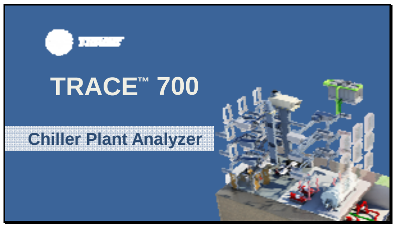
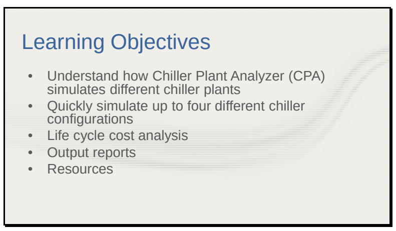
Slide 1



Hello, my name is Austin Kaiser and I'm a marketing engineer in the C.D.S. group at Trane.

Today, I am going to show you how to set up and run a chiller plant analyzer file to evaluate four different alternatives.

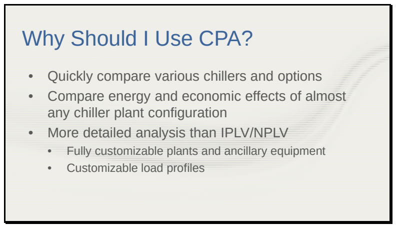
Slide 2



In this video, we will explain the methodology or how chiller plant analyzer simulates various chiller plants and how it is different than TRACE. We will go through an example chiller plant scenario and model 4 alternatives to see which produces the lowest life cycle cost. We will also review some of the other output reports and resources available to help you with chiller plant analyzer.

Keep in mind that this in an introductory tutorial to chiller plant analyzer and will not cover all of the details of the program. An understanding of the TRACE 700 application functionality will help to fill in what is not covered in this video.

Slide 3



Let's quickly discuss why you might benefit from using chiller plant analyzer. The main reason that you would use this tool in general, or instead of TRACE 700, is because it is simple and fast. If you easily want to compare different plant configurations or equipment efficiencies, chiller plant analyzer is the tool for you! It is easy to configure numerous plant configurations with the detailed wizard tool. And you can quickly compare up to 4 alternatives, for example: chillers in parallel versus series versus ice storage versus heat recovery.

Chiller plant analyzer will allow you to evaluate the economic impact and life cycle cost payback of almost any chiller plant configuration. The life cycle cost of a chiller is much more significant than its initial cost, so it is important to evaluate this when specifying and purchasing equipment, especially considering that chillers will last an average of 20 to 25 years!

Additionally, some people use IPLV or NPLV efficiency values to quickly calculate a life cycle cost for a chiller. Chiller plant analyzer will give you much more accurate energy and economic information compared to using IPLV or NPLV efficiencies for life cycle cost estimates. The IPLV value was not intended to be used to predict the annualized energy consumption of a chiller in any specific application or operating conditions. It does not take into account any specific weather location or building load profile, like chiller plant analyzer does. For more information on why IPLV and NPLV should not be used for energy analysis, see the AHRI standard 550/590 Appendix D and the ASHRAE Journal Article titled “A Closer Look at Chiller Ratings.”

Unlike IPLV or NPLV, chiller plant analyzer will give you the ability to evaluate the total energy use of the plant, including the chiller, cooling tower, pumps, etc. It also allows for full customization of the load profiles and equipment.

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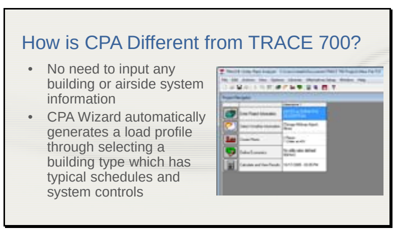
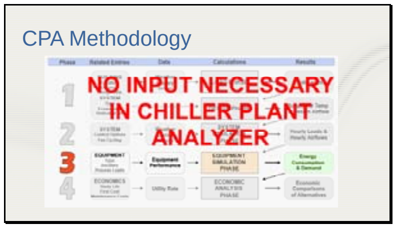


If you have used TRACE before, but not chiller plant analyzer, you might be wondering how chiller plant analyzer is different from TRACE.
Chiller plant analyzer looks and feels similar to TRACE 700, but it does not have the ***inputs*** associated with the building information or the airside system. The chiller plant analyzer wizard creates the building construction, system inputs, and airside system control options automatically when you choose a building type and load capacity in the wizard. The building load is created automatically so you do not need to spend time with the room or airside system inputs.

