



**Industrial Process Cooling (Chilled Water)
Systems**
Virtual INPLT Training & Assessment

Session 4

Thursday – August 1, 2024

10 am – 12:30 pm

Welcome

- Welcome to the 4th Chilled Water Systems Virtual INPLT training series
- Eight, 2-1/2 hour webinars, focused on Industrial Process Cooling (Chilled Water) Systems Energy Assessment and Optimization
- These webinars will help you gain a significant understanding of your industrial process cooling system, undertake an energy assessment using a systems approach, evaluate and quantify energy and cost-saving opportunities using CWSAT and other US DOE tools and resources
- Thank you for your interest!



Process Cooling (Chilled Water Systems) Virtual INPLT Facilitator



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Process Cooling Virtual INPLT Agenda (2024)

- Session 1 (July 17) – Industrial Chilled Water Systems Fundamentals
- Session 2 (July 18) – Review of Chilled Water System Scoping Tool; Efficiency Metrics & Calculations
- Session 3 (July 31) – Introduction to Chilled Water System Assessment Tool (CWSAT)
- **Session 4 (August 1) – Using CWSAT to Quantify Energy Efficiency Opportunities – Part 1**
- **Session 5 (August 14) – Using CWSAT to Quantify Energy Efficiency Opportunities – Part 2**
- **Session 6 (August 15) – US DOE MEASUR, 3EPlus, etc.; Undertaking a VINPLT Assessment & Reporting**
- **Session 7 (August 28) – Case Studies; Refrigerants – Past, Present & Future; Reclamation and O&M**
- **Session 8 (August 29) – Industrial Process Cooling (Chilled water) System VINPLT Wrap-up Presentations**

Agenda – Session 4

- Welcome and Introductions
- Safety and Housekeeping
- Today's Content:
 - Example Chilled Water Plant
 - Modeling in CWSAT – Base Model
- Kahoot Quiz Game
- Q&A



Safety and Housekeeping

- Safety Moment

- Chillers have oil sumps, filters, etc. – be careful when walking around a chiller – oil may be leaking on the floor or there may be a puddle making the floor extremely slippery – exercise caution, wear proper safety shoes to avoid slipping

- You are welcome to ask questions at any time during the webinar
- When you are not asking a question, please MUTE your mic and this will provide the best sound quality for all participants
- We will be recording all these webinars and by staying on-line and attending the meeting you are giving your consent to be recorded
 - A link to the recorded webinars will be provided, afterwards



Modeling the Example Chilled Water System in CWSAT

Aim of Student Exercise

- Provide an understanding of an actual industrial chilled water system
- Hands-on exercise to demonstrate operation and functionality of CWSAT in a real-life scenario
- Start from the basics and get into details and build a “Baseline Model” for a central chilled water system
- Students will learn to model their own chilled water plant and develop a baseline for the energy consumption and the breakdown of energy consumed by the individual sub-systems


Start CWSAT 3.0.1

<input type="checkbox"/>	Name	Status	Date modified	Type
<input type="checkbox"/>	OUTPUTDATA	✔	4/20/2022 8:42 AM	File folder
<input type="checkbox"/>	Sample Weather Upload Files	✔	4/20/2022 8:42 AM	File folder
<input type="checkbox"/>	User Manual	✔	4/20/2022 8:42 AM	File folder
<input type="checkbox"/>	USERCHILLER	✔	4/20/2022 8:42 AM	File folder
<input type="checkbox"/>	USERPROFILE	✔	4/20/2022 8:42 AM	File folder
<input type="checkbox"/>	WEATHER	✔	4/20/2022 11:22 AM	File folder
<input checked="" type="checkbox"/>	CWSAT 3.0.1	✔	4/20/2022 8:42 AM	Application
<input type="checkbox"/>	CWSAT	✔	4/20/2022 8:41 AM	Compressed (zip)

Chilled Water System Analysis Tool

Version 3.0.1

Description: This program calculates the annual energy requirements of various chilled water systems. It also evaluates the energy and cost savings that result when a variety of changes are made to the chilled water system.



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Continue

Facility Description

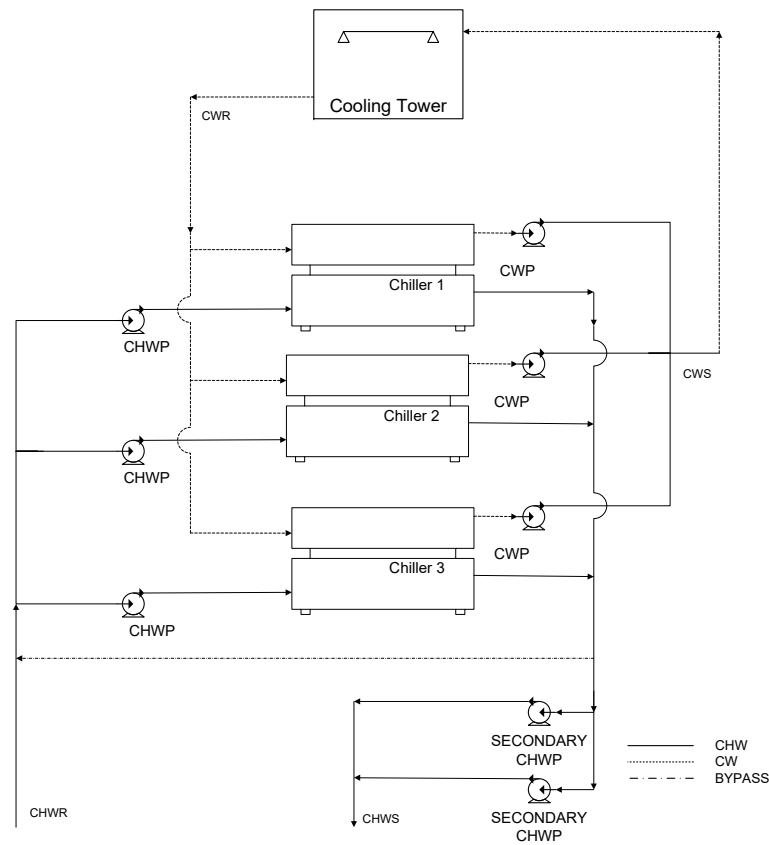
- The plant / facility is a large Food & Beverages plant located in the St. Louis, MO area
- The system selected for the energy assessment provides chilled water for process, packaging, air-conditioning plant areas and warehouse storage
- The plant operates a 3-shift per day operation, 8-hour per shift and runs all year round
- Possible shut-downs are planned for periodic maintenance activities

Description of Chilled Water System

Chilled Water System:

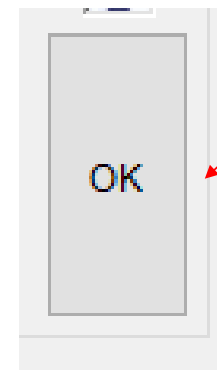
- Water-cooled
- 10 years old
- 3 Chillers
- 2 cell 1-speed Tower (1)
- Primary / Secondary Chilled Water Distribution System

