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CALIFORNIA ENERGY COMMISSION

In the matter of:

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2020 Energy Code              )   Docket No. 19-BSTD-03
Pre-Rulemaking:               )
                              )
Computer Rooms, Compressed    )
Air Systems, and Refrigeration)
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WORKSHOP

REMOTE VIA ZOOM

WEDNESDAY, SEPTEMBER 23, 2020

9:00 A.M.

Reported by:

Elise Hicks

APPEARANCES

CEC STAFF

Payam Bozorgchami, Project Manager

Haile Bucaneg, Senior Mechanical Engineer

Ron Balneg, Mechanical Engineer

Cheng Moua, Mechanical Engineer

ALSO PRESENT

Hillary Weitze, Red Car Analytics

Lisa Saponaro, Vertiv

Jon McHugh, McHugh Energy Consultants

M M Valmiki

Trevor Bellon

PUBLIC COMMENT

Laura Petrillo-Groh, Air Conditioning, Heating, and Refrigeration Institute

Meg Waltner, Energy 350

Nick Harbeck, Air Conditioning, Heating, and Refrigeration Institute

P R O C E E D I N G S

9:05 A.M.

WEDNESDAY, SEPTEMBER 23, 2020

MR. BOZORGCHAMI: Good morning everyone. My name is Payam Bozorgchami. I'm the Project Manager for the 2022 Building Energy Efficiency Standards. I want to welcome you to the --

MS. BECK: Payam, can you please push record?

MR. BOZORGCHAMI: Yes. I always forget. Thank you. Thank you, Amber.

I want to welcome you to the Commission's workshop, Pre-Rulemaking Workshop for 2022 Energy Standards. Let me provide you with some housekeeping rules.

We will be muting everyone. And after each proposed measure is presented, you can either raise your hand and we will un-mute you, or you can submit your questions in the question and answer window and we'll try to answer your questions as soon as we can. If we notice the question is a little bit too long, and it's going to be our discretion, I will un-mute you and you can ask your question so everybody else can also participate.

If you're calling by phone, you can use the star six to mute and un-mute yourself.

One important thing, as you all heard, this workshop presentation is being recorded, and it's also going to be transcribed. So the information you see today as the PowerPoint presentations will be posted tomorrow, early morning tomorrow. And the transcripts will be available later on, as soon as we get those back.

So with that, I think we should start. So for the workshop today, we're going to go through some basic backgrounds on how Title 24 is developed.

Haile Bucaneg, our Senior Mechanical Engineer here at the Energy Commission, will talk about the computer room efficiencies. Ronald Balneg, our Mechanical Engineer here at the office, will talk about a proposed measure that was provided to us by a private entity regarding integrated pump refrigerant economizer as a prescription option. We'll have Haile Bucaneg again. He'll be talking about pipe sizing and monitoring the leak testing of compressed air systems. And Cheng Moua, one of our mechanical engineers here in the office, will also be talking about two new mandatory requirements for covered processes.

So that -- with that, I'll start by explaining how the Energy Commission was developed. It was done by two California Assemblymen, Assemblyman Warren and Assemblyman Alquist, to develop what's known as the Warren-Alquist Act. They proposed it to Governor Ronald Reagan in 1972 where he signed it into bill. And in 1975, when Jerry Brown came into office, he funded it and we started what's known as the California Energy Commission.

This was done to reduce wasteful, uneconomic, inefficient, and unnecessary consumption of energy in California. This Act also gives authority to the Energy Commission to develop the Energy Code on a triennial basis as part of the Building Codes or Building Standards. And these codes and regulations are to be enforced by the local jurisdictions.

There's other areas that the Energy Commission also have to look into as we're developing the 2022 standards. These are regulations, state bills, and assembly bills that have been added on -- or senate bills, excuse me, that's been added on to the work that we do here at the Energy Commission. And it's really looking at global greenhouse gas reduction goals and looking at how to provide an option for electrification for buildings, and self-utilization also.

