

David Sellers

From: David Sellers
Sent: Wednesday, January 15, 2020 7:49 PM
To: Daniel S Imperiale
Cc: Ryan Hoest; Ryan Stroupe (R2S2@pge.com); stanford.rollins@1earth.ws; Knipfing, Isaac
Subject: RE: San Mateo CHW Diagram

Hi Daniel,

Ryan has asked me to do something with this in an upcoming EBCx class, so I will get into more depth in preparation for that. But for now, with regard to the last bullet point, I realize they might show what you say in their diagram. But sometimes, I have found that what is written down may not be what is actually happening.

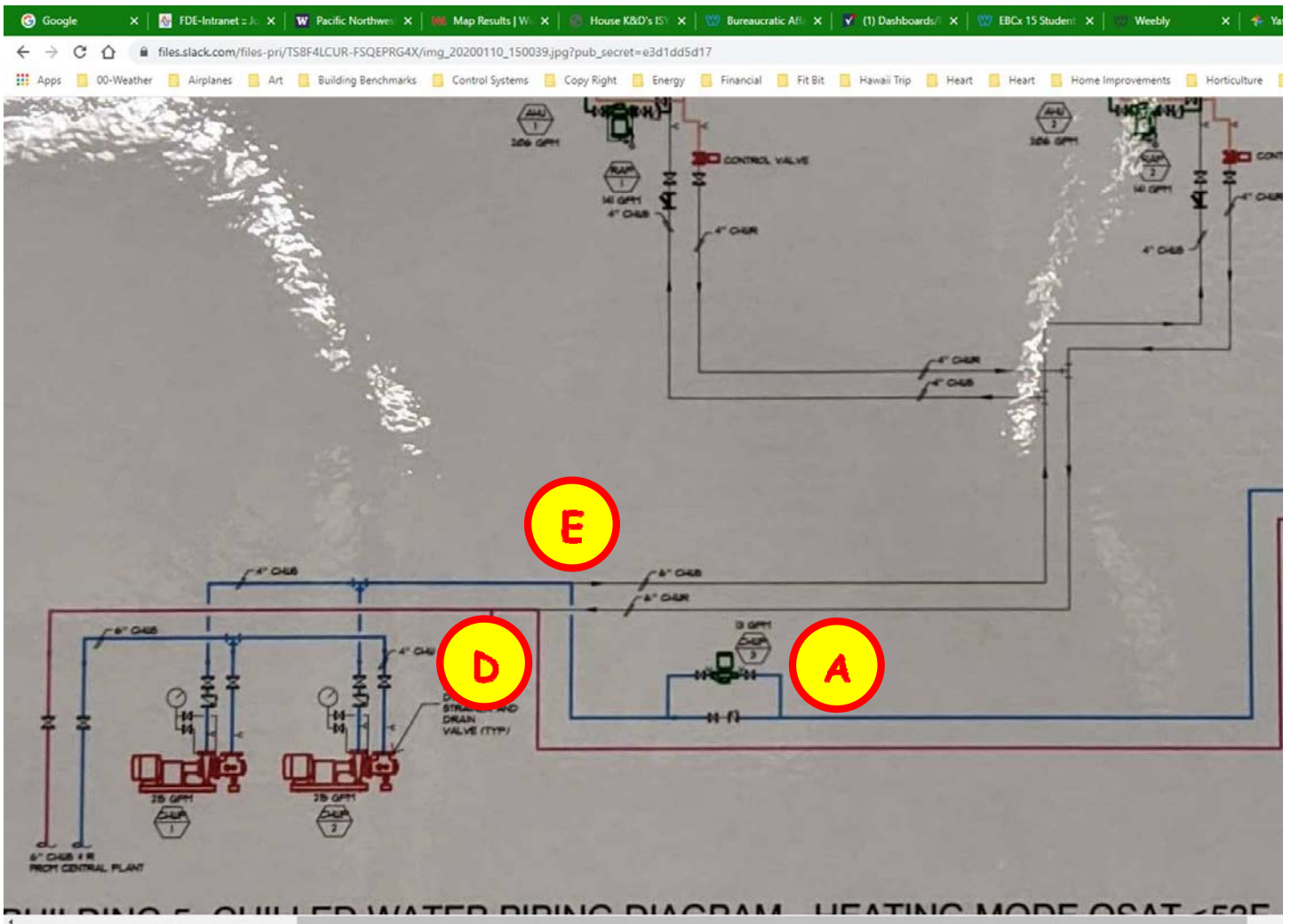
In situations like that I try to go back to fundamental principles and in this case, my conclusion is based on conservation of mass as follows.

