4600 kW = 0.652 kW/ton

ECHB chiller at 5600 tons and 3600 kW = 0.643 kW/ton

CH8 at 0.615 kW/ton and 5800-tons is 3567 kW.

4 x ECHB chillers at
7050 tons (4600 kW) =
18,400 kW

4 x ECHB chillers at
5600 tons (3600 kW)
plus CH8 at 5800 tons
(3567 kW) = 17,967 kW

18,400 kW - 17,967 kW = 433 kW

But adding CH8, instead of keeping ECHB chillers loaded higher, would add another ~700 kW condenser pump and another ~490 kW of CHWP (total of 1190 kW plus additional CP cooling tower fan energy minus some CHW pumping energy at ECHB)

Net savings is roughly 1190 – 433 = 757 kW

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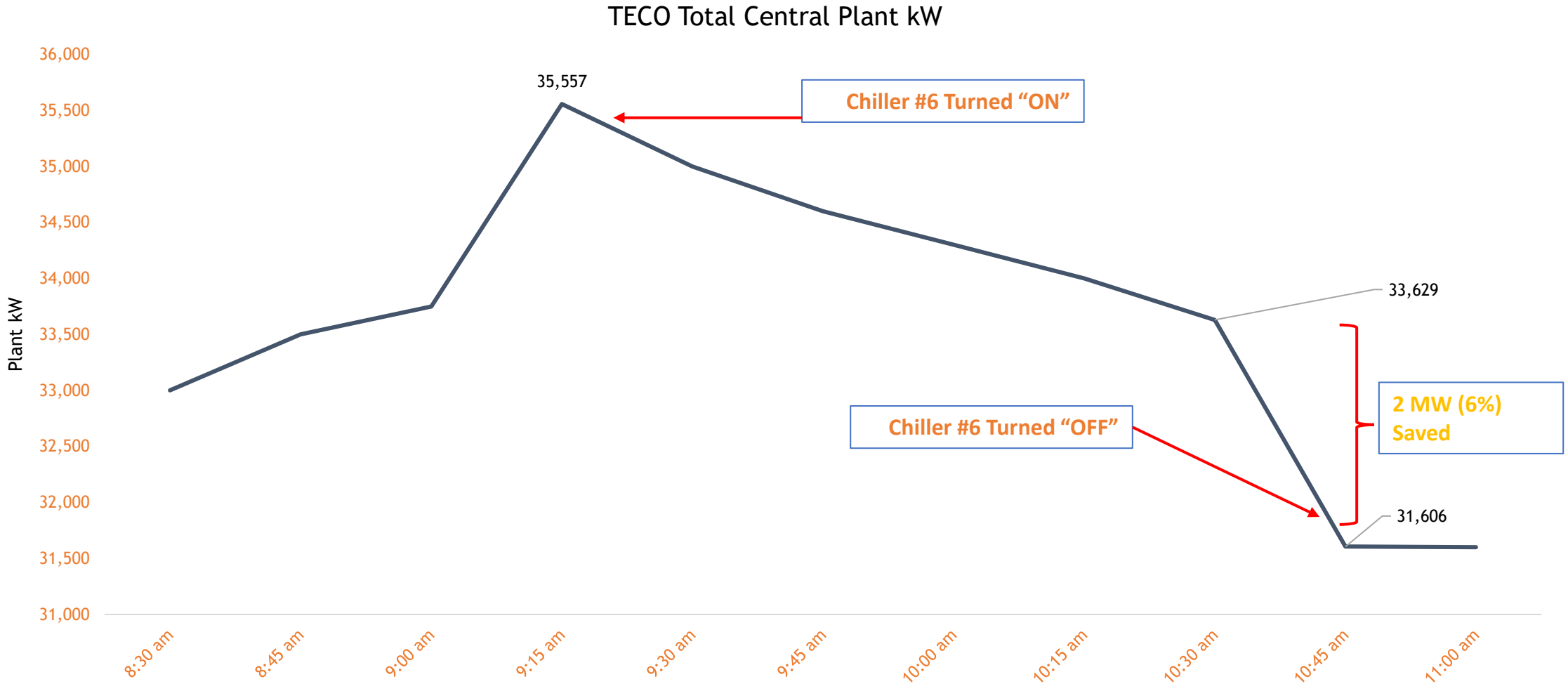
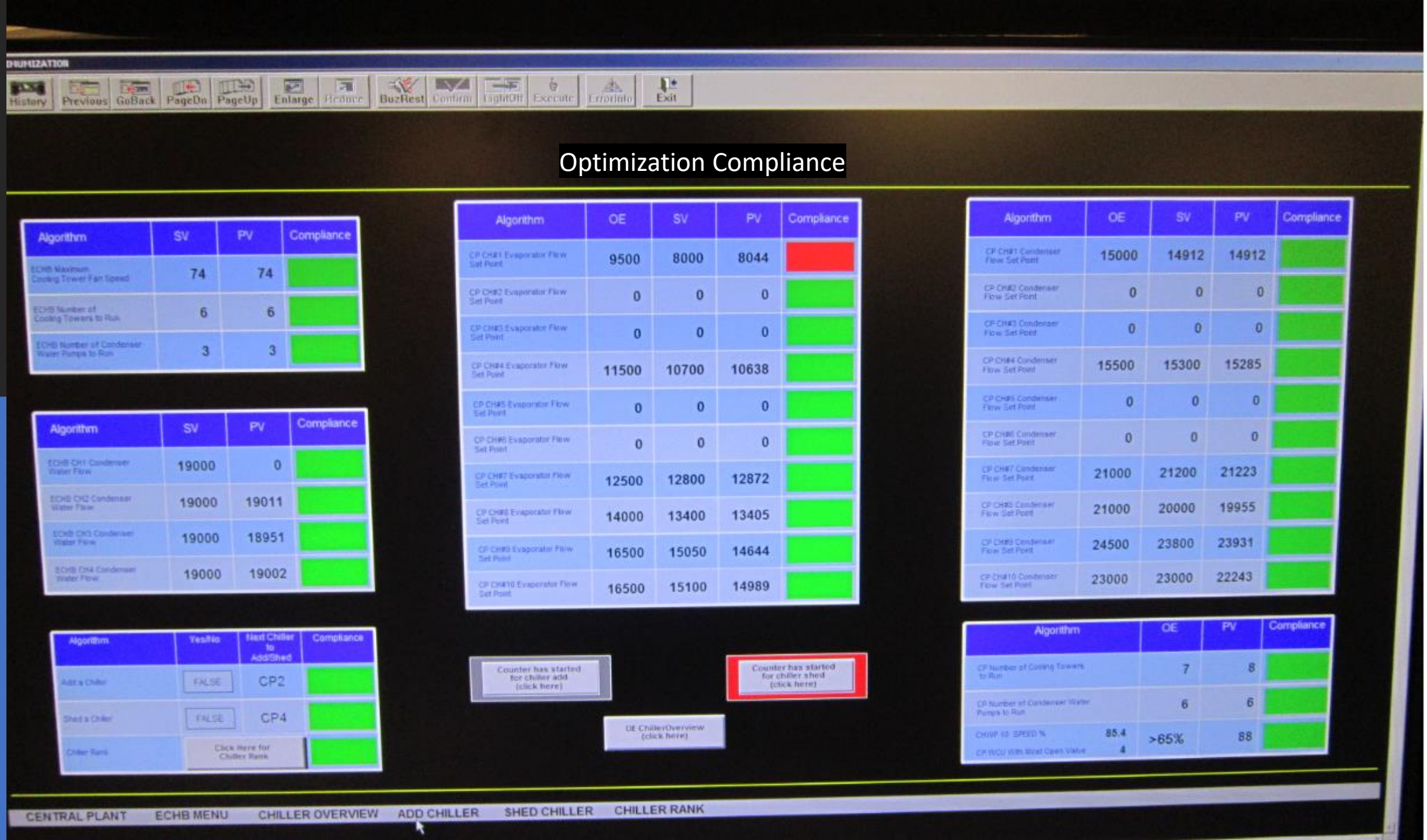
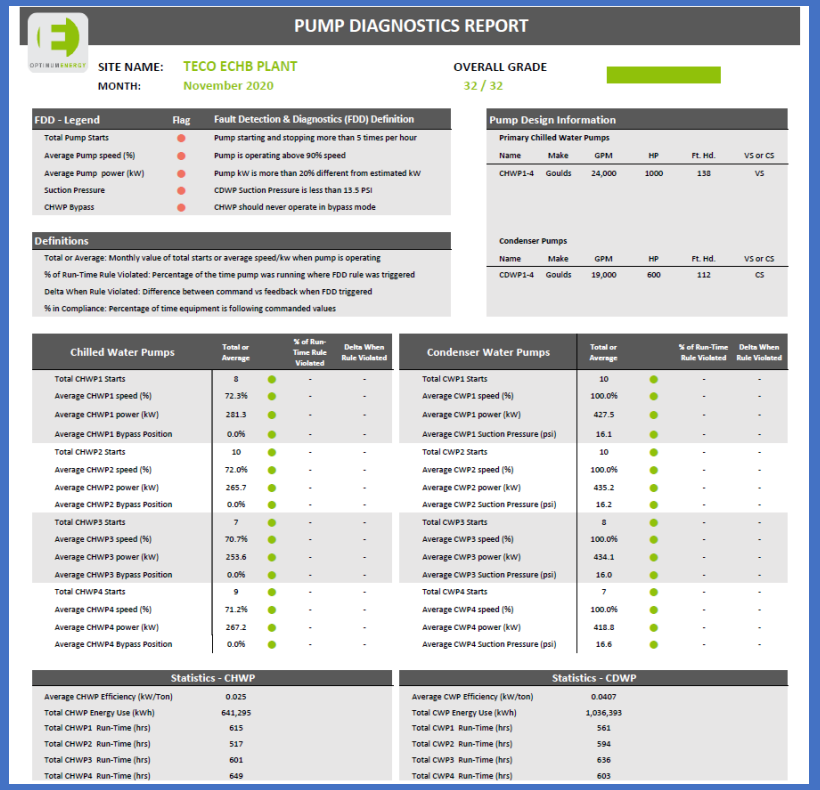
Actual Results at CP – June 2020 (staging, lift reduction, and optimized condenser pumping and tower control)