The work that we do here at the Energy Commission is done with the help of our utility partners. And the utility partners have been very grateful and gracious in helping us out, as Pacific Gas and Electric, Southern California Edison, Sacramento Municipal Utility District, Los Angeles Department of Water and Power, and their consultants. They provide these measures to the Energy Commission.

But prior to doing so they provide -- they do two utility-sponsored stakeholder calls, meetings where each proposed measure is presented, and they take feedback from the public. And they try and answer all questions and concerns and comments and develop what we call a Codes and Standards Enhancement Document, where it is a proposal to the Energy Commission that shows the benefit cost analysis for every proposed measure, based on the time-dependent evaluations for the current 2022 Standards. When they submit that to the Energy Commission, we review and we provide these sponsored pre-rulemaking workshops where we take more feedback from you folks.

One of the things that we were trying to do with the utilities is try to get your comments and concerns earlier on, so we have a more productive path moving forward with our Code development. There's a lot that's happening and within a little bit amount of time, this Code cycle.

Right now, what we call the Case Team is, through the utilities, are submitting their proposals to the Energy Commission for review. That will be happening until October. Staff has been reviewing and providing presentations, as you will be hearing today, in pre-rulemaking workshops.

From there we take your comments and your concerns and we develop the 45-day language. And this language needs to be done and completed within -- by September or end of September. And we will have a workshop. This one will be a Commissioner-led workshop in February. It will be probably be three workshops, one for residential, one for nonresidential, and one for multifamily electrification. And within those, we’ll try to get the last set of comments to develop what we call the 15-day language, which becomes a document for adoption for the 2022 Standards. It will be happening at a business meeting, hopefully, in July of 2021.

After that the Staff works on developing compliance manuals, compliance forms, and working on the -- and the computer modeling programs, to really capture everything that we presented for the July 2021 workshop for adoption.

We’re trying to do this all one year before the effective date of the standards. And that effective date right now is January 1 of 2023.

And why one year? The one year is to really make sure the energy consultants, the local jurisdictions are trained, that third-party verifiers are set to really take on the program as it takes effect on January 1st.

So our schedule so far. We’ve had four

workshops so far. Our last one was yesterday on outdoor and daylighting requirements. Today we will hear about the nonresidential mechanical measures. We will have a workshop next week. This is a Commissioner-led workshop. It's a roundtable, per se. It's discussions with the scientists and researchers related to indoor air quality and, in particular, to gas cooktop versus electric cooktop and the particulates that are emitted from cooking.

One of the key issues that everybody's been interested in hearing about is the electrification program and the process and procedures. That workshop will be led by Mazi Shirakh and that will happen. The first one will be on October 6th where he will present what path, what type of buildings we're looking into this Code cycle, and how we're going to be looking at electrification. And on November 17th, he will be presenting the final proposals for -- to be embedded into Part 6 of Title 24 as we move forward.

Key websites and links that you should be -- you might be interested in. The first one is the utility sponsors/stakeholders website. Here you'll find all the information the utility and the Case Team used to develop the proposals, the proposals themselves are also located here, and then past workshops that utility sponsors have conducted for the proposals that you will be hearing today also.

Our website, this information has all the current regulations, current documents and manuals, and it has the current proposed measures that's come in through these workshops here.

The last link here is the most important link. We need your -- we need you to submit your comments on this workshop by -- excuse me, that date is wrong, it should be October 7th of next month for this workshop. I will fix this before we send this out for you folks to review on our docket. But I just want to make sure that if you have any concerns, comments, that there's a comment that we did not get to, please submit it in writing here by October 7th to be looked at and reviewed.

