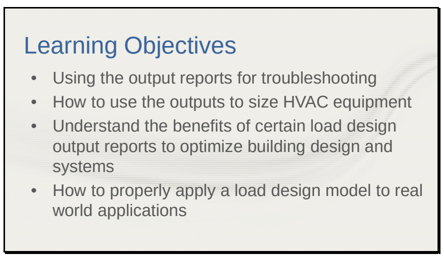
Slide 1

Hello, my name is Kit Fransen and I am the Customer Training Manager in the C.D.S. group at Trane.

Today, we will be going over TRACE 700 load design output interpretation. We'll go through a few examples and I will highlight some common reasons for viewing load outputs.

Slide 2



Specifically, we'll do a general overview of load design reports and then take a look at outputs of an example I created of a five zone model. With this example, we'll learn how to use the outputs for troubleshooting issues such as uncharacteristic system coil sizes or airflow, learn how to use the outputs to size HVAC equipment for selections and then discuss benefits of certain reports for optimizing load design to reduce cost of a project. We'll cap the video off with output considerations that discuss how to properly apply a load design model to real world applications.

To start it off, let's first talk about all of the key load design reports.

Slide 3

These are all located on the "design reports" tab located in the view results section of the program. There is also a "detailed reports" section in view results as well, but we will not be touching on those today. Those reports break down envelope and internal loads even further and are more granular in detail.

We will venture into some of these reports later on in this video.

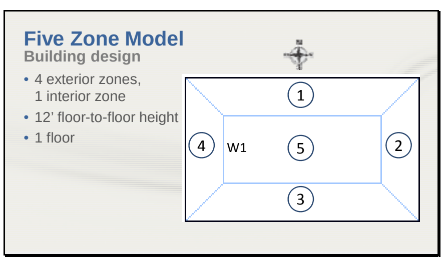
Slide 4

Now we've seen all of the important results, how can we apply these reports to a real world example?

Slide 5

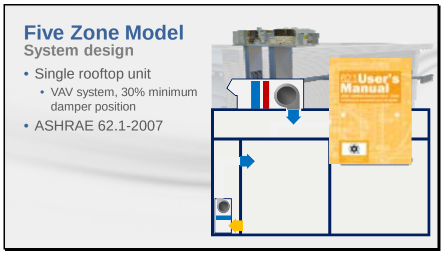
Using the new file wizard, we can create a 5 zone office building located in La Crosse, WI that is 62,500 square feet that is 40% glass on all exposures.

Slide 6



The building will be one floor with 4 exterior zones and 1 interior zone with an internal geometry of 12 feet for a floor to floor height. There will be standard office internal loads and the construction will better than the section 5 minimum insulation values for walls and roofs as well as minimum glazing performance in ASHRAE 90.1-2010.

Slide 7



From a system perspective, the whole building will be served by a single rooftop unit that is a VAV system w/ 30% minimum damper position and will bring in the required OA to meet ASHRAE 62.1-2007.

Slide 8

In advance of this video, I created this model using the new file wizard and made proper adjustments to the envelope construction as well as ventilation rates. If you are interested in learning how to use the new file wizard, please watch our other YouTube video that explains how to create a quick block building for analysis.

Since the file is created and the rooms are assigned, we can now click the calculate and view results button, run the file, and view our load output design results.

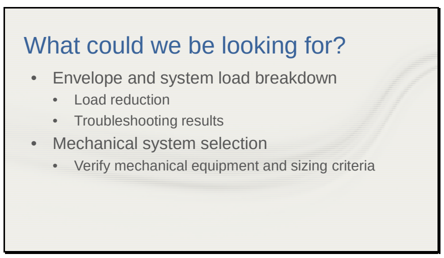
There are quite a few reports we can view the building loads in a variety of different ways to efficiently determine..

- The components of the building that drastically impact the total outputted coil load
- Fan and coil sizes for equipment within the building

Slide 9

With TRACE 700 Load Design reports, there are some reports that can be more important than others. In this case, we'll focus on three reports here that are frequently used by our customers: checksums, psychrometrics, and system component selection report which can be used for a variety of interpretations.

Slide 10



When doing a load design analysis, we typically see our customers looking for ways to reduce load on their systems, troubleshoot results, or size their equipment.