High-level System Schematic



CWSAT INPUT Screenshots

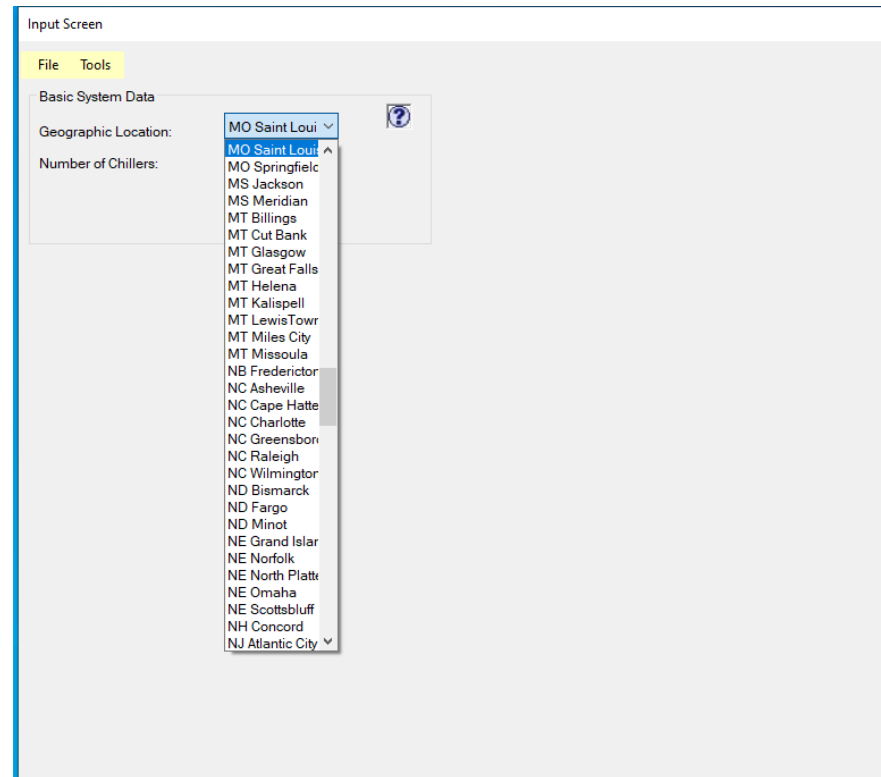
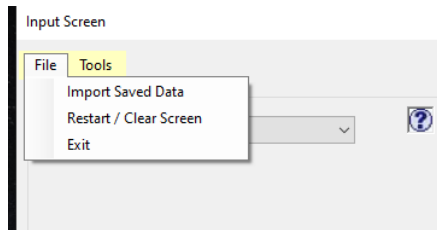
- Geographic location
- System description
- Heat rejection setup
- Pump setups
 - Chilled water
 - Condenser water (if applicable)
- Chiller setup
 - Default
 - Custom
- Utility Cost
- Operation Schedule & Load Profile



Click the “OK”
Button to
proceed to the
next Input Sub-
block

Input Geographic Location

- St. Louis, MO



Chiller Plant Information

- Number of Chillers: 3
- Chilled Water Setpoint: 44°F
- Water-Cooled Condensers

Input Screen

File Tools

Basic System Data

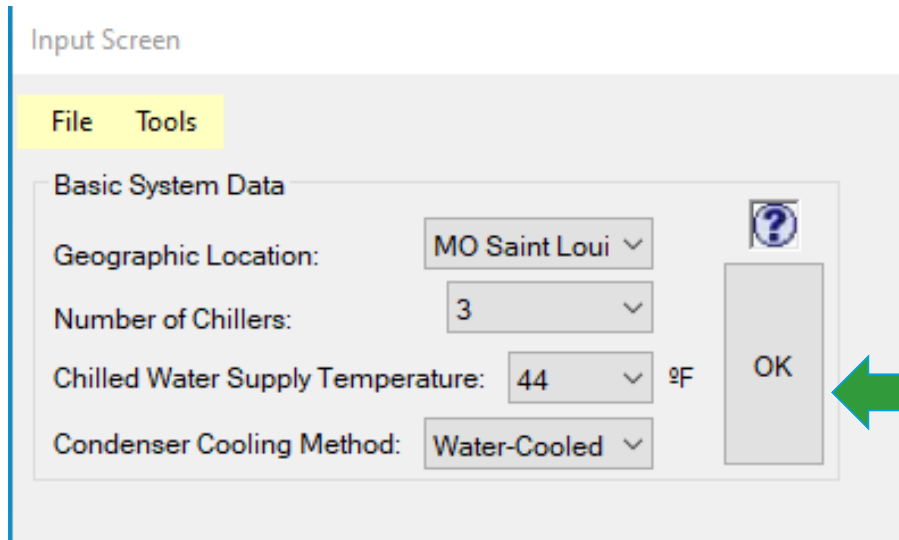
Geographic Location: MO Saint Loui ?

Number of Chillers: 3

Chilled Water Supply Temperature: 44 °F

Condenser Cooling Method: Water-Cooled

OK



Input Screen

File Tools

Basic System Data

Geographic Location: MO Saint Loui ?

Number of Chillers: 3

Chilled Water Supply Temperature: Default °F

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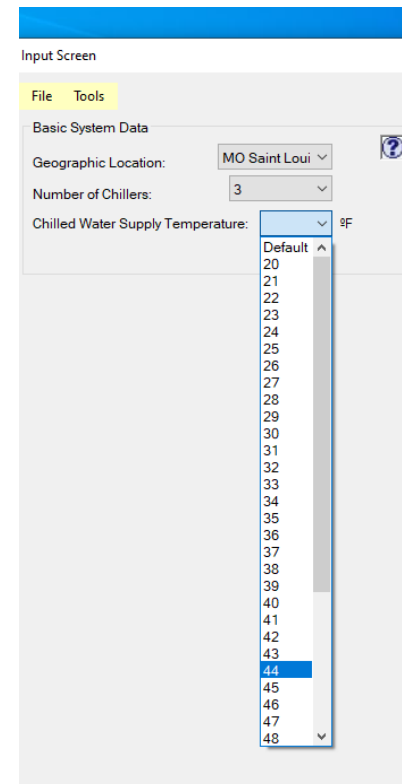
44