Some key Staff members here at the Energy Commission. Mazi Shirakh, he will be -- he's the lead that's looking at electrification and decarbonization in California. Myself. Larry

Froess, he's our Senior Mechanical Engineer, and his responsibility is the computer software program and the performance packages. Peter Strait, he's the Supervisor of the Building Standards Development Team. Haile Bucaneg, he's our Senior Mechanical Engineer, and you'll be hearing from him today too. He's been a very essential help to me in getting the 2022 Standards moving. And Will Vincent, he's our new Office Manager here at the Building Standards Office. This is second week. And right now he does not have a phone number because we have not been back in the office and there's not one been assigned to him yet.

Again, I have the right date here. Due date for this comment -- for this workshop for comments is on October 7th. And this is the link to submit your comments to.

Any questions?

Also, when -- during the presentation, when I -- when you raise your hand and I un-mute you, please state your name and your affiliations. This is very important so that we know who made the comment, and if we -- and who we need to touch bases and have side discussions, if needed, as we're developing Code language. So if you don't, I will probably jump in and stop you and have you state your name and your affiliation and restate your question or comment.

So with that, I'm going to pass it on to Haile.

MR. BUCANEG: Good morning everyone. Can you guys see my screen?

MR. BOZORGCHAMI: Yes, Haile.

MR. BUCANEG: Okay. Perfect.

So, as Payam mentioned, my name is Haile Bucaneg and I am a Senior Mechanical Engineer with the Building Standards Office. This morning, I will be discussing the Codes and Standards Enhancement Initiative Nonresidential Computer Room Efficiency Proposal.

Before I begin, I want to thank Hillary Weitze, Neil Bulger, and Jeff Stein, who were the primary authors for this proposal.

Oops. Let me see here. There you go.

Staff received proposals pertaining to nonresidential computer room efficiencies. And there are three measures that I would like to present for the 2022 Energy Commission update. These are increased temperature thresholds for economizers, uninterruptable power supply efficiency, and moving reheat, humidification, and fan controls to mandatory requirements. These proposed measures will affect Section 110.1(a), 140.9(a), and create a new Section 141.1(b).

The first measure I will discuss is the increased temperature threshold. I'll be discussing the specifics of the proposal and the analysis of the proposal. And I will also be discussing some of the exceptions included in the measure proposal before touching upon the estimated statewide savings.

Under the 2019 Energy Code, four economizing requirements are dependent on whether the economizer used is an air economizer or water economizer. For air economizer, full economizing is required at a dry bulb temperature of 55 degrees Fahrenheit and a wet bulb temperature of 50 degrees Fahrenheit. For water economizers, the threshold is 40 degrees dry bulb and 35 degrees wet bulb.

Additionally, under current requirements, air containment is required at a design load of 175 kilowatts per room.

This proposal would revise the temperature threshold where full economizing occurs to a dry bulb temperature of 65 degrees and a wet bulb temperature of 50 degrees Fahrenheit. These threshold would apply to any type of economizer.

Additionally, the requirement for air containment would be revised to an information technology equipment design load of 10 kilowatts per room, and that's an ITE design load.

These proposed requirements pertain to new construction. Note that for existing facilities the proposal allows for computer room cooling systems to follow the 2019 temperature threshold for economizers.

It should be noted that the revised requirement for air containment of an ITE designed load of 10 kilowatts per room would still apply to existing facilities.

The revisions to the full economy threshold is expected to have an affect on the number of hours when full economizing and, also, partial economizing is expected to occur. The expected economizing hours under 2019 dry bulb standards in blue and those under the proposed dry bulb requirements in green can be seen here. Since the proposed requirements for full economizing was increased, the amount of time when full economizing occurs also increased. This table is based on increasing the dry bulb temperature from 55 degrees to 65 degrees. And this kind of represents the least amount of increase in economizing hours.

A similar trend can be seen in comparing expected economizing hours for wet bulb temperatures. Here, we're looking at 35 degrees to 55 degree increase in the temperature threshold. And this represents a larger increase in the number of economizing hours that would occur.

