David Sellers

From: David Sellers
Sent: Tuesday, May 29, 2018 8:45 PM
To: 'Pewitt, Paul'
Cc: Liz Fischer (lfischer@bcxa.org)
Subject: RE: test

Hi Paul,

A bit of a delay from when we talked and I apologize. I had a full week all day teaching thing the next week and went straight from that to meet up with Kathy in Palm Springs for a turn of the world week and I didn't quite get this finished.

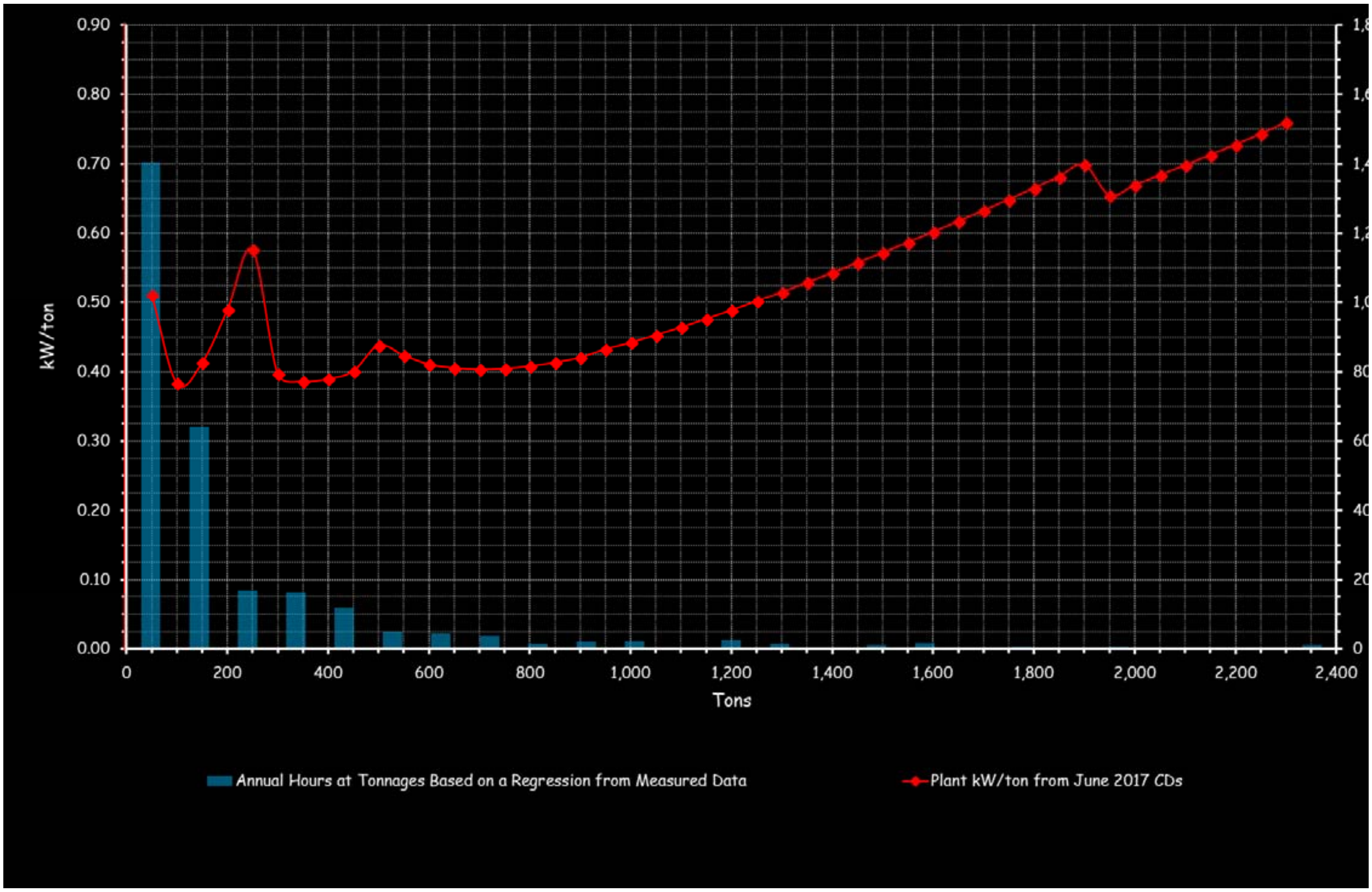
In any case, as you know from AEP, the efficiency of a piece of equipment or system on the design day, which is what the designers often target, can be very different from what it is under the various conditions it seems most of the time in the form of the seasonal and daily load profile.