45

46

47

48



Default

Chiller Plant Information

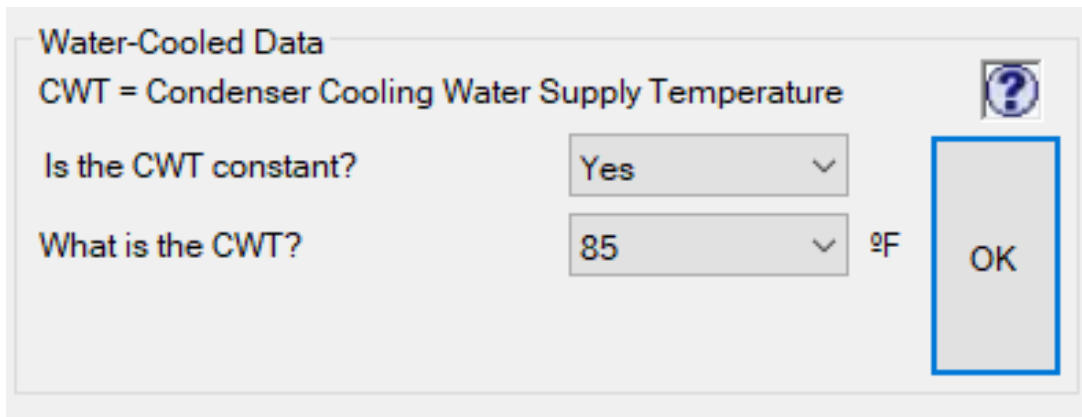
- Cooling Water Supply Temperature is **CONSTANT**
- Cooling Water Supply Setpoint: **85°F**
- Water-Cooled Condensers

Water-Cooled Data
CWT = Condenser Cooling Water Supply Temperature

Is the CWT constant? Yes

What is the CWT? 85 °F

OK

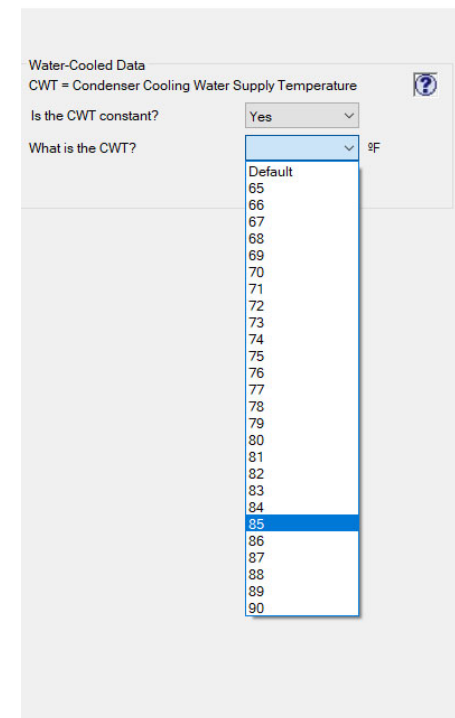


Water-Cooled Data
CWT = Condenser Cooling Water Supply Temperature

Is the CWT constant? Yes

What is the CWT? °F

Default
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Cooling Tower Information

- One tower with 2-cells and 1-speed motor
- Tower rated capacity – 2,000 RT

Tower Data

System with Free Cooling ? Yes No

Tower Type: 2-Cell With 1-Speed Motors

Num of Towers: 1

Size Tower by: Tons 2000 tons/tower

Axial Fan Type

OK

Tower Data

System with Free Cooling ? Yes No

Tower Type: 2-Cell With 1-Speed Motors

Num of Towers: 1




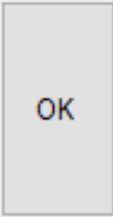
Sub-System Information

■ Chilled Water Pumps

- Primary
 - 3 x 15 hp Constant Speed
 - Flow rate based on 2.40 gpm/RT
- Secondary
 - 2 x 20 hp Variable Speed

■ Condenser Water Pumps

- 3 x 10 hp Constant Speed
- Flow rate based on 3.0 gpm/RT

Pump Data	CHW	CW	
Variable Flow?	No	No	
Flow Rate [gpm/ton]:	2.4	3	
Motor Size (hp):	Unknown	Unknown	
Pump Efficiency [%]:	75	75	
Motor Efficiency [%]:	85	85	

Unknown

Default



Sub-System Information

Input Screen

File **Tools**

Basic System Data

Geographic Location: MO Saint Loui

Number of Chillers: 3

Chilled Water Supply Temperature: 44 °F

Condenser Cooling Method: Water-Cooled

Water-Cooled Data

CWT = Condenser Cooling Water Supply Temperature

Is the CWT constant? Yes

What is the CWT? 85 °F

Tower Data

System with Free Cooling? Yes No

Tower Type: 2-Cell With 1-Speed Motors

Num of Towers: 1

Size Tower by: Tons 2000 tons/tower

Axial Fan Type

Pump Data

	CHW	CW
Variable Flow?	No	No
Flow Rate [gpm/ton]:	2.4	3
Motor Size (hp):	Unknown	Unknown
Pump Efficiency [%]:	75	75
Motor Efficiency [%]:	85	85

Current Chiller Data

User Chiller ? (Y/N)	Compressor/Chiller Type	Full Load Eff Known?	Chiller Capacity [tons]	Age [Years]
Chiller 1 <input type="radio"/> Y <input checked="" type="radio"/> N				
Chiller 2 <input type="radio"/> Y <input checked="" type="radio"/> N				
Chiller 3 <input type="radio"/> Y <input checked="" type="radio"/> N				

System Information


- Chillers:
 - 2 Centrifugals and 1 Screw machine (constant speed)
 - Centrifugals - 1,000 RT each
 - Screw - 350 RT
 - Rated Full Load Efficiency (kW/RT)
 - Centrifugals – 0.65
 - Screw – 0.75
 - Age: 10 years
 - Chilled Water Setpoint – 44°F
 - Condenser Water Supply Temperature – 85°F

System Information

- There are 3 methods to specify chillers in CWSAT
- Each chiller is specified independently and can be done in either of the 3 ways
- How you specify a chiller depends on how much information you have on the chiller
- CWSAT is built w/default information


Chiller Specification Methodology – Method 1

- No information about performance is known
- Following information is enough to use the default performance curves within CWSAT
 - Compressor type – Centrifugal, Screw (helical rotary), Reciprocating
 - Chiller Design Capacity (RT)
 - Age of chiller (years)

Current Chiller Data					
User Chiller ? (Y/N)	Compressor/Chiller Type	Full Load Eff Known?	Chiller Capacity [tons]	Age [Years]	
Chiller 1 <input type="radio"/> Y <input checked="" type="radio"/> N	Centrifugal	No	1000	10	

Chiller Specification Methodology – Method 2

- Full Load performance (kW/RT) is known but part-load information is not available
- Following information is enough to use the default performance curves within CWSAT
 - Compressor type – Centrifugal, Screw (helical rotary), Reciprocating
 - Chiller Design Capacity (RT)
 - Full Load Efficiency (kW/RT)
 - Age of chiller (years)

Current Chiller Data						
User Chiller ? (Y/N)	Compressor/Chiller Type	Full Load Eff Known?	Chiller Capacity [tons]	FLE Value [kW/ton]	Age [Years]	
Chiller 1 <input type="radio"/> Y <input checked="" type="radio"/> N	Centrifugal	Yes	1000	0.65	10	