Four prototypes were analyzed for this measure. First was looking at a baseline computer room air conditioner with an air economizer. This prototype required the addition of an air containment -- of air containment equipment to meet the proposed requirement. The cost for the addition for the air containment equipment can be seen here. And this is per kW ITE load.

Based on the cost incentive -- sorry.

The associated energy savings per kilowatt ITE load are shown here. In addition to increasing economizing hours, there were also some energy benefits from increased efficiencies for the direct-expansion air conditioner, and this was due to higher return air temperatures from the air containment system. Based on the costs and benefits, we can see that this would be cost effective in all climate zones.

A computer room air handler with chilled water system and air economizer would represent the best case scenario for this proposal from an incremental cost standpoint. And this is because no additional costs would be incurred when meeting new proposed Code requirements.

This system would still realize energy savings due to increased economizing hours. These savings were a little bit less than the first case proposal. But since there were no additional costs, the benefit-to-cost for this scenario were higher than those seen in the direct-expansion air conditioner system.

The third prototype, based on a computer room air handler with a water economizer, was also reviewed. It was determined that to meet the higher temperature threshold a larger heat exchanger was required. Again, this is per ITE design load kilowatt, so the larger the system the higher the incremental costs. Again, the savings here are based on increased economizing hours and were estimated to be higher per kilowatt ITE load than the previous two scenarios.

Although this system did have increased costs around the heat exchanger, the benefit-to-cost ratio was still pretty significant because that increased cost for the heat exchanger wasn’t too much compared to the energy savings.

Finally, a worst case scenario in terms of additional costs is shown here. And this is an existing system with a dry cooler being changed to a water economizing system, yeah, being changed to a water economizing system. This included a number of additional incremental costs which were estimated here. You can actually see that the cost for the air-cooled chiller actually went down. And that’s because it no longer has to provide economizing. However, there were significant increases in costs associated around the cooling tower and heat exchanger.

While there are significant incremental costs for this prototype -- oh, I'm sorry.

The proposed system did have energy savings based on increase economizing hours. And similarly, it wasn't as much as in the third case scenario but it was more than in the first two scenarios that were looked at.

While there are significant incremental costs for this prototype, the benefit-to-cost ratio was still found to exceed 1.0 in all climate zones. Of the four scenarios analyzed, this represented the least cost effective, and this was just due to the high incremental costs. And, also, in this analysis there were increased costs associated with increased water usage for this system.

There were several exceptions included as part of this proposal. The first two exceptions regarding small computer rooms and computer rooms with a secondary fan system are based on existing exceptions with just some minor adjustments. In the case of the small computer rooms, the 18 kilowatt ITE design load threshold was identified. And in the case of the computer rooms with a secondary fan system the 70 kilowatt ITE design load was identified. And, also, the economizer, the last bullet here, which is the economizer, can meet the computer room ITE design load, or 5 tons plus 25 percent of economizing capacity at design conditions was added in.

An exception was included for areas where local water authorities do not allow for cooling towers. In this case, we were allowing for 2019 requirements around the economizer.

And, finally, an exception was included in computer room fan systems if computer room fan systems do not exceed 0.35 watts per CFM and the differential of supply air, and return air is at least 25 degrees, and cooling system efficiencies are 20 percent better than Table 110.2(a) through 110.2(k), or Title 20, Table C-7. If all of these conditions are met, again, we would allow for -- or the proposal allows for 2019 threshold to be used.

Overall, this measure is expected to result in 215 gigawatt hours in electricity savings and $514 million over the 15-year analysis period.

For additions and alterations, the only

savings here are associated with revised air containment requirements which were relatively minor. As you recall, for additions and alterations, they would not -- they would be able to meet the 2019, the current, threshold in regards to economizing temperatures.

A reduction of approximately 51,600 metric tons in greenhouse gases is expected with this measure. And this is due to the high number of operating hours of cooling systems servicing computer rooms which run 24/7.