For a chiller plant, one of the ways to start to understand that is to use trend data to allow the building to inform you of the load profile that actually exists and supplement that by developing the theoretical kW per ton profile for the plant based on the full and part load operating characteristics of the prime movers and auxiliary equipment. Then, by looking at those two profiles concurrently, you often can identify areas were significant savings can be achieved simply by changing how you sequence machinery.

It also is a great tool for master-planning plant upgrades and equipment replacement selections. For instance, you may discover that you would be better served by replacing your aging 1,000 ton chiller with a 250 ton chiller and 750 ton chiller because of the number of hours at those tonnages vs. 1,000 tons and the turn down capabilities of the smaller machines.

Finally, it becomes a good persistence tool, because once you have established what the kW per ton profile should look like, based on the actual installed machinery and performance characteristics and plotted that line, if you then use that line as a baseline and plot logged kW per ton points against it in real time, you end up creating a data cloud that, if things are working correctly, should follow the line you developed. If it doesn't then something changed and the deviation you see in the data cloud from the line gives you a sense of where to go looking.

This image illustrates the concept.



So, what we would like to do for a field based class at your hotel would be to develop this profile for your plant (the red line) and if possible, contrast it for the measured load profile for your plant (the blue bars).

To do that, sometime prior to the class, I would need to spend 2-3 days in your plant, making a system diagram of the chilled and condenser water systems, gathering the equipment nameplate information, reviewing any submittal information you might have that was not lost in the flood, taking a look a t a couple of typical loads, working with you to get trend data or set up trends or deploy a few loggers, and maybe doing a few tests.   That would give me the data I needed to develop the kW/ton profile and may be the building load profile (which for the class is secondary; what we would be focusing on would be the kW per ton profile).

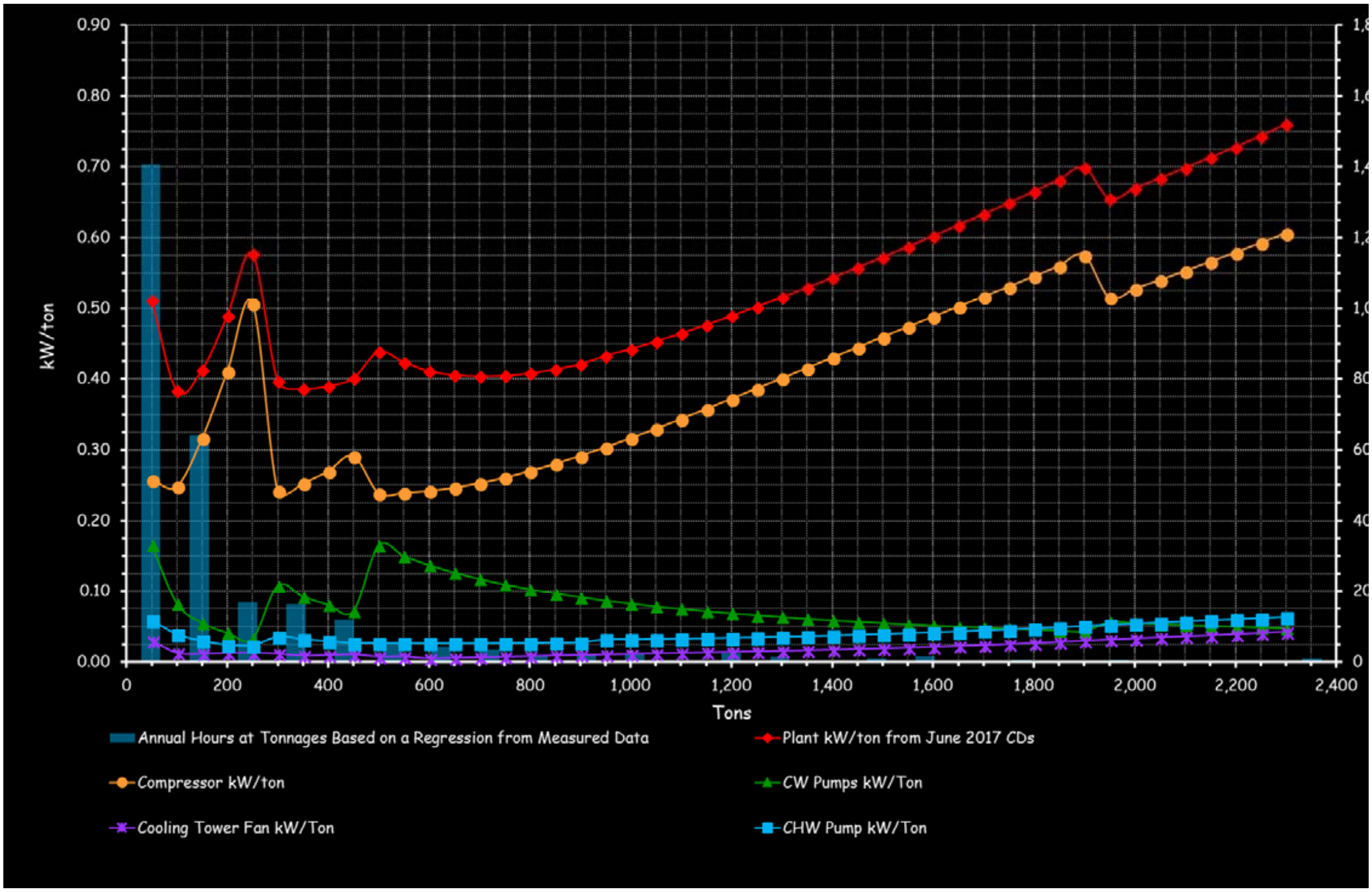
For the actual class, most of the time would be spent in a class-room setting understanding the concept and "doing the math".   But fairly early on in the process, we would want to bring the students into your plant for a tour and maybe a little field work, like having them gather some of the data they need for them-selves, starting a system diagram, some Q&A about what they were seeing.