Chiller Specification Methodology – Method 3

- Full Load performance (kW/RT) is known
- Part-load information is also available
- The following information is used to build a performance curve for the specific chiller in CWSAT
 - Compressor type – Centrifugal, Screw (helical rotary), Reciprocating
 - Chiller Design Capacity (RT)
 - Efficiency (kW/RT) at the following load conditions
 - 25% load
 - 50% load
 - 75% load
 - 100% load

Chiller Specification Methodology – Method 3

Input Screen

File Tools

Upload New Geographical Location

Define Chiller

Basic

Geographic Location: [dropdown]

Number of Chillers: 3

Chilled Water Supply Temperature: 44 °F

Condenser Cooling Method: Water-Cooled

Water-Cooled Data

CWT = Condenser Cooling Water Supply Temperature

Is the CWT constant? Yes

What is the CWT? 85 °F

Tower Data

System with Free Cooling? Yes No

Tower Type: 2-Cell With 1-Speed Motors

Num of Towers: 1

Size Tower by: Tons 2000 tons/tower

Axial Fan Type

Pump Data

CHW CW

Variable Flow? No No

Flow Rate [gpm/ton]: 2.4 3

Motor Size (hp): Unknown Unknown

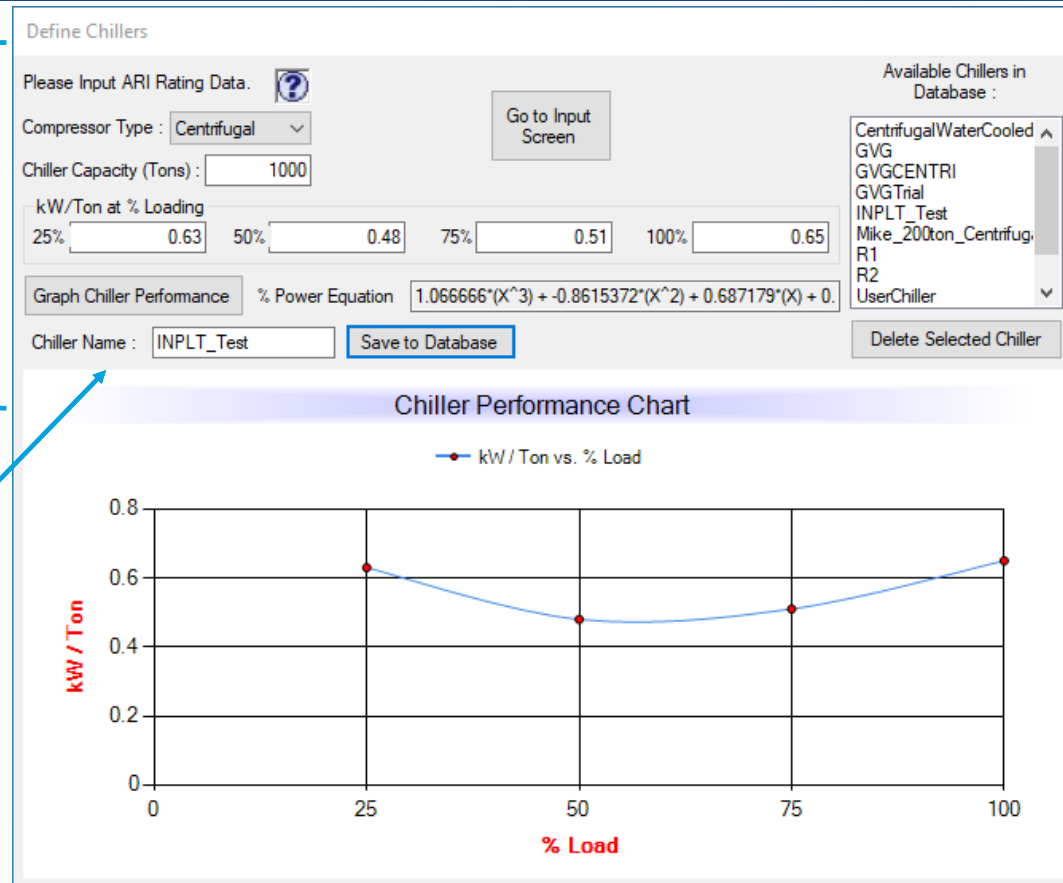
Pump Efficiency [%]: 75 75

Motor Efficiency [%]: 85 85

Current Chiller Data

User Chiller ? (Y/N)	Compressor/Chiller Type	Full Load Eff Known?	Chiller Capacity [tons]	FLE Value [kW/ton]	Age [Years]
Chiller 1 <input type="radio"/> Y <input checked="" type="radio"/> N	Centrifugal	Yes	1000	0.65	10
Chiller 2 <input type="radio"/> Y <input checked="" type="radio"/> N	[dropdown]				
Chiller 3 <input type="radio"/> Y <input checked="" type="radio"/> N	[dropdown]				

Chiller Specification Methodology – Method 3



- Provide Chiller Name and it will now show up in the database

Chiller Specification Methodology

- Method 3 is the ideal way to specify chillers in CWSAT
- It will require some due diligence and information gathering but to build confidence in the assessment and results thereafter, it is well worth the extra effort
- Nevertheless, it should not be a show-stopper and if getting the information is delayed, use Method 2 – FLE required
- Method 1 should NOT be used for assessments and quantifying energy efficiency opportunities but can be used for scoping purposes

System Information

- Chillers:
 - 2 Centrifugals and 1 Screw machine (constant speed)
 - Centrifugals - 1,000 RT each
 - Screw - 350 RT
 - Rated Full Load Efficiency (kW/RT)
 - Centrifugals – 0.65
 - Screw – 0.75
 - Age: 10 years
 - Chilled Water Setpoint – 44°F
 - Condenser Water Supply Temperature – 85°F

Use Method 2

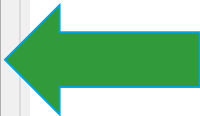
System Information

Current Chiller Data

User Chiller ? (Y/N)	Compressor/Chiller Type	Full Load Eff Known?	Chiller Capacity [tons]	FLE Value [kW/ton]	Age [Years]	
Chiller 1						
<input type="radio"/> Y <input checked="" type="radio"/> N	Centrifugal	Yes	1000	0.65	10	
Chiller 2						
<input type="radio"/> Y <input checked="" type="radio"/> N	Centrifugal	Yes	1000	0.65	10	
Chiller 3						
<input type="radio"/> Y <input checked="" type="radio"/> N	Helical Rotary	Yes	350	0.75	10	

?