So as mentioned, this measure is cost effective in all climate zones. There were a number of exceptions included to allow for flexibility in various scenarios. And this measure is no longer based on air and water economizers. Only as long as the temperature threshold can be met, any type of economizer would be allowed.

With that, we can take questions. You can type questions into the Q&A box, or you can go ahead and raise your hand and we can un-mute you.

MR. BOZORGCHAMI: Haile, we have one raised hand.

Laura, I'm going to un-mute you.

MS. PETRILLO-GROH: Hello. This is Laura Petrillo-Groh with the Air Conditioning, Heating, and Refrigeration Institute. Can you hear me okay?

MR. BOZORGCHAMI: Perfect. Go ahead.

MS. PETRILLO-GROH: Yeah. Thanks Brian. Thanks Haile.

So for the benefit of the record, the Air Conditioning, Heating, and Refrigeration Institute represents over 320 manufacturers of air conditioning, heating, ventilating, water heating, and commercial refrigeration products. We appreciate the work that the Case Team has done to date. The process was -- we were very, very engaged with the process and it included us as stakeholders. And we've seen some pretty significant improvement in the readability, understandability, and general enforceability of the draft proposal. So, you know, thanks to the Case Team for that hard work at the beginning.

I do have three questions that I'd like to raise here, if that's okay?

MR. BOZORGCHAMI: Please. Go ahead. Sure.

MS. PETRILLO-GROH: Okay. Thank you.

So, you know, appreciate that the -- where the proposal clearly includes refrigerant economizers. However, it looks like, in the Case Report, only one manufacturer was cited to meet the temperature, the new higher temperature threshold requirements.

You know, have other manufacturers been approached for data? Or, you know, we, I think, the public and design engineers need to be confident that the proposal will not limit the technology options of the manufacturers that are allowed to compete in the California marketplace. So can you talk about any other manufacturers' products that are able to meet those increased temperature thresholds for refrigerant economizers?

MR. BOZORGCHAMI: Haile?

We lost Haile. He's trying to come back on. I apologize.

MS. PETRILLO-GROH: Okay. Well, I barely got to make a comment without a baby screaming in the background, so this new reality is certainly challenging.

MR. BUCANEG: I'm sorry about that. I

did get dropped off the call. I'm back on now. This is Haile Bucaneg with the Energy Commission.

MS. PETRILLO-GROH: Hi Haile. Did you catch my question or would like me to repeat?

MR. BUCANEG: I caught the beginning of the question regarding one identified refrigerant system that would meet the requirements. That is a question that we have as well. At the end of the presentation, I was going to be bring up a question, just asking for additional input regarding whether or not additional technology meet this revised temperature threshold and getting public input around that.

MS. PETRILLO-GROH: Okay. Thanks.

MR. BUCANEG: I believe Hillary is on the call as well. I'm not sure if she would like to speak to this as well. I can ask if she would like to un-mute herself here?

MR. WITTERS: Sure. Thanks Haile.

Yeah, I think that's a good question, if you wanted to bring that up at the end. I guess, maybe, two comments I will bring up.

One is we were able to get some data, just in terms of market share of different economizer types in California, that was added into the Final Case Report. And based on the data that we received it did look like only about 13 -- 10 to 15 percent of computer rooms were served by refrigerant economizers. And that includes both -- we were not able to disaggregate between new construction and existing computer rooms. So based on -- we don't have hard numbers, but based on discussions with stakeholders, design engineers, the feedback we got is that the majority or a good, at least, you know, more than half of the refrigerant economizers are being installed in existing computer rooms or computer rooms in existing buildings, which would not be subject to the new higher economizer threshold in the proposal.

MS. PETRILLO-GROH: Thanks for that background, Hillary. Yeah, we do want to be sure that the Code is open and doesn't end up inadvertently mandating proprietary technology. So AHRI can certainly look into, you know, which technologies can meet this and try to provide you some additional information by the 7th. Noting that about 50 percent of the products are in existing construction, that, to me, I think would mean that there is a desire to install refrigerant economizers in California.