Slide 5

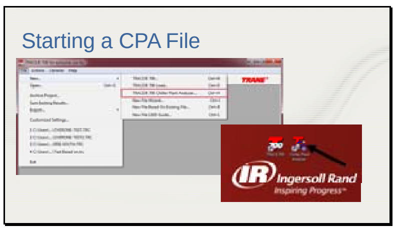


Now let's look at the methodology of chiller plant analyzer. You will see here that there are four phases that TRACE uses to define and calculate the building load profiles and energy and economic information.

In phase 1, TRACE determines the <u>peak</u> loads and airflows for the building. In phase 2, TRACE determines the <u>hourly</u> loads and airflows, or the off-peak information. TRACE then reads the load information from the first two phases into Phase 3 where the loads are then translated into energy use. The economic comparison using the utility rate information is then determined in Phase 4. Chiller plant analyzer ONLY focuses on phases 3 and 4. During the equipment simulation phase, chiller plant analyzer takes the peak loads of the building, combined with the equipment selected, the part load curves, pump energy, full load equipment energy rates, etc. and uses this data to calculate the consumption and demand of the chiller plant.

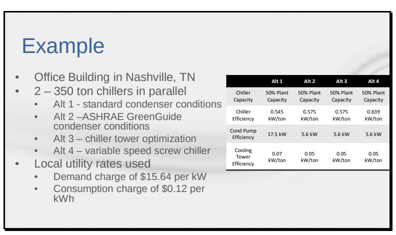
You will not enter in each room, wall, window, construction type, and so on, which saves about 90% of the time it takes to create and run the file. Since the chiller plant analyzer wizard generates the building and system inputs automatically, they cannot be modified or changed. Keep in mind that the results will not be as specific or detailed as a TRACE run because you are not inputting your specific construction types, windows, airside systems, or any other similar data like you would in TRACE 700.

Slide 6



Now that you know more about when to use chiller plant analyzer and how the methodology works, let's look at the basic inputs of the program.
Keep in mind that if you have TRACE 700, you have the chiller plant analyzer software installed already!
To start the program, you can either start a new chiller plant analyzer file directly from TRACE, or you can use the shortcut icon on your desktop or start menu.

Slide 7



To show you how to set up and run a file in chiller plant analyzer, we will go through an example and evaluate 4 different chiller plant configurations.
This example involves an office building in Nashville, TN with a cooling load of 700 tons. Heating will be ignored in this example for sake of time.
We will have 2, 350 ton variable speed centrifugal chillers in parallel for 3 of the alternatives. We will use a 42F leaving evap temperature with a 14F delta T for

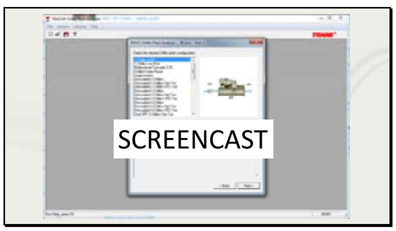
all alternatives. Since the chilled water side is not changing at all between the alternatives, we will set the chilled water pump energy to zero and keep the secondary distribution pump full load energy consumption at the default value.

Alternate 1 will be the baseline and will evaluate the chillers with standard condenser conditions.
Alternate 2 will evaluate the chillers with ASHRAE GreenGuide condenser water flow conditions, which are lower flow, higher delta T conditions.
Alternative 3 will keep the low flow condenser and add chiller tower optimization on the cooling tower side.
Alternative 4 will be the same as alternative 3, but with variable speed screw chillers instead of centrifugals.