How much and how long would to a large extent, depend on what you were comfortable with. But in practical terms to get through everything we would need to accomplish, I suspect the field session would be somewhere between one and two hours long, maybe broken up in to two sessions; one early on during the exercise and one later on after they had worked with the initial data bit.

So that is what we are hoping to do.   If you are comfortable with that, I think the next step is for me to think through the details of the class a bit and develop a sort of lesson plan and then to schedule a site visit with you and your team to do the field work I mentioned.

If you are wanting a bit more detail about the technical aspect of the activity, what follows after this will give you a bit more insight into that. I think I was still working on the project this came from when you did AEP and did not share it with your class. But Blake may have seen it already; I may have had it developed by the time he took the class; I can't quite remember.

Anyway, the way you get the red line is to add up the kW contribution of each of the elements it takes to run the plant at a given load condition (pumps cooling towers, compressors, etc.) Here are the components behind the red line in the first picture.



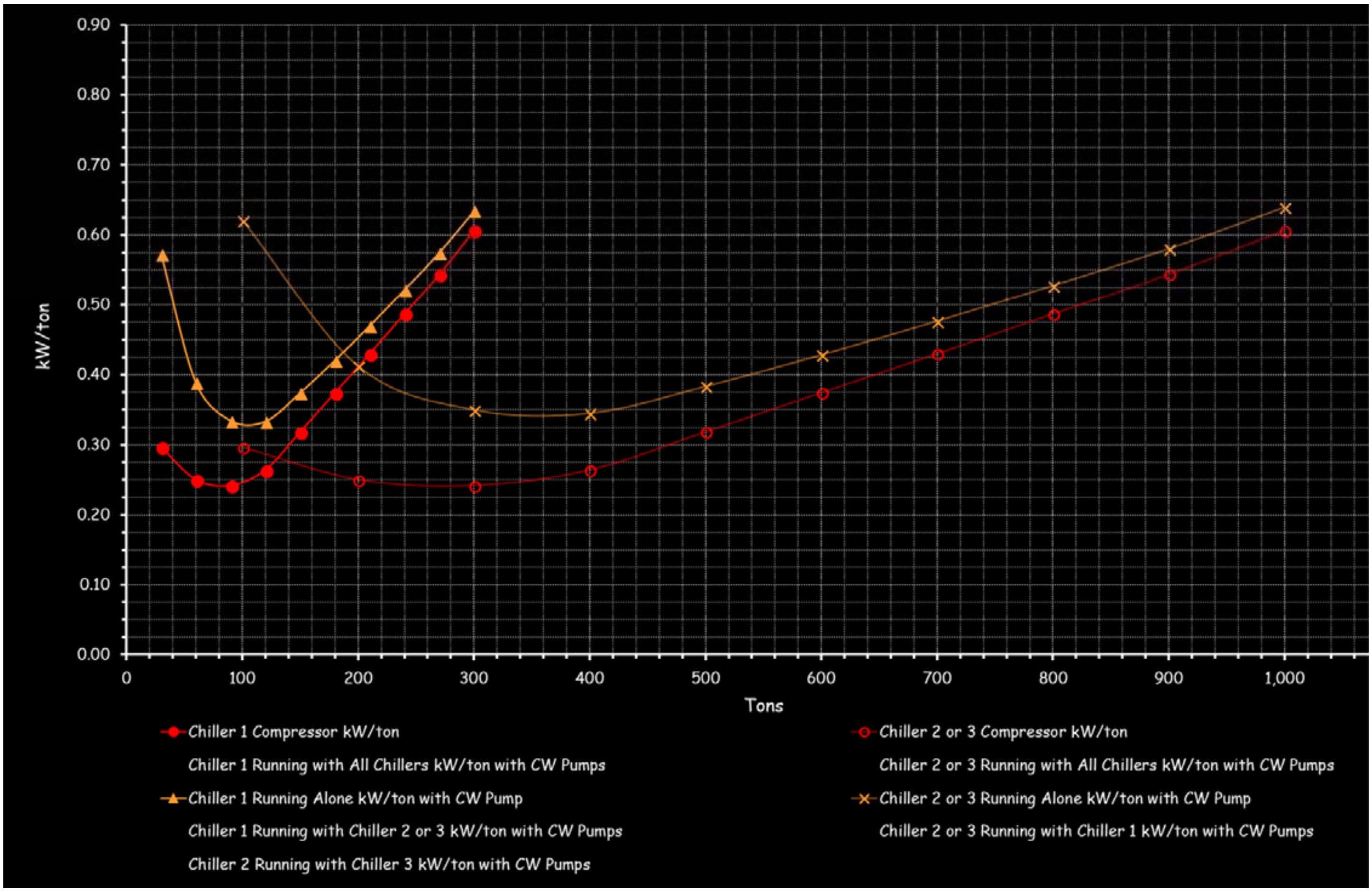
The blue bars represent the load profile for a 59 or so story high-rise up in Seattle, which is where this plant is located. I was involved because they were getting ready to upgrade their plant and I suggested the perhaps we should let the building tell us what the chiller tonnage break-down should look like and then pick the machines and develop the sequence on that basis.

All the air handling systems all have integrated economizers so while there actually hour hours out at 2,400 tons, most of the hours are below 400 – 600 tons. This is information the building gave us about it self via a flow trend, an entering and leaving water temperature trend and the Q = 500 x gpm x Δt equation.

As a result of the "blue bars" the designers for the new plant picked a 300 ton modular chiller along with two 1,000 ton modular chillers for new plant vs. 3 at 800 tons for instance. So that was a step in the right direction.