History
Previous
GoBack
PageDn
PageUp
Enlarge
Reduce
BuzRest
Confirm
LightOff
Execute
ErrorInfo
Exit
Optimization Compliance
Algorithm
SV
PV
Compliance
ECHB Maximum Cooling Tower Fan Speed
74
74
ECHB Number of Cooling Towers to Run
6
6
ECHB Number of Condenser Water Pumps to Run
3
3
Algorithm
SV
PV
Compliance
ECHB CH1 Condenser Water Flow
19000
0
ECHB CH2 Condenser Water Flow
19000
19011
ECHB CH3 Condenser Water Flow
19000
18951
ECHB CH4 Condenser Water Flow
19000
19002
Algorithm
Yes/No
Next Chiller to Add/Shed
Compliance
Add a Chiller
FALSE
CP2
Shed a Chiller
FALSE
CP4
Chiller Runs
Click Here for Chiller Rank
Algorithm
OE
SV
PV
Compliance
CP CH#1 Evaporator Flow Set Point
9500
8000
8044
CP CH#2 Evaporator Flow Set Point
0
0
0
CP CH#3 Evaporator Flow Set Point
0
0
0
CP CH#4 Evaporator Flow Set Point
11500
10700
10638
CP CH#5 Evaporator Flow Set Point
0
0
0
CP CH#6 Evaporator Flow Set Point
0
0
0
CP CH#7 Evaporator Flow Set Point
12500
12800
12872
CP CH#8 Evaporator Flow Set Point
14000
13400
13405
CP CH#9 Evaporator Flow Set Point
16500
15050
14644
CP CH#10 Evaporator Flow Set Point
16500
15100
14989
Counter has started for chiller add (click here)
Counter has started for chiller shed (click here)
OE ChillerOverview (click here)
Algorithm
OE
SV
PV
Compliance
CP CH#1 Condenser Flow Set Point
15000
14912
14912
CP CH#2 Condenser Flow Set Point
0
0
0
CP CH#3 Condenser Flow Set Point
0
0
0
CP CH#4 Condenser Flow Set Point
15500
15300
15285
CP CH#5 Condenser Flow Set Point
0
0
0
CP CH#6 Condenser Flow Set Point
0
0
0
CP CH#7 Condenser Flow Set Point
21000
21200
21223
CP CH#8 Condenser Flow Set Point
21000
20000
19955
CP CH#9 Condenser Flow Set Point
24500
23800
23931
CP CH#10 Condenser Flow Set Point
23000
23000
22243
Algorithm
OE
PV
Compliance
CP Number of Cooling Towers to Run
7
8
CP Number of Condenser Water Pumps to Run
6
6
CHWP 10 SPEED %
85.4
>65%
88
CP WCU With Most Open Valve
4
CENTRAL PLANT
ECHB MENU
CHILLER OVERVIEW
ADD CHILLER
SHED CHILLER
CHILLER RANK