(I've copied Stanford and Isaac on this since they may find it helpful and more timely than waiting until the next class).

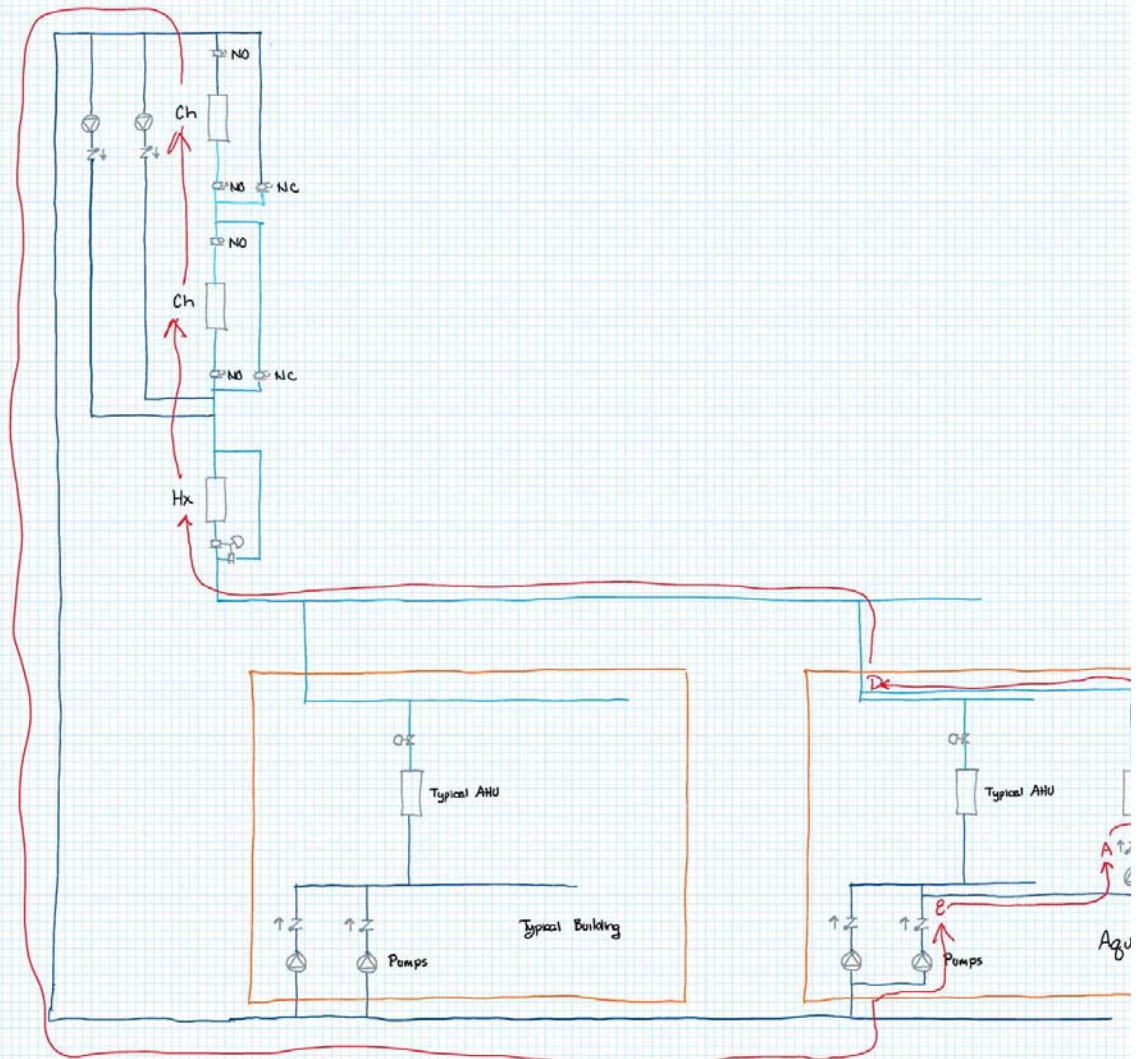
I should also mention at the end of the day, the building probably was telling us the answer; we (or at least I) forgot to see what it had to say. In other words, if the pipes at the remote location are cold/at or near the CHW supply temperature, then there is flow. If there really is no flow, then the lines would warm up.