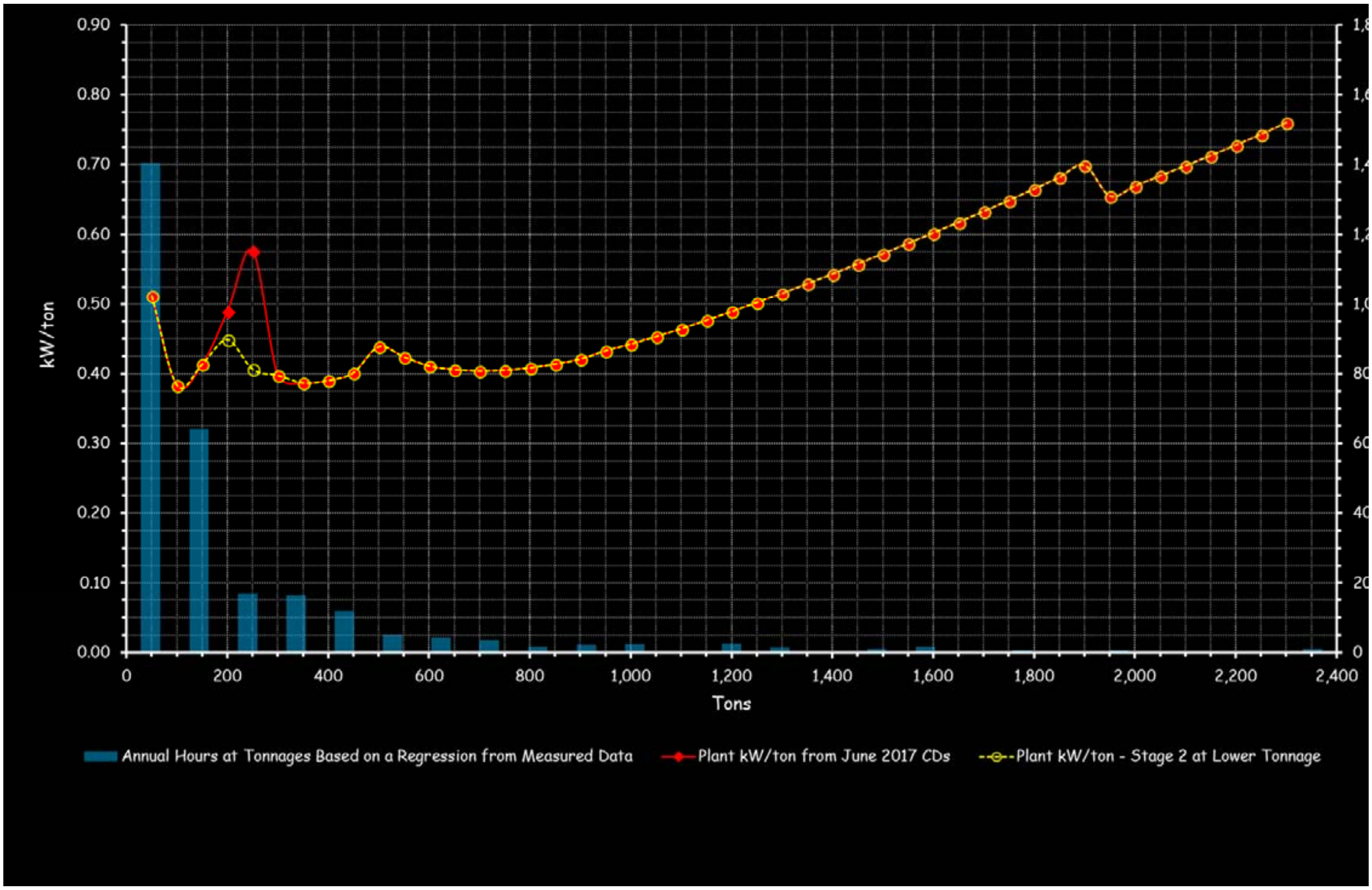
The sequence for the new plant specified running the 300 ton machine first, then staged over to the 1,000 ton machine at around 280-290 tons, then brought on the second 1,000 ton machine when the load reached about 500 tons, and then brought the 300 ton machine back on line to peak.

The red line is the kW per ton profile that I developed for the new design based on the equipment selections and that sequence. As you can see, it had a pretty big spike under a load condition that the plant would see a lot. Based on the contributors, the most likely cause seemed to be how the 300 ton chiller (and associated CW pump) were being staged.