Load reduction is going to be more granular as we will look at line by line load outputs. This is where we need to introduce energy conservation measures on either the envelope, system, or internal loads in order to reduce the capacity of the cooling or heating coils. If we are troubleshooting, this is where we can determine if the end results make sense, and work backwards to determine what is driving certain results. Even if we are focused on energy and not load design, we can use the load design reports to even diagnose issues such as high energy usage which can sometimes related to equipment size. Lastly, we can look at specific reports to determine how many systems or equipment we should be incorporating in the building.

So what we'll do today is to take a look at the breakdown of the loads for this building's system in the checksums, how the coil and fan are sized through psychometrics, and verify the size of the equipment through the system component selection report.

Slide 11

To start off, let's take a look at the checksums so we can look at a breakdown of building and system loads. I'll mention right away that these reports are not meant for equipment sizing. Please refer to the system component selection report for equipment sizing.

In this case, we'll open up the system checksums for the cooling coil information since we have a VAV system. This report will give us a breakdown of cooling and heating loads at coil and space peaks in addition to some basic sizing information.

We can start by looking at the cooling coil peak and space peak which will show us a breakdown of envelope, internal, and system loads at each respective peak hour. This area of the results is useful because it can show us the breakdown of loads in the plenum as well as in the space. TRACE assumes that the space and plenum are separate thermodynamic volumes and a heat balance is performed between these two spaces. What we can determine from here is the distribution of loads in the building and how much of an impact it can have on the resulting supply air dry bulb temperature and CFM. This could be helpful for troubleshooting – if we have high plenum loads and low space loads, we could potentially have a low CFM/ton which may not be realistic.

If we look at the details of this section, you can see from the output that the largest loads on the system are from the internal loads and ventilation load followed by the roof conduction. As an example, we can use this analysis as a way to optimize our system type. We might be able to add in an energy wheel or potentially even reduce internal loading through usage of LED lighting.

NEXT VIDEO

If we move on, you will also see a heating load calculation performed, which is using the worst case OA winter dry bulb condition and assuming that there are no solar loads. Here we can take a look at specific breakdown of components

Additionally, we can also take a look at the cooling space peak column. We can use the sensible cooling total to validate the main fan airflow calculation through using the sensible heat equation which is Q = Density Specific Heat Product multiplied by CFM and then multiplied by the temperature difference from the space to the supply air. This total sensible cooling load might be either from a peak load or block load depending on the system type. VAV systems have the fan and coil loads typically calculated based on a block methodology as the fan is usually allowed to modulate its airflow as the load decreases or increases for the system to properly condition the spaces. Constant volume systems is continuous air volume and have to be sized on the peak airflow and load of every space as the airflow cannot to be shifted to condition spaces during certain hours.

NEXT VIDEO

If we were troubleshooting, let's say… extremely high airflows or even high fan energy usage, we can first start here and see what is driving the high airflow. Is it the load? Is it the supply air dry bulb? All of information about the design of our system as well as the building loads are shown all together here.

Additionally, from an input standpoint, we can see drastic changes in results by the scheduling of internal loads. It is best to create custom schedules for people, miscellaneous loads, and lighting to be reflective of actual building operation in order to apply diversity to the system if it allows it.

To jump back into the results, the supply air dry bulb temperature in cooling will be output in the top right hand corner and the space temperature we will have to determine based on our own inputs. TRACE determines the supply air dry bulb temperature through a psychrometric calculation using the building loads in conjunction with the system type. We will not be going over the calculation today, but we have more information in our TRACE 600 Engineering Manual that discusses that calculation and we also will be looking at the psychrometric report. If you were to fix a supply air dry bulb temperature, you could potentially see over/under sizing for your system type.

NEXT VIDEO

In this case, based on looking at the right hand side of the outputs, you will see we have roughly 40,000 CFM calculated for our main fan airflow. However, there are other airflow outputs as well. Based on the system type or inputs modified, you may see different airflows for the diffuser and terminal from the main fan airflow. As an example, if there is duct leakage, you can see some of the terminal and diffuser airflows changes. Or if there is a secondary fan (which is a terminal box fan such as a PFP or SFP fan), then airflow will appear under the secondary fan category. Here's a good time to mention F1 help. If you are unsure what a specific output may mean, you can also press F1 which will bring up the appropriate description of most of these line items.