OK



System Information

Input Screen

File Tools

Basic System Data

Geographic Location: MO Saint Loui

Number of Chillers: 3

Chilled Water Supply Temperature: 44 °F

Condenser Cooling Method: Water-Cooled

Water-Cooled Data

CWT = Condenser Cooling Water Supply Temperature

Is the CWT constant? Yes

What is the CWT? 85 °F

Tower Data

System with Free Cooling? Yes No

Tower Type: 2-Cell With 1-Speed Motors

Num of Towers: 1

Size Tower by: Tons 2000 tons/tower

CHW CW

Pump Data

Variable Flow? No No

Flow Rate [gpm/ton]: 2.4 3

Motor Size (hp): Unknown Unknown

Pump Efficiency [%]: 75 75

Motor Efficiency [%]: 85 85

Current Chiller Data

User Chiller ? (Y/N)	Compressor/Chiller Type	Full Load Eff Known?	Chiller Capacity [tons]	FLE Value [kW/ton]	Age [Years]
<input type="radio"/> Y <input checked="" type="radio"/> N	Centrifugal	Yes	1000	0.65	10
<input type="radio"/> Y <input checked="" type="radio"/> N	Centrifugal	Yes	1000	0.65	10
<input type="radio"/> Y <input checked="" type="radio"/> N	Helical Rotary	Yes	350	0.75	10

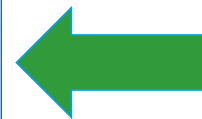
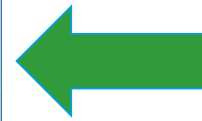
Energy Cost Data

Electricity Cost: 0.10 [\$/kWh]

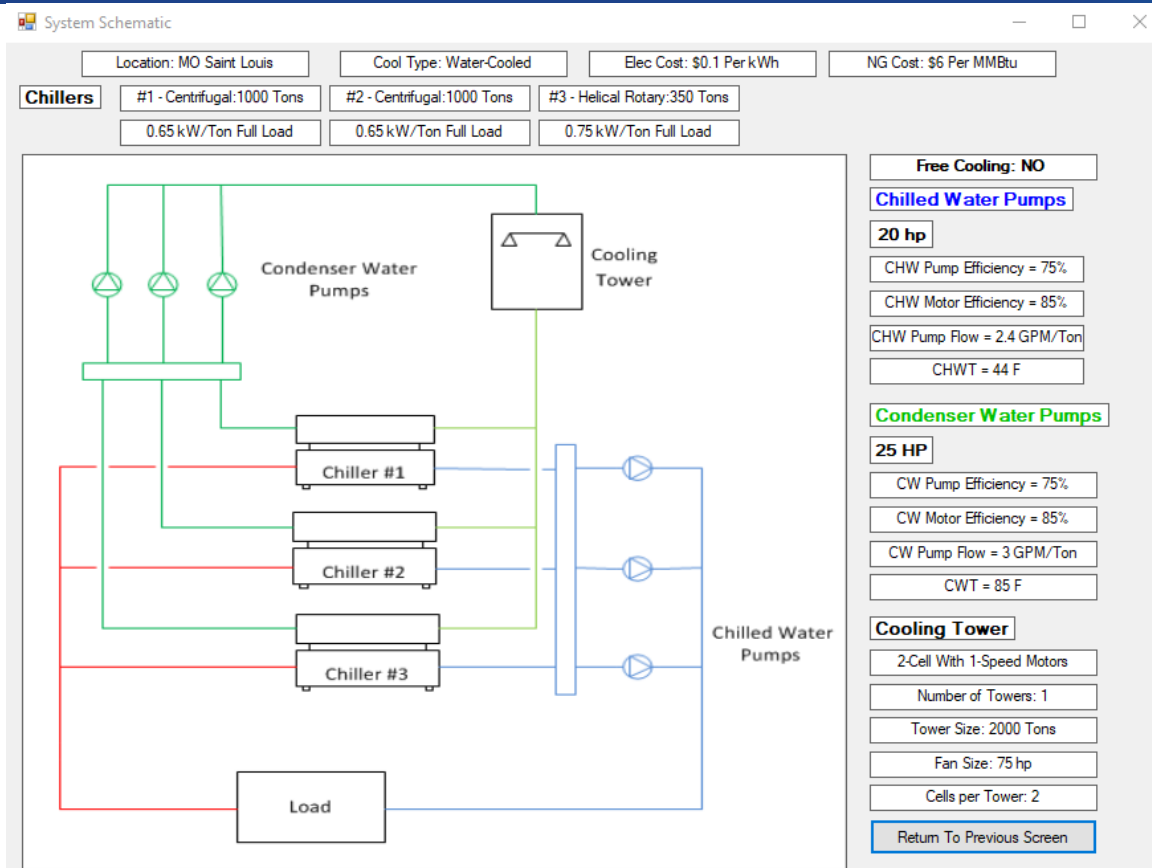
Natural Gas Cost: 6.00 [\$/MMBtu]

OK

- The electricity utility rate is a very important number
- For CWSAT – a bundled cost (annual average) should be used
- For more detailed analysis, multiple bin models can be developed
- Natural gas cost can be ignored



System Schematic



Review

Operating Schedule Information

- Operating Schedule provides information on when the chilled water plant is ON or OFF.
- Simplest option – plant is ON all year round (24x7) – 8,760 hours
- ONLY if the chilled water plant is turned OFF manually or if it is on an automatic ON/OFF schedule based on day of the week, shift schedule, etc. should this operating schedule screen be used for details
- If a chiller turns OFF automatically because the chilled water system load is met, that information is captured on the load profile

Operating Schedule Information

Operating Schedule Screen

Weekly Operating Schedule

Please input the typical weekly operating hours for the chiller. This information is used to exclude weather data for non-operating hours.
If system is ON all day, start: 0000; finish: 2400
If system is OFF all day, set values equal.

Sunday	0000	To	2400
Monday	0000		2400
Tuesday	0000		2400
Wednesday	0000		2400
Thursday	0000		2400
Friday	0000		2400
Saturday	0000		2400

Monthly Operating Schedule

Please input the typical monthly operating hours for the system. The allowable input values are in increments of 24 hours. This information is used to calculate the annual operating hours of the chilled water system..

January	744	hours	July	744	hours
February	672	hours	August	744	hours
March	744	hours	September	720	hours
April	720	hours	October	744	hours
May	744	hours	November	720	hours
June	720	hours	December	744	hours

Weekly: M-F, 8-5 only

Weekly: Copy Mon to Tue-Fri

Input: 8,760 Hours

Loading Data
Does the chilled water system load vary according to the ARI 550/590 schedule?