The utility rate information that we will use for Nashville will be a demand charge of $15.64 per kW and a consumption charge of $0.12 per kWh. Make sure that you understand and input your local utility rates instead of using one of the default library members. Utility rate information can be very complex and you will not get a realistic life cycle cost analysis if you do not enter in the correct utility rate info. For more information on utility rate inputs, please reference the TRACE User's Manual. Another good ASHRAE Journal article on this topic is, "The Hidden Daytime Price of Electricity."

Now, let's open the program and set up this example.

Slide 8



This is the first screen you will see once you open the program and name your file. Remember that file names should be shorter than 15 characters and contain no special characters.

As you can see, chiller plant analyzer is a wizard tool – you will need to select the chiller plant that you want to start with from the configuration menu. Notice that each chiller plant configuration has a description and a picture associated with it. If this wizard does not have your specific chiller plant configuration (air cooled chillers, for example), you can modify the configuration later on. So don't worry if you do not see your specific plant configuration on this screen.

I will start with Alternative 1 by picking the Manifold Variable Primary Flow 2 Chillers VFD Tower plant configuration. From the picture and description, you will see that this configuration puts the 2 centrifugal chillers in parallel and includes a VFD on the cooling tower. Once I hit next, I will need to select my weather location. Chiller plant analyzer has over 500 weather locations to choose from, plus the ability to import full year weather data from sources such as the Department of Energy. I will select my weather location as Nashville, TN. Step 3 of the chiller plant analyzer wizard is selecting the building type and specifying the building profile peak loads. TRACE creates a profile based on the weather selected and the peak tonnage defined. The building type selected has typical occupancy, plug load, and fan schedules. All buildings have a choice of with or without economizer. Keep in mind that an airside economizer may limit the amount of waterside free cooling available. I will select an office with economizer for our example and enter 700 cooling tons. Even though we are not modeling a heating plant for this example, keep in mind that there always needs to be a heating plant in TRACE or chiller plant analyzer. This is simply a limitation of the tool. If you do not wish to model heating in your plant, enter a small number, like 0.01, so it does not impact the associated heating equipment in your facility.

Once you hit finish, chiller plant analyzer will export the weather and run through a building analysis, quickly. You will automatically be brought to the economics section next. On the Utility Rates & Life Cycle Costs tab, you will enter in the equipment installed cost, which may include the chillers, pumps, piping, cooling towers, controls, etc. You can also add any maintenance expenses and other first costs like the contractor install cost. Since most of this information varies greatly between jobs, I will keep it simple and only enter in an estimated equipment installed cost. Keep in mind that I did not get specific quotes for any of the equipment so this number is just a rough estimate. Next, make sure to select the appropriate utility rate. I have already created my custom utility rate based on the $15.64 demand charge and the $0.12 consumption charge. Any recurring costs like maintenance or replacement costs can also be entered on this tab. The next tab is the economic information tab. Unlike the information on the utility rates tab, this information carries across all alternatives in the project, so you will only need to enter it once. Again for simplicity, I will leave these as the default values. To learn more about the inputs on this tab, hit the F1 key on your keyboard to bring up the F1 Help Tab. The F1 help tab can be used anytime when you are using chiller plant analyzer. The window that pops up is context sensitive based on the screen that you are currently on.

At this point, we are ready to calculate the file, however, I want to edit the default equipment to make it more realistic for my example. In the create plants window, you will see the equipment that was selected during the chiller plant wizard configuration step. I can add equipment to my cooling plant on this screen if needed by dragging and dropping. I can also add things like air cooled chillers instead of water cooled chillers. The Cooling Equipment tab is where we will define the specific information about the chillers themselves.