In heating mode, the airflow is calculated based on the system type selected. If it's a VAV system, the heating airflow is usually the minimum stop which is 30% of the cooling design airflow, or the ventilation rate (whatever is greater). However, if it's a CV system, the airflow will be identical to the cooling airflow. We do not perform a secondary psychometric analysis to determine the heating airflow. If you are curious on how the heating airflow is calculated for certain system types, the User's Manual or TRACE 700 Output Interpretation manual will give some examples of different system types. In addition to the airflow, the supply air temperature in heating is calculated based on the total heating load and the resulting airflow as discussed earlier. For certain system types, supply air temperatures are defaulted to certain conditions, and as said before, use the appropriate reference materials or contact our support team for more information.

NEXT VIDEO

Next, we can take a look at the cooling coil selection information. This will show us the total capacity of the coils in our system. The main coil is the coil meant for conditioning the space or spaces to the thermostat set point conditions. If you have a DOA unit, it would be under optional ventilation coil. If you had a chilled beam, or other auxiliary coil, it would be under auxiliary coil. Here you will see total capacities, sensible capacities, airflows, as well as entering and leaving conditions off of the coil. The systems main coil size is roughly 100 tons.

One thing to mention here is that the airflow is calculated based off of the space sensible loads at the COIL peak where as the airflow on the right hand page is calculated based on the space sensible loads at space peak. So you may ask the question… why does the space and coil peak at different times? Usually glass solar will drive the space peak while ventilation (or system type loads) will drive the coil peak.

In general, you can select your fan airflow based off of the design airflow on the right hand side of the page since this is the airflow required to meet the thermostat set point. However, if you are concerned about dehumidification issues (since a higher airflow may not be able to ring as much moisture out of the air), you can always select a supply airflow that is somewhere between the coil airflow and the design main fan airflow but it is a design consideration that one must make.

Let’s talk about some troubleshooting real quick. Let’s say we have unmet hours. Here we can check coil sizes and make sure they aren’t undersized through the undersized line item. Remember, in cooling, negative means undersized while in heating, negative means oversized.

NEXT VIDEO

Moving back to the cooling coil selection, for the entering conditions, these values are calculated based off of the mix of return and outside air. For the leaving SADB, this is calculated based on psychrometrics. For the WB and HR, these are calculated not through pscyhrometrics but by a delta enthalpy across the coil. If you are interested in seeing what a generic coil curve would generate for leaving WB and HR, look at the psychrometric statepoints found in the psychrometrics report, not in this report. We’ll talk about how this is important later on when we are discussing TRACE 700 versus what happens in the real world.

Finally, we can take a look at the heating coil sizes. In this situation, we are looking at the system checksums, so the pre-heat coil would only apply to this report. How did I know this? Well look at the schematic for the system type chosen from Create Systems. This will give you a clue to where the coils are located. Now if we want to see what the terminal box reheat coil sizes are, we can look at the zone checksums.

What's important here in general is that we need to look at information that is relevant to the system we have chosen and the inputs we have modified related to the output. The checksums is a "catch-all" for outputs where some items may or may not necessarily apply. TRACE also makes assumptions based on the ASHRAE fundamentals as a guideline on how certain coil sizes are calculated – they may not be exactly what your methodology is so call into our support line if you have questions regarding TRACE's calculations.

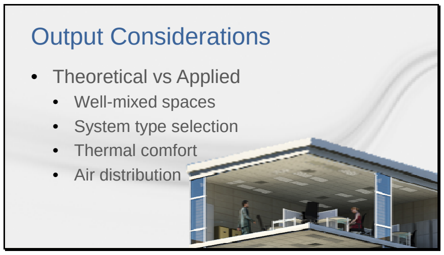
NEXT VIDEO

Moving on to the psychrometrics report, we can take a look at the specific report relevant to our cooling coil. In this case, we have a system level cooling coil so only the system level report is available. This is where we can view the different state points and plot them on a psychrometric chart if we wanted to visually view it. Here we can see what the space condition is and the resulting relative humidity as well as the calculated supply air temperature and sensible heat ratio. We can then make a judgment call on whether or not our SHR makes sense based on our inputs as well as the resulting dry bulb and wet bulb conditions off of the coil.

What's great about this report is the ability to dissect an air system and interpret results for either troubleshooting or optimizing a system. It could be a situation where we need to look at the ventilation state points to see if an ERD is properly pre-conditioning OA or if we need further dehumidification on our system to remove more moisture out of the space or spaces.