Monthly: Maximum hours

Restart Screen
Exit Program



Individual Chiller Load Profile

- The geographic location's weather data, load profile along with the operating schedule allows the CWSAT to allocate actual cooling load (RT) for each hour of operation to each chiller
- CWSAT does a very detailed chilled water system analysis – 8,760 individual runs representing each specific hour of the year
- CWSAT has an algorithm to match every hour of the year with the actual operating load and corresponding efficiency based on the system

Individual Chiller Load Profile

- CWSAT offers a default AHRI chiller load profile
- This can be used when
 - The cooling load is purely HVAC (or predominantly HVAC > 90%)
 - Chiller load information is not available yet but it is clear that a major portion of the load (50% or so) is comfort cooling for personnel and environment

Chiller Loading Schedule											
Chiller	0% load	10% Load	20% load	30% load	40% load	50% load	60% load	70% load	80% load	90% load	100% load
ARI	0%	0%	1%	5%	13%	23%	26%	19%	9%	3%	1%

Individual Chiller Load Profile

Loading Data
Does the chilled water system load vary according to the ARI 550/590 schedule? Yes


Loading Data
Does the chilled water system load vary according to the ARI 550/590 schedule? No
Does chiller loading vary from month to month? Yes
Does chiller loading vary from chiller to chiller? Yes

- AHRI Load profile selection
- Chiller load variation – month to month
- Load variation between chillers

Individual Chiller Load Profile

- Most Complex
- Most Detailed
- Recommended for Assessments
- Can capture seasonality of operations, weather impacts, etc.

Loading Schedule Screen

Provide the loading schedule for the chiller(s). 

Chiller #	Compressor Type	Capacity [tons]	Age [yrs]
1	Centrifugal	1000	10

Loading Schedule

Time at:	0% Load	10% Load	20% Load	30% Load	40% Load	50% Load	60% Load	70% Load	80% Load	90% Load	100% Load	Total % Load
January	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="100"/>
February	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="100"/>
March	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="100"/>
April	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="100"/>
May	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="100"/>
June	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="100"/>
July	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="100"/>
August	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="100"/>
September	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="100"/>
October	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="100"/>
November	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="100"/>
December	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="100"/>

Example System Chiller Load Profile

Operating Schedule Screen : VINPLT_Example

Weekly Operating Schedule

Please input the typical weekly operating hours for the chiller. This information is used to exclude weather data for non-operating hours.
If system is ON all day, start: 0000; finish: 2400
If system is OFF all day, set values equal.

Sunday	0000	To	2400
Monday	0000		2400
Tuesday	0000		2400
Wednesday	0000		2400
Thursday	0000		2400
Friday	0000		2400
Saturday	0000		2400

Monthly Operating Schedule

Please input the typical monthly operating hours for the system. The allowable input values are in increments of 24 hours. This information is used to calculate the annual operating hours of the chilled water system..

January	744	hours	July	744	hours
February	672	hours	August	744	hours
March	744	hours	September	720	hours
April	720	hours	October	744	hours
May	744	hours	November	720	hours
June	720	hours	December	744	hours

Loading Data

Does the chilled water system load vary according to the ARI 550/590 schedule? No

Does chiller loading vary from month to month? No

Does chiller loading vary from chiller to chiller? Yes

Monthly: Maximum hours

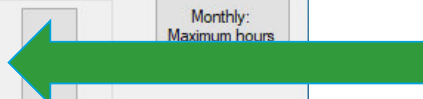
Weekly: M-F, 8-5 only

Weekly: Copy Mon to Tue-Fri

Input: 8,760 Hours

Restart Screen


Exit Program



Centrifugal Chillers Load Profile

- There are 2 centrifugal chillers that are operated in a manner such that they are at similar load conditions all the time unless there is maintenance activity on one of them

Loading Schedule Screen : VINPLT_Example

Provide the loading schedule for the chiller(s). 

Chiller #	Compressor Type	Capacity [tons]	Age [yrs]
Current Chiller 1	Centrifugal	1000	10


Loading Schedule

Time at:

0% Load	10% Load	20% Load	30% Load	40% Load	50% Load	60% Load	70% Load	80% Load	90% Load	100% Load	Total % Load
5	0	0	0	10	20	20	20	15	10	0	100

All Months


Copy Paste



Centrifugal Chillers Load Profile

- There are 2 centrifugal chillers that are operated in a manner such that they are at similar load conditions all the time unless there is maintenance activity on one of them

Loading Schedule Screen : VINPLT_Example

Provide the loading schedule for the chiller(s). 

Chiller #	Compressor Type	Capacity [tons]	Age [yrs]
Current Chiller			
2	Centrifugal	1000	10


Loading Schedule

Time at:

0% Load	10% Load	20% Load	30% Load	40% Load	50% Load	60% Load	70% Load	80% Load	90% Load	100% Load	Total % Load
5	0	0	0	10	20	20	20	15	10	0	100

All Months


Copy Paste



Screw Chiller Load Profile

- Chiller #3 is a screw chiller that does come ON periodically when loads are high or when one of the centrifugal chillers is down for maintenance

Loading Schedule Screen : VINPLT_Example

Provide the loading schedule for the chiller(s). 

Chiller #	Compressor Type	Capacity [tons]	Age [yrs]
Current Chiller			
3	Helical Rotary	350	10

Loading Schedule

Time at:	0% Load	10% Load	20% Load	30% Load	40% Load	50% Load	60% Load	70% Load	80% Load	90% Load	100% Load	Total % Load
All Months	30	0	0	30	0	30	0	0	0	0	10	100

Copy Paste



All INPUT is COMPLETE!

- At this point in CWSAT – all the inputs required for modeling the chilled water system are completed
- The next step is to “Go to Output Screen”
- The Output Screen is a high-level summary of the overall chilled water plant operations
- It has options to go into details of the sub-systems

Output Screen (Baseline)

- All the major inputs are shown here
- Annual energy consumption (kWh)
- Annual operating cost (\$)
- System graphic
- Energy / Cost graphic

Output Screen : VINPLT_Example

Current Chiller System

Basic System Summary

Number of Chillers:

CHWT Setpoint:

Geographic Location:

Condenser Cooling Method:

Water-Cooled Summary

Constant CWT?:

Constant CWT Setpoint:

Tower Summary

Type:

#Towers: Sizing:

Fan Motor HP: Tons:

Number of Cells per Tower:

Pump Summary

	CHW	CW
Variable Flow?:	<input type="text" value="No"/>	<input type="text" value="No"/>
Flow Rate [gpm/ton]:	<input type="text" value="2.4"/>	<input type="text" value="3"/>
Motor Size (hp):	<input type="text" value="20"/>	<input type="text" value="25"/>
Pump Efficiency [%]:	<input type="text" value="75"/>	<input type="text" value="75"/>
Motor Efficiency [%]:	<input type="text" value="85"/>	<input type="text" value="85"/>

Current Chiller Summary

Compressor	Capacity [tons]	Age [years]	FLE [kW/ton]
Chiller 1			
Centrifugal	<input type="text" value="1000"/>	<input type="text" value="10"/>	<input type="text" value="0.650"/>
Chiller 2			
Centrifugal	<input type="text" value="1000"/>	<input type="text" value="10"/>	<input type="text" value="0.650"/>
Chiller 3			
Helical Rotary	<input type="text" value="350"/>	<input type="text" value="10"/>	<input type="text" value="0.750"/>