Anyway:

1. If we start at "A" and assume the fan coil unit valve is open and the pump is running, then, if I am thinking about it right, the water would want to flow from A to B to C and then back to the mains at D.



2. To conserve mass, from D, the water would have to get back to E somehow. This is where my diagram might come in handy



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- There are two options I think. One route would be to flow back to the plant, go through the plant and come back as cold water, flow through one or both pumps, lift their check valves, and return to E and then to the booster pump suction and back to A, the booster pump discharge.

That path is not inconceivable, with out the primary pumps running and of course, is the path that would happen if the primary pumps were running.

But with out the primary pumps, it means the booster pump would need to have enough head "compete" with the building pumps in the other buildings if they were running. That is because the booster pump would be in parallel with them through the load and through the aquatic center building pumps. In other words, it's suction connection traces back to the same pipe as the suction connection of the other building pumps, and its discharge connection also traces to the same pipe as the discharge connection of the building pumps.

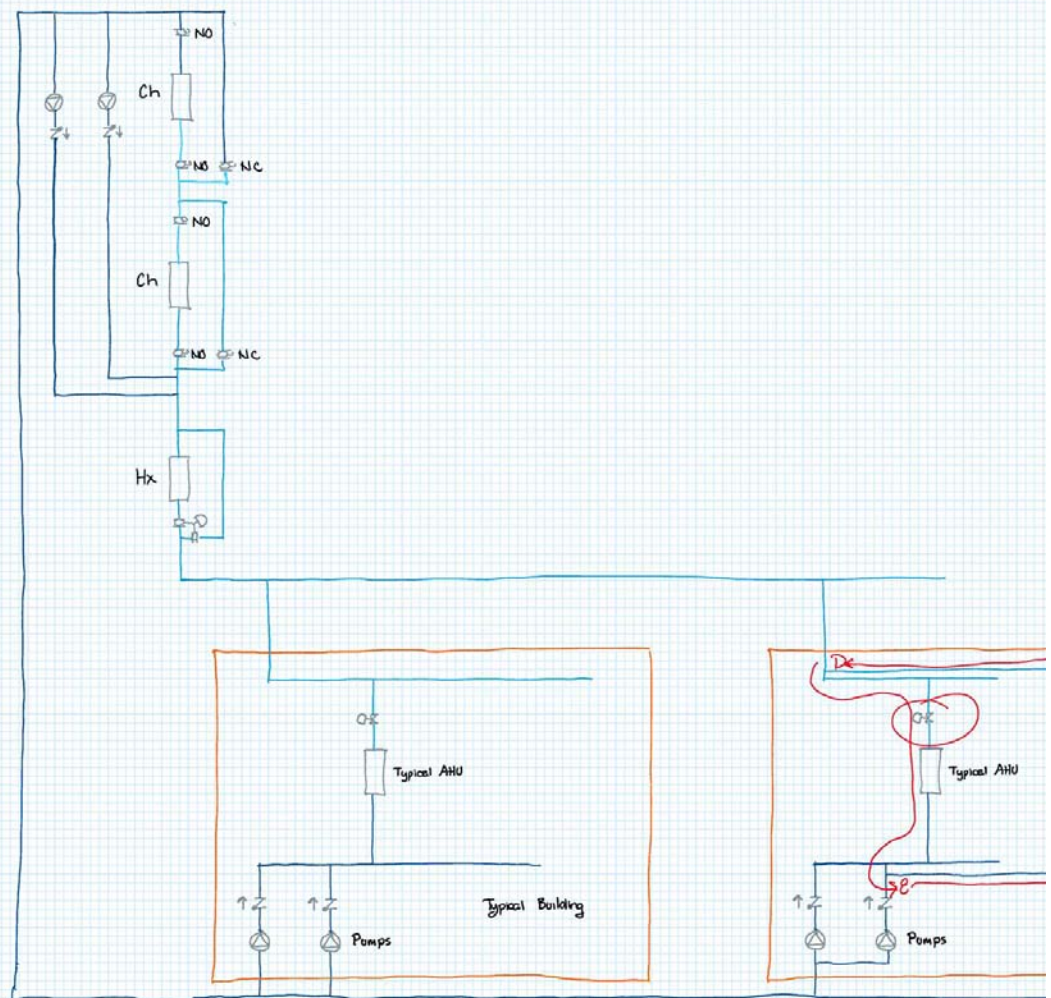
In addition, it would have to have enough head to lift the check valves on the primary pumps. This is probably less of an issue than competing with other, potentially higher head pumps in parallel with it. But, most check valves rely on more than differential pressure and/or gravity to close in order to ensure that they close before flow reversal happens. That means most of them have springs that force the discs closed. That means that before the valve opens the pump has to generate enough pressure to overcome the spring forces. I believe the spring force is not particularly huge, maybe 0.5 - 1 psig (1-2 ft.w.c.). But it could be a factor for a pump selected for a relatively low head, which is typically what booster pumps are picked to do.