The default cooling equipment type from the plant wizard is a Centrifugal 2-Stage with Variable Frequency Drive Tower with an energy rate of 0.5 kw/ton and a condenser water pump full load consumption of 75 feet of water. I created my specific chiller beforehand to save some time and called it Centrifugal VFD 14F Evap 10F Cond. You can see the custom information that I entered in the cooling equipment library – specifically the energy rate of 0.545 kw/ton and the 42F leaving evaporator temperature with a 14F delta. Any standard library member can easily be copied and modified to fit your specific conditions and efficiency. Notice that when I selected this new equipment type, my efficiency changed and the heat rejection updated to a Cooling Tower with VFD. These were pulled automatically from this equipment type library member. I need to change the capacity to 50% of plant capacity and enter in my condenser pump energy rate. I will use units of kW for this example. Based on a 3 gpm/ton chiller condenser flow rate and an estimated delta P of 60 feet, my pumping kW works out to be 17.5 kW. Let me quickly show you the equation I used to calculate this.

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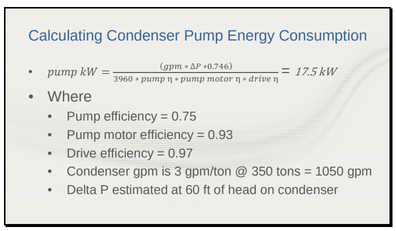

This is the pump power equation with the conversion to kW factored in. As mentioned previously, if I factor in a flow rate of 1,050 gpm from the condenser, as well as a head pressure of 60 ft., I can crunch the numbers listed here to get 17.5 kW for my condenser pumping energy.

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Once my pump energy is entered, I will repeat the previous steps for chiller number 2 on this plant.

That’s it for Alternative 1! We can now move on to creating Alternative 2.

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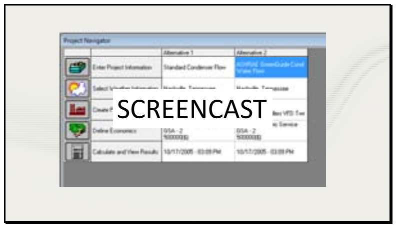


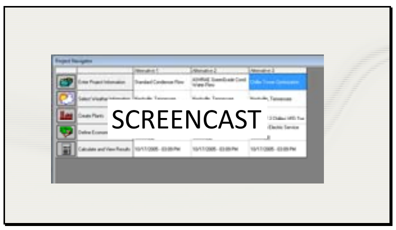
Since we only need to change the chiller and cooling tower type, we will simply make a copy of our first alternative and edit those fields. I will rename my alternatives so we can keep track of them better.

If you do not want to copy an alternative for comparison, and instead want to pick a completely different plant configuration, keep in mind that you can access the plant configuration wizard at any time from the Create Plants, Configuration screen.

For this alternative, we want to compare the energy savings of a chiller that has a lower flow and higher delta T on the condenser side. Again, I have already created my custom equipment library member for this alternative to save some time, so we will select the Centrifugal VFD chiller with a 14F Evap AND 14F Cond delta T. The cooling tower type is updated to Cooling Tower with VFD 15F Updated. This cooling tower equipment has a lower flow rate, lower fan total kW, and a higher range within the library member. Notice that the energy rate of this chiller went up, which is to be expected based on a higher chiller lift. We will again need to select the capacity and pump energy. Now, instead of reducing the initial cost of this alternative by factoring in smaller pipes and smaller pumps from the lower chiller flow rates, I will simply take the energy savings from the lower flow rates and enter in a proportional full load pump consumption. The pump power changes with approximately the cube of the flow rate so I can take the ratio of my two flow rates, 2 gpm/ton over 3 gpm/ton, and cube that ratio to get my proportional pump consumption. I will repeat these same steps for chiller number two.

That's it for Alternative 2, let's move on to number 3.

Slide 11



Again, I will copy Alternative 1 to save time. This alternative will evaluate a lower condenser flow rate in addition to chiller tower optimization. I will rename it Chiller Tower Optimization. In the Create Plants Screen, I will again select the Centrifugal VFD 14F Evap 14F Cond, but I will change my heat rejection type to Optimized Cooling Tower with VFD 15F. My chiller efficiency and pump energy will be the same as the last alternative.