Energy Summary

Chiller Energy: kWh

Tower Energy: kWh

Pump Energy: kWh

Total Energy: kWh

Go To Operating Cost Reduction Screen

Go To Current Chiller Details Screen

Go To Current Tower Details Screen

Go To Current Pump Details Screen

Return to Input Screen

Export to File

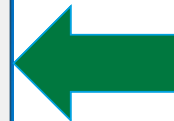
Show System Graphic

Show Energy/Cost Graphic

Exit Program

Comments Outtemp

Detail Screens



Energy Usage & Cost Graphic (Baseline)



Chiller Operating Details Screen (Baseline)

Current Chiller Details Screen : VINPLT_Example.txt

	0% Load	10% Load	20% Load	30% Load	40% Load	50% Load	60% Load	70% Load	80% Load	90% Load	100% Load	Total
Chiller 1: Centrifugal (Rated Capacity: 1000 tons)												
[kW/ton]:	0.000	0.000	0.000	0.000	0.608	0.591	0.592	0.609	0.638	0.675	0.000	
Hours:	444	0	0	0	873	1,754	1,753	1,746	1,317	873	0	8,760
Power [kW]:	0.0	0.0	0.0	0.0	243.1	295.6	355.2	426.4	510.1	607.3	0.0	
Energy [kWh]:	0	0	0	0	212,211	518,474	622,681	744,485	671,859	530,216	0	3,299,925
Chiller 2: Centrifugal (Rated Capacity: 1000 tons)												
[kW/ton]:	0.000	0.000	0.000	0.000	0.608	0.591	0.592	0.609	0.638	0.675	0.000	
Hours:	444	0	0	0	873	1,754	1,753	1,746	1,317	873	0	8,760
Power [kW]:	0.0	0.0	0.0	0.0	243.1	295.6	355.2	426.4	510.1	607.3	0.0	
Energy [kWh]:	0	0	0	0	212,211	518,474	622,681	744,485	671,859	530,216	0	3,299,925
Chiller 3: Helical Rotary (Rated Capacity: 350 tons)												
[kW/ton]:	0.000	0.000	0.000	0.932	0.000	0.820	0.000	0.000	0.000	0.000	0.826	
Hours:	2,634	0	0	2,627	0	2,626	0	0	0	0	873	8,760
Power [kW]:	0.0	0.0	0.0	97.8	0.0	143.4	0.0	0.0	0.0	0.0	289.0	
Energy [kWh]:	0	0	0	257,036	0	376,682	0	0	0	0	252,271	885,988

Pumps Operating Details Screen (Baseline)

- Be careful with this output – water flow rate allocation is an issue
- It's a good estimate but actual operation may be different
- Assumes no flow when chiller is OFF
- Primary loop ONLY

Current Pump Details Screen : VINPLT_Example.txt

Chilled Water Pump Summary		Condenser Water Pump Summary	
Variable Flow?:	<input type="text" value="No"/>	Variable Flow?:	<input type="text" value="No"/>
Flow Rate [gpm/ton]:	<input type="text" value="2.4"/>	Flow Rate [gpm/ton]:	<input type="text" value="3"/>
Motor Size (hp):	<input type="text" value="20"/>	Motor Size (hp):	<input type="text" value="25"/>
Pump Efficiency [%]:	<input type="text" value="75"/>	Pump Efficiency [%]:	<input type="text" value="75"/>
Motor Efficiency [%]:	<input type="text" value="85"/>	Motor Efficiency [%]:	<input type="text" value="85"/>

Chilled Water Pumping Energy [kWh]		Condenser Water Pumping Energy [kWh]	
	Constant Flow		Constant Flow
Chiller 1:	<input type="text" value="145,970"/>	Chiller 1:	<input type="text" value="182,463"/>
Chiller 2:	<input type="text" value="145,970"/>	Chiller 2:	<input type="text" value="182,463"/>
Chiller 3:	<input type="text" value="107,529"/>	Chiller 3:	<input type="text" value="134,412"/>
Total:	<input type="text" value="399,470"/>	Total:	<input type="text" value="499,337"/>

[Return to Output Screen](#)

Tower Operating Details Screen (Baseline)

- Model provides good results when the cooling towers are within reasonable design limits
- Look for number of hours when the tower setpoint is NOT achieved

Current Tower Details Screen : VINPLT_Example.txt

The screenshot displays the 'Tower Summary' and 'Tower Energy Summary' sections. A red arrow points to the 'Fan CWT Setpoint Not Achieved' field, which shows a value of 48. The 'Tower Energy Summary' table shows the number of hours and energy consumption for different wet-bulb temperature bins.

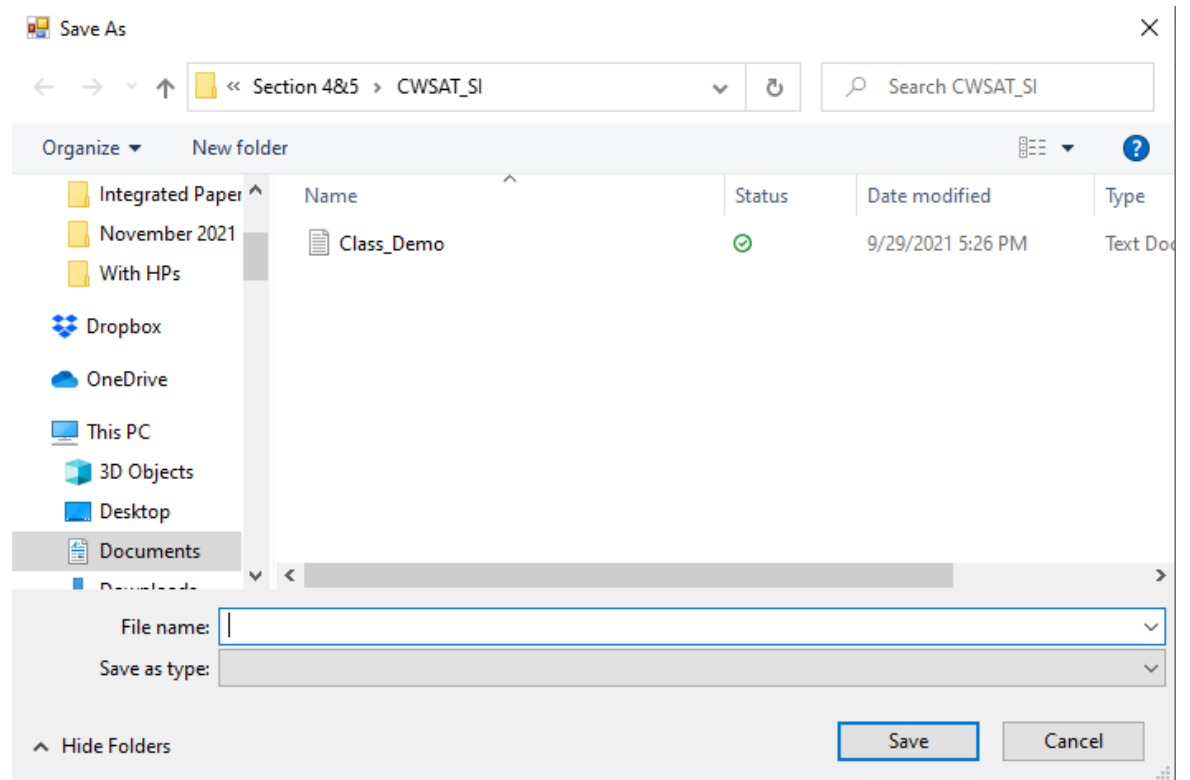
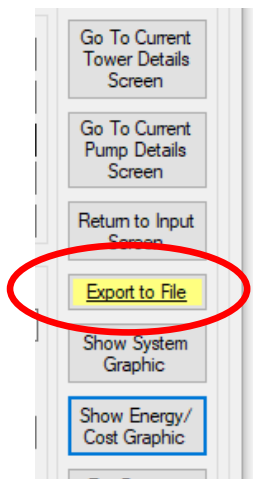
WB Bin:	WB < 35 °F	35 - 45 °F	45 - 55 °F	55 - 65 °F	65 - 75 °F	WB > 75 °F	Total
Hours:	2,030	1,464	1,296	1,680	1,898	392	8,760
Energy [kWh]:	0	0	0	13,965	91,048	33,804	138,817