Health Reports



PUMP DIAGNOSTICS REPORT

SITE NAME: TECO ECHB PLANT
MONTH: November 2020
OVERALL GRADE 32 / 32

FDD - Legend	Flag	Fault Detection & Diagnostics (FDD) Definition
Total Pump Starts		Pump starting and stopping more than 5 times per hour
Average Pump speed (%)		Pump is operating above 90% speed
Average Pump power (kW)		Pump kW is more than 20% different from estimated kW
Suction Pressure		CDWP Suction Pressure is less than 13.5 PSI
CHWP Bypass		CHWP should never operate in bypass mode

Definitions

Total or Average: Monthly value of total starts or average speed/kw when pump is operating
% of Run-Time Rule Violated: Percentage of the time pump was running where FDD rule was triggered
Delta When Rule Violated: Difference between command vs feedback when FDD triggered
% in Compliance: Percentage of time equipment is following commanded values

Pump Design Information

Primary Chilled Water Pumps

Name	Make	GPM	HP	Ft. Hd.	VS or CS
CHWP1-4	Goulds	24,000	1000	138	VS

Condenser Pumps

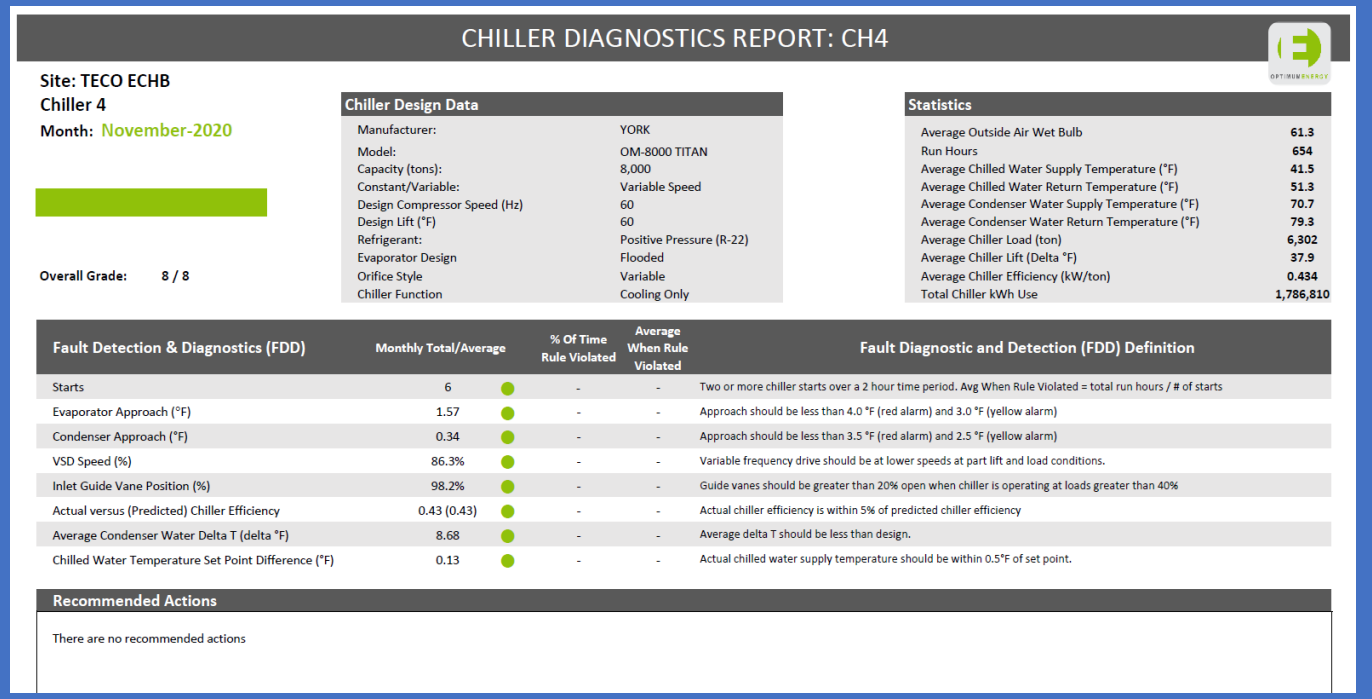
Name	Make	GPM	HP	Ft. Hd.	VS or CS
CDWP1-4	Goulds	19,000	600	112	CS

Chilled Water Pumps	Total or Average		% of Run-Time Rule Violated	Delta When Rule Violated
Total CHWP1 Starts	8		-	-
Average CHWP1 speed (%)	72.3%		-	-
Average CHWP1 power (kW)	281.3		-	-
Average CHWP1 Bypass Position	0.0%		-	-
Total CHWP2 Starts	10		-	-
Average CHWP2 speed (%)	72.0%		-	-
Average CHWP2 power (kW)	265.7		-	-
Average CHWP2 Bypass Position	0.0%		-	-
Total CHWP3 Starts	7		-	-
Average CHWP3 speed (%)	70.7%		-	-
Average CHWP3 power (kW)	253.6		-	-
Average CHWP3 Bypass Position	0.0%		-	-
Total CHWP4 Starts	9		-	-
Average CHWP4 speed (%)	71.2%		-	-
Average CHWP4 power (kW)	267.2		-	-
Average CHWP4 Bypass Position	0.0%		-	-

Condenser Water Pumps	Total or Average		% of Run-Time Rule Violated	Delta When Rule Violated
Total CWP1 Starts	10		-	-
Average CWP1 speed (%)	100.0%		-	-
Average CWP1 power (kW)	427.5		-	-
Average CWP1 Suction Pressure (psi)	16.1		-	-
Total CWP2 Starts	10		-	-
Average CWP2 speed (%)	100.0%		-	-
Average CWP2 power (kW)	435.2		-	-
Average CWP2 Suction Pressure (psi)	16.2		-	-
Total CWP3 Starts	8		-	-
Average CWP3 speed (%)	100.0%		-	-
Average CWP3 power (kW)	434.1		-	-
Average CWP3 Suction Pressure (psi)	16.0		-	-
Total CWP4 Starts	7		-	-
Average CWP4 speed (%)	100.0%		-	-
Average CWP4 power (kW)	418.8		-	-
Average CWP4 Suction Pressure (psi)	16.6		-	-