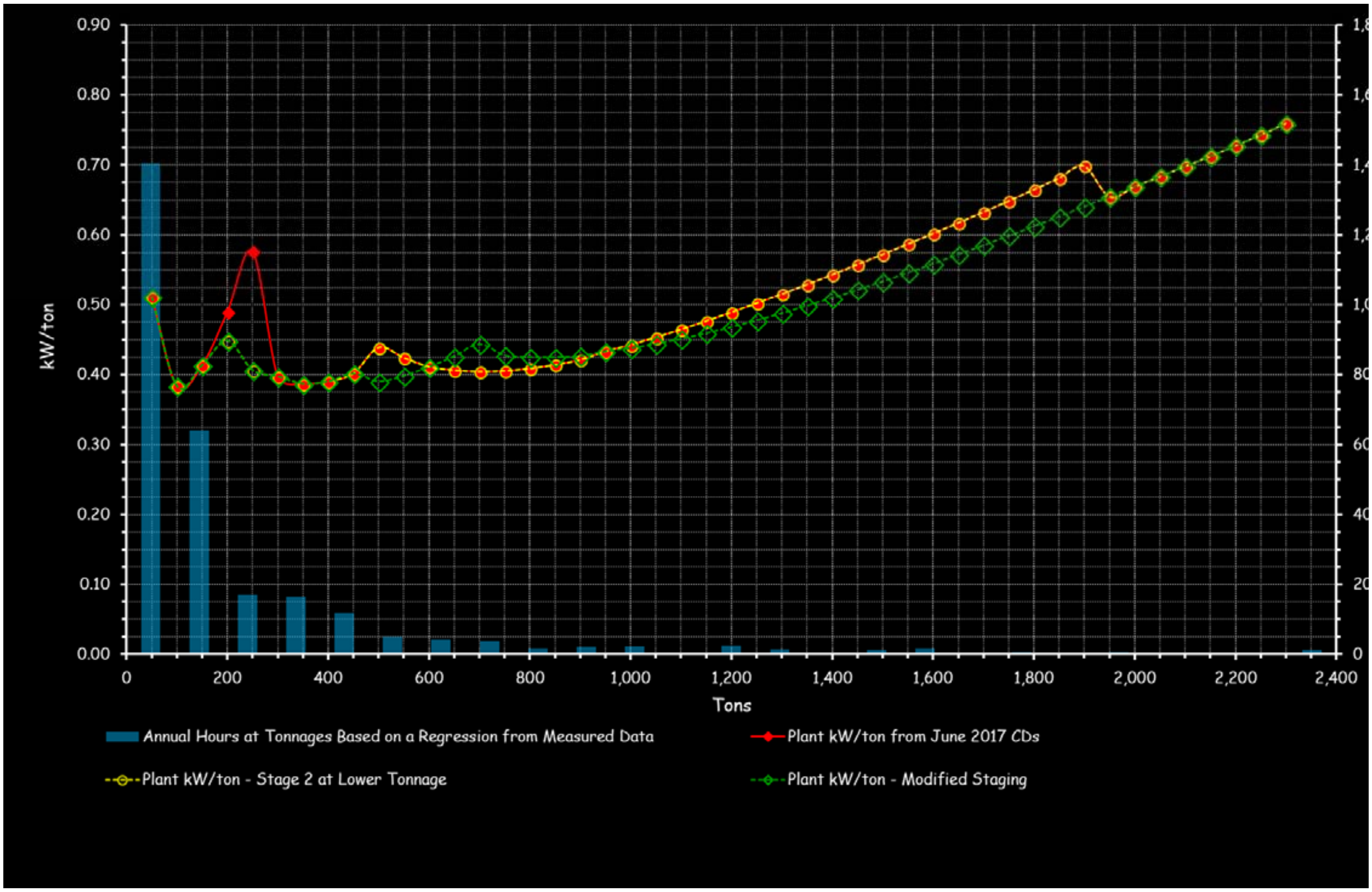
Even thought intuitively, it would seem like you would want to run the 300 ton modular chiller until it was fully loaded, it turns out that if you look at the compressor kW per ton curves for it and the larger machine, the larger machine compressor energy is actually lower than the 300 ton machine starting around 130 tons (where the 2 red lines cross). When you toss the condenser pump energy into the mix, that point shifts to about 185 - 190 tons (where the two orange lines cross above).

So, if you change the sequence to stage the chillers at 195 tons, you go from the red line to the yellow line in the chart below.



So, a pretty good improvement in efficiency at a point where the plant will spend a lot of hours, all captured by a programming change.

A similar analysis for the other staging points shifts you from the yellow line to the green line in the chart below.



Feel free to call if you want to discuss this vs. type about it. I am in the Pacific Time zone and have a few meetings off and on this week, but mostly am doing office work.

Thanks for considering this, and tell Blake I said hi.

David

Senior Engineer
Facility Dynamics Engineering
Northwest Satellite Office
8560 North Buchanan Avenue
Portland, Oregon 97203
Office - 503-286-1494
Cell - 503-320-2630
DSellers@FacilityDynamics.com
http://www.facilitydynamics.com/
Visit my Commissioning Resources website at www.Av8rDAS.com
View *A Field Perspective On Engineering* and past posts from
A Field Guide for Engineers at http://av8rdas.wordpress.com/
View *The Other Side of Life* at https://av8rdaslife.wordpress.com/

From: Pewitt, Paul <PPewitt@GaylordHotels.com>
Sent: Thursday, May 10, 2018 12:09 PM
To: David Sellers <dsellers@facilitydynamics.com>
Subject: test

Paul Pewitt | Chief Engineer Mechanical
Gaylord Opryland Resort and Convention Center
2800 Opryland Drive, Nashville, TN 37214
P (615) 458-2860 F (615) 458-1412