Note: Tower calculations are made on an hourly basis. Bins are shown here for brevity

Return to Output Screen

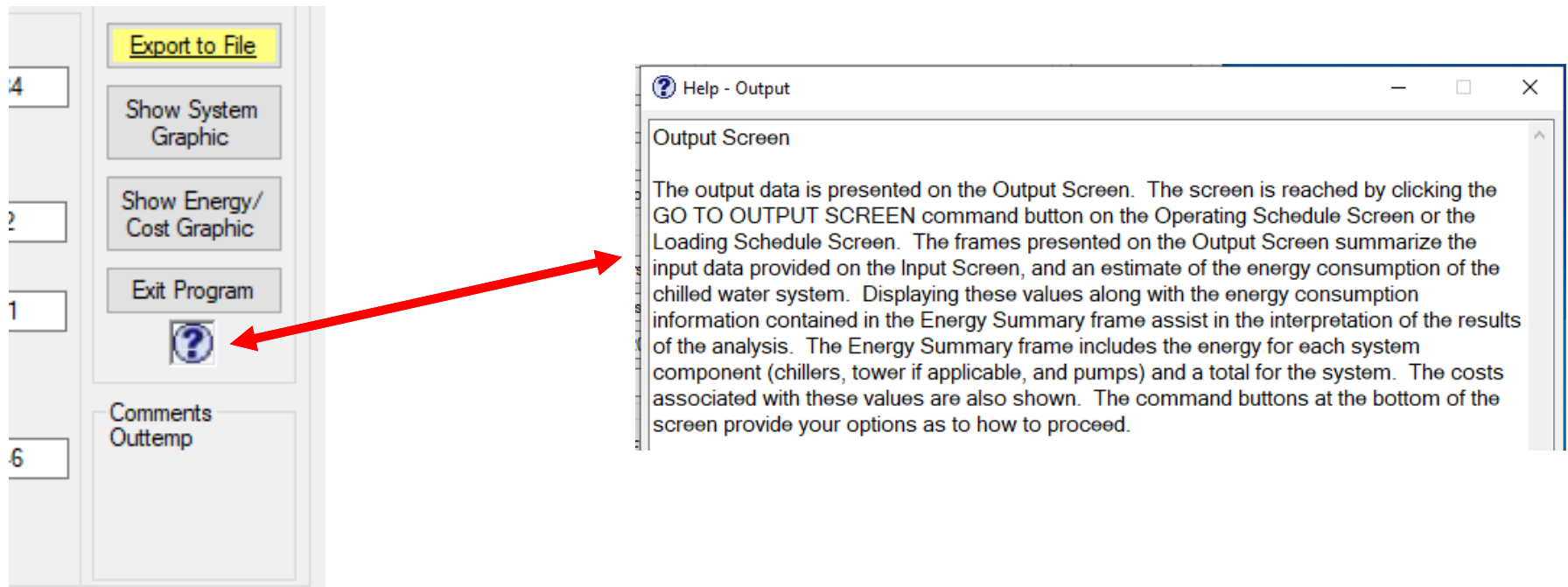
Saving the Baseline Model file – MOST IMPORTANT!

- Output Screen



The HELP Button

- Use it as often as you need



Additional CWSAT Topics

- Installing and weather folder location / use
- Input Sensitivity
- Hourly text files output
- Detailed results screens
- Tool Benefits:
 - Energy end-use distribution
 - Identify areas to examine for conservation
 - “What-if” analyses

CWSAT Folder & Files

- CWSAT 3.0.1 – Application file which runs CWSAT
- Folder – USERCHILLER – Stores data of all user-defined chillers and their performance curves so that one can retrieve them for modeling in the chilled water system
 - Ideal when user has all the information about their chillers and DO NOT want to use the default performance curve built-in in CWSAT
- Folder – WEATHER – Stores weather data for all the geographical locations that can be used by CWSAT (pull down menu on INPUT screen)
 - One can add more weather data in this folder using the same format provided in any of the weather files
 - WEATHER folder is weather files for cities in US/Canada

CWSAT Folder & Files

- Folder – OUTPUTDATA – Stores all the Output data in an extremely detailed hour-by-hour (8,760) manner
 - Can be used when user wants to export results, operational information to another program (for example - Excel)
 - Ability to debug and additionally, parse data for specific day/time operation
- Chilled water plant models can be stored anywhere on your computer - They don't need to be in a specific location
 - SUGGESTION – Make your personal model folder within the CWSAT main folder and store all your work there – easier to reach the files since they will all be in one place and will minimize searching
- Please DO NOT move any other files and folders

Key Points / Action Items



1. *A chilled system consists of multiple chillers and NOT all chillers have the same performance curves – full load and part-load*
2. *To do an accurate model, it is important to have the part-load design performance of each chiller and define the chillers in CWSAT*
3. *CWSAT can model a chilled water system and provide significant details to understand overall operations of the plant*



Homework #4

- Attempt to build a chilled water system model in CWSAT of your own chilled water plant
- Use default information of CWSAT wherever your information is not available
- Compare the CWSAT annual energy usage and costs with information that you may have on your plant
- Identify areas that you had difficulty in understanding and modeling
- Identify discrepancies and shortcomings, if any, in the CWSAT software

Thank You all for attending today's webinar.

See you all on Wednesday – August 14, 2024 – 10 am ET

If you have specific questions, please stay online and we will try and answer them.

Alternately, you can email questions to me at paparra@ornl.gov

Kahoot Quiz Time