Statistics - CHWP	
Average CHWP Efficiency (kW/Ton)	0.025
Total CHWP Energy Use (kWh)	641,295
Total CHWP1 Run-Time (hrs)	615
Total CHWP2 Run-Time (hrs)	517
Total CHWP3 Run-Time (hrs)	601
Total CHWP4 Run-Time (hrs)	649

Statistics - CDWP	
Average CWP Efficiency (kW/ton)	0.0407
Total CWP Energy Use (kWh)	1,036,393
Total CWP1 Run-Time (hrs)	561
Total CWP2 Run-Time (hrs)	594
Total CWP3 Run-Time (hrs)	636
Total CWP4 Run-Time (hrs)	603



CHILLER DIAGNOSTICS REPORT: CH4

Site: TECO ECHB
Chiller 4
Month: November-2020

Overall Grade: 8 / 8

Chiller Design Data

Manufacturer:	YORK
Model:	OM-8000 TITAN
Capacity (tons):	8,000
Constant/Variable:	Variable Speed
Design Compressor Speed (Hz)	60
Design Lift (°F)	60
Refrigerant:	Positive Pressure (R-22)
Evaporator Design	Flooded
Orifice Style	Variable
Chiller Function	Cooling Only

Statistics

Average Outside Air Wet Bulb	61.3
Run Hours	654
Average Chilled Water Supply Temperature (°F)	41.5
Average Chilled Water Return Temperature (°F)	51.3
Average Condenser Water Supply Temperature (°F)	70.7
Average Condenser Water Return Temperature (°F)	79.3
Average Chiller Load (ton)	6,302
Average Chiller Lift (Delta °F)	37.9
Average Chiller Efficiency (kW/ton)	0.434
Total Chiller kWh Use	1,786,810

Fault Detection & Diagnostics (FDD)	Monthly Total/Average		% Of Time Rule Violated	Average When Rule Violated	Fault Diagnostic and Detection (FDD) Definition
Starts	6		-	-	Two or more chiller starts over a 2 hour time period. Avg When Rule Violated = total run hours / # of starts
Evaporator Approach (°F)	1.57		-	-	Approach should be less than 4.0 °F (red alarm) and 3.0 °F (yellow alarm)
Condenser Approach (°F)	0.34		-	-	Approach should be less than 3.5 °F (red alarm) and 2.5 °F (yellow alarm)
VSD Speed (%)	86.3%		-	-	Variable frequency drive should be at lower speeds at part lift and load conditions.
Inlet Guide Vane Position (%)	98.2%		-	-	Guide vanes should be greater than 20% open when chiller is operating at loads greater than 40%
Actual versus (Predicted) Chiller Efficiency	0.43 (0.43)		-	-	Actual chiller efficiency is within 5% of predicted chiller efficiency
Average Condenser Water Delta T (delta °F)	8.68		-	-	Average delta T should be less than design.
Chilled Water Temperature Set Point Difference (°F)	0.13		-	-	Actual chilled water supply temperature should be within 0.5°F of set point.

Recommended Actions

There are no recommended actions

Savings to Date – 6%

Month	Actual Ton Hours	Actual kW/Ton	Average Demand Reduction (kW)	Actual kWh Saved
Jun-20	36,339,945	0.76	1,802	1,297,296
Jul-20	44,465,023	0.79	2,305	1,714,576
Aug-20	41,482,745	0.78	2,460	1,830,344
Sep-20	32,805,074	0.76	2,120	1,526,382
Oct-20	26,295,248	0.71	1,911	1,421,481
Nov-20	22,794,551	0.62	1,982	1,427,048
Dec-20	16,055,010	0.58	1,706	1,269,568
YTD	220,237,595	0.74	2,041	11,449,950

Questions?

Thank you!

Mike Manoucheri, P.E.

Ben Erpelding, P.E.