Lastly, we can look at the system component selection report and view how many coils, fans, and systems we have in our particular building. It also gives us total coil and fan sizes so we can use this for a selection process. This is easier to read than the checksums and it is highly recommended to use this report for equipment selection and then validate these values through the other reports. If we were selecting equipment looking at the cooling coil information here, the questions to be asked here are… can we get a rooftop unit in this size? Are the entering conditions realistic? What about sensible and latent capacities? These are all important questions when looking at this type of report.

Slide 12



Now that we've seen an example, let's spend a little bit of time talking about some output considerations that must be made after analyzing a TRACE 700 load design run.

The output from TRACE doesn't necessarily relate to what can be done in the real world. Additionally, the level of accuracy is up to the modeler and how much effort is put into the load design. This is what should be considered from a "theroetical versus applied" consideration.

For all conventional systems, TRACE assumes a space is well-mixed. However, in reality, even in a standard VAV system, if the system isn't designed properly, air from diffusers may not reach all areas of a zone which can lead to higher or lower space temperatures than expected. Another example is thermostat placement – TRACE doesn't have an input for which wall a thermostat is placed on which can impact predicted loads as well as energy usage. Remember, all software programs have assumptions, so one has to go beyond taking outputs from TRACE and assuming it matches exactly what the building design contains.

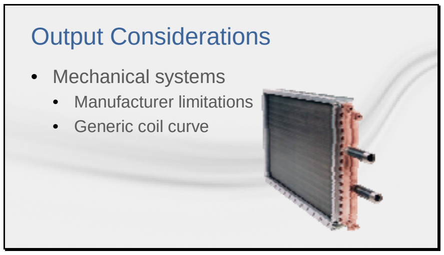
Speaking of system types, TRACE has a variety of standard system types that are used in many buildings today. However, there are a lot of special cases out there that don't fit the molds of what TRACE has to offer. Even if you choose a system in TRACE that have some characteristics of the intended design, this does not mean that the output will be close to the actual performance of the system. A few examples such as using baseboard heating for main heating source or radiant cooling instead of conventional overhead cooling can be done in reality but TRACE has limitations in modeling these scenarios. If you are ever in doubt, consult with C.D.S. support for more clarification.

TRACE assumes the entire space meets the set point temperature in load design. In reality, this may not be the case, so it is important to think about when running load design calculations.

And finally, when it comes to delivering OA TRACE does not take into consideration how air is being distributed within a building.

Within TRACE, it is as easy to change a dropdown to allow for outside air to be delivered as room direct or ducted directly into units, however, there are massive real world trade-offs when it comes to implementing these types of scenarios – especially related to cost and controlling of a system type. This also can impact the indoor air quality of the occupants.

Slide 13



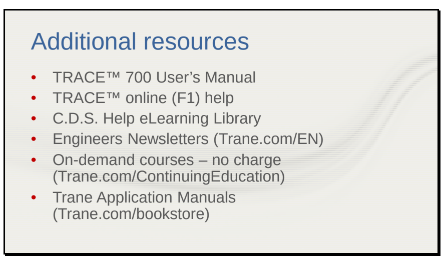
With that in mind, various manufacturers may not be able to produce a certain type/size of equipment as well as generate the same performance or design criteria as shown in TRACE 700. As such, results need to be thoroughly analyzed and discussed with a manufacturer to determine if what is proposed is possible. TRACE does not know many variables that can impact a building's mechanical system design.

From a selection standpoint, the output that TRACE provides for equipment selections is only a guide and should be treated as such. This is because the coil curves for various equipment and manufacturers can vary significantly depending on several properties, such as the fin stamping and material surface of the coils. TRACE uses a generic coil curve algorithm that in most cases will provide the engineer the information necessary to make the proper equipment selection from a manufacturer's selection tool.

Overall, it is an iterative process working with a manufacturers selection tool and then modifying the load design inputs to appropriately select the mechanical system for the building.

Above all, careful thought must be made when selecting a system. Energy impact should also be considered even if the goal of the model is to determine equipment size.

Slide 14



This completes our discussion on load design output interpretation. Hopefully, we've given a basic understanding of the load design outputs in TRACE™ 700 and how to use them. If you need some assistance in other areas of the program or just want a better understanding of some of the concepts we talked about today, here are some additional resources available to you.

Slide 15

As always, please feel free to contact the C.D.S. Support Center by phone or email with any comments, questions or modeling issues you may be experiencing.

Thank you for your time and happy energy modeling!