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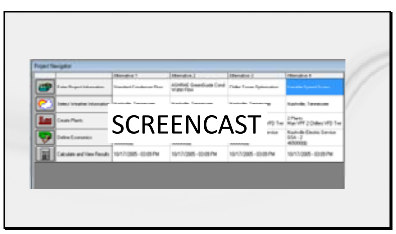
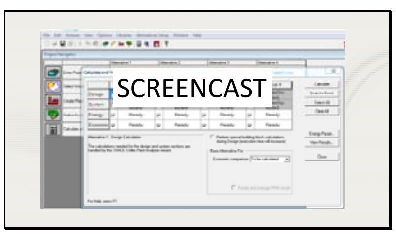


The last alternative will evaluate a variable speed screw chiller with the low condenser flow and chiller tower optimization. I created custom unloading curves and a custom library member ahead of time for this alternative. For additional information on how to create custom equipment performance curves, see our eLearning video on general equipment performance curves. I named my custom library member Variable Speed Screw Chiller, which I will select for the equipment type. Notice that the heat rejection type is still the optimized cooling tower with VFD and 15F range. The capacity I will change to 50% plant capacity and the chiller energy rate updated automatically based on my custom library member data. I will again enter 5.6 kW for the pump energy. I will repeat these steps for chiller number 2.

Since I have changed my chiller type from a more efficient centrifugal chiller to a less efficient screw chiller, I will update my equipment installed cost in the economics window to reflect a less expensive chiller cost.

Now we are ready to calculate our results and see which alternative will give us the lowest life cycle cost!

Slide 13

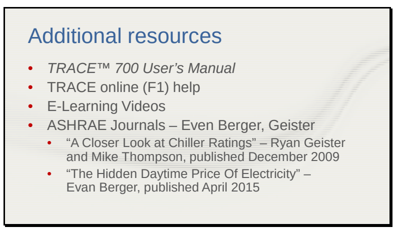


Once you hit Calculate and View Results, you will see that each of the alternatives have the required information and are ready to be calculated. Hit the calculate button and wait for the results to appear.

The first report that automatically pops up shows the economic summary and life cycle cost of the various alternatives. It also shows what the payback would be and how the monthly utility costs compare. Based on this report, Alternative 3, the centrifugal chiller with low flow condenser and chiller tower optimization has the lowest life cycle cost out of the 4 alternatives. The second page shows the breakdown of the energy use of each piece of equipment. If you close out of this report, there are other reports that you can access as well. Hit the View Results tab to see more specific reports like the cooling tower analysis, equipment energy consumption, or the monthly utility costs.

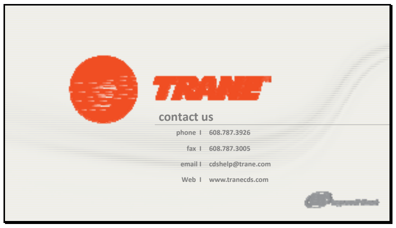
That's it for our example!

Slide 14



Obviously there are many different ways to customize your chiller plant that I did not cover in this video. Here are a list of resources to help you with additional chiller plant analyzer files.
Chapter 3 of the TRACE 700 User's Manual covers cooling and heating plants which will apply to chiller plant analyzer. Other sections of this document will apply to chiller plant analyzer as well. You can access this document from the Help drop down menu under documentation.
Remember to hit the F1 key for context sensitive help or descriptions of the program inputs.
You can watch our other eLearning videos on www.tranecds.com to see how to model heat recovery chillers, ice storage systems, and modeling waterside economizers.
Finally, here are a few ASHRAE Journal articles that relate to some of the topics discussed today.

Slide 15



That concludes this short video on chiller plant analyzer. If you have any questions about this software program or any other modeling or CDS software questions, please feel free to contact CDS support at the phone number or email listed here.