I don't know the booster pump's rating but it would not surprise me if one or the other of the items I just mentioned was a constraint. For instance, if the other building pumps were creating a head of 50 ft.w.c. across the mains to/from the plant, the booster pump would need to have that much head available between D and E to push water into the system along with whatever head it took to move the required flow for the fan coil unit through the circuit it served, which would include the primary pump check valves, pump bodies and piping if the primary pumps were off.

And, if the flow was occurring on this route, then it would go by the flow sensor for the BTU meter, which appeared to be located in the common piping just outside the pump room (kind of where the orange "building" line crosses the dark blue CHW line ahead of the building pumps). So, if there was flow in this line and it was above the cut-in point for the flow meter, then it should have shown up as flow on the meter.

Note that it is possible for the flow to be low enough that the flow meter can not pick it up; virtually every meter has some minimum flow it can detect. If that is going on, then there is flow but the energy associated with it is not being documented, so a billing problem.

4. The second option would be to flow backwards through the AHUs.



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This would not work if the AHU control valves were closed and the pump would be dead headed. But if the AHU control valves were open and the AHUs were running, it may actually work and provide cooling if the temperatures were just right.

In other words, if I was bringing in - for the sake of discussion - 58°F outdoor air and passing it through a 6 or so row large cooling coil with a trickle of flow through it (relative to its design flow), I would not be surprised if I could generate water that was in the 60-62°F range. If that water was circulated to the fan coil unit and exposed to - say - 72°F air, then it would cool the air some and the water would be warmed up, which would set it up to be cooled again by the cooling coil.

Basically, the loop would be "stealing" cooling from the AHU. But since it would not be much relative to the AHU capacity, it could probably get away with it. And in fact, the AHU control

process may simply deal with it by backing the preheat coil off a bit so the air coming in is a bit cooler.

It could even be that this is some sort of ingenious design intent. But it falls apart in that context perhaps because if the units are off (or their control valves are closed if they do not need chilled water), then the process would not work.

I can't remember if the units are scheduled, but if they are, then this theory only could support IT when the units were running and moving air across their coils.

5. Another possibility (in terms of why, if there really is not cooling provided some of the time, the IT room manages to get by) (which may or may not be the case, I don't know) is that the IT room actually does not need much cooling. This will sound crazy, but it is not totally uncommon for a room called an IT room to have a very small load in it, like a desktop PC running as a server vs. being a server in a Google data farm IT area.

Anyway, pretty interesting and we will figure it out eventually I suspect. Gotta run because Kathy says dinner is ready.

David

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From: Daniel S Imperiale <dsimperiale@ucdavis.edu>
Sent: Wednesday, January 15, 2020 2:44 PM
To: David Sellers <dsellers@facilitydynamics.com>
Cc: Ryan Hoest <rhoest@ecovoxinc.com>; Ryan Stroupe (R2S2@pge.com) <R2S2@pge.com>
Subject: RE: San Mateo CHW Diagram

Hi David,
Thank you so much for providing the level of detail you did. I shared with the team here and they're all fascinated by the design.

One side note, I respectfully disagree on your last bullet point or I'm still confused. I'm having a discussion with myself in the slack app regarding that topic. If you look at the system diagram for OSAT < 53 they show that chw pump 1 and 2 are off when chw pump 3 is on.

<https://slack-files.com/TS8F4LCUR-FSQEPRG4X-e3d1dd5d17>

I think that we were showing no flow at the CW BTU meter because the FCU1 valve was closed. So I think the opportunity there is to program the CHW3 VFD speed to the position of the valve or to some DP.

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From: David Sellers <dsellers@facilitydynamics.com>
Sent: Tuesday, January 14, 2020 6:43 PM
To: Daniel S Imperiale <dsimperiale@ucdavis.edu>
Cc: Ryan Hoest <rhoest@ecovoxinc.com>; Ryan Stroupe (R2S2@pge.com) <R2S2@pge.com>
Subject: RE: San Mateo CHW Diagram

Hi Daniel,

I hope to get this up as follow-up information in the next day or two, but meanwhile, attached is a .pdf of the system diagram.

Here are the things that made the system I was seeing unique.

- It was a variable flow primary only system with chillers in series instead of in parallel. I have not seen that before although I have seen chillers in series before. But that is also not common. But it can be an innovative approach to dealing with some of the issues that can come up in various system configurations, including constant flow systems in the olden days.
- It was a variable flow primary only system where the building pumps also provided the head needed to move water through (or around) the plate and frame Hx and the chillers. All of the variable flow primary only systems I have been around so far had the distribution flow handled by pumps in the central plant. Some (I think) had building pumps piped as secondary or tertiary loops. But so far, no systems where the building pumps also pumped the chillers.
- Because of the preceding, the building pumps are in parallel with each other through their loads, which sets up interactions that can be somewhat odd and unanticipated if you did not think it through beyond the design day, especially if the pumps have different head ratings.
- It was the second variable flow primary only system I have seen with an integrated water side economizer (i.e. the plate and frame could supplement the chillers vs. it being either or). The other was the system serving a fairly big corporation involved with smartphones at their new

campus in San Jose, which was designed by one of the best designers I know. That one worked but there were a lot of subtleties to getting it just right.

- It was the first variable flow primary only system I have seen where the minimum flow requirement was met by using a secondary pumping circuit instead of a minimum flow bypass valve.
- The booster pump configuration in the aquatic center was sort of odd in that it required the building pumps to run to be able to deliver water to the mission critical load. My shoot from the hip assessment was that maybe the pump should have been in parallel with the building pumps instead of in series with them. (We didn't have time to talk about that in class).

I actually ended up using the diagram as an example for a Marriott webinar yesterday morning about scoping and how field clues can lead you to opportunities. I have included a .pdf of that for you to consider if you want (starts around slide 27).

I'm open to a longer conversation about this, either personally or as a GoToMeeting if other are interested. I suspect the site you set up could facilitate that.

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A Field Guide for Engineers at <http://av8rdas.wordpress.com/>

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From: Daniel S Imperiale <dsimperiale@ucdavis.edu>

Sent: Monday, January 13, 2020 9:37 AM

To: David Sellers <dsellers@facilitydynamics.com>

Cc: Ryan Hoest <rhoest@ecovoxinc.com>

Subject: San Mateo CHW Diagram

David,

Could you send a screenshot of the chw plant diagram you were showing us on Friday? Also, there was a comment that you had never seen a system quite like the one they had at San Mateo. Was that still the case after you had more time to analyze the design? If so, which part was of their system was unique?

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