Overall, I think the, you know, the rule of thumb is that, you know, about 80 percent of products go into existing construction and 20 percent into new buildings. So that's, you know, a different breakout, 50/50 is certainly a different breakout than the 80/20. So I would hope that we could make sure that other manufacturers would have the opportunity to compete in the state of California.

MS. WEITZE: Sorry. Can I just clarify? The more than 50 percent, that definitely is not a hard number. I think I was, basically, trying to -- well, the 80/20 is good information and we did not have that specific of a number. I think my comment was mostly just to say, our understanding is that the majority of refrigerant economizers are going into existing, which, I think, is what you just kind of supported. So I just, I want to be careful. The 50 percent was not a specific number that we have.

MS. PETRILLO-GROH: Okay.

MS. WEITZE: Yeah. Yeah. Thank you.

MS. PETRILLO-GROH: Sure. Yeah, just a general rule of thumb.

So my next question is really about just trying to seek clarification where you've got water economizers with evaporative cooling towers and air economizers in the Case Report. That, to me, it seems that, you know, any system with a water-cooled economizer to meet the full requirements about running in economizer mode and that the load on the chillers is below the design requirement in full economizer mode, this, to me, is that the redundant equipment that might be installed, and is typically installed in the mission-critical space, would need to be operating during standard economizer mode. Is that the correct interpretation of this proposal as written or is it just the -- can you, perhaps, speak to that?

MR. BUCANEG: I didn't really understand the question. Can you restate it? Sorry.

MS. PETRILLO-GROH: Sure. So in the Case Report, it states that -- you know, it's the importance of recognizing that redundant equipment should be running in economizer mode, and that the load on the cooling tower should be below the design load in full economizer mode, making it easy to achieve full economizing at 50 degrees wet bulb.

So I’m wondering if the backup equipment needs to be running during full economizing, if that’s what the language is suggesting? Is that the correct interpretation?

MR. BUCANEG: Hillary, do you want to speak to that one? I don’t think that I can answer that specifically.

MS. WEITZE: Sure. Yeah. No, it is not required that the backup equipment is running to meet the elevated temperatures. You could select cooling towers that are designed for the elevated temperatures without having to, you know, to run additional towers and parallel at a lower load factor.

So that was suggested in the Case Report as, perhaps, a more -- you know, the sort of most efficient way to achieve the proposed elevated temperatures but it is -- it wouldn’t be required. You could select towers at, you know -- to -- you know, whether or not you want -- you could decide whether you wanted to, you know, run everything in parallel at that peak condition or at the peak economizing condition or just select your towers and just run the nonredundant equipment.

MS. PETRILLO-GROH: Okay. Thank you so much for clarifying. We might make comments around suggesting an improvement to reflect that intention. It was confusing as we had read it.

And then the last question I had was on the, you know, the refrigerant economizers that are going to be permitted to -- in the Additions and Alterations section. I noticed that there are certain individual climate zones that -- where this is permitted, but I didn't see that there was any justification for that. Could you maybe speak a little bit about the limitations in those climate zones?

MR. BUCANEG: So the economizer portion that was discussed and proposed, that is based on what is allowed prescriptively in the Energy Code right now. So that was what that proposal was based around.

MS. PETRILLO-GROH: So there is a limitation in the climate zones where that is permitted, where refrigerant economizer has been shown to be more efficient than the baseline water economizers?

MR. BUCANEG: Let me get back to you on

that one because I know that we have some additional questions around that. So let me make sure that I get you the correct answer on that one.

MS. PETRILLO-GROH: Okay. Thank you so much. Again, I appreciate all the time that has gone into developing this proposal.

It would be very helpful if, maybe, meeting materials could be made available in advance of these presentations. And if I missed something posted to the docket, my apologies. I did check right before. So being able to see the slides and follow along with you would be very helpful. The slides were not numbered.

And also, you know, as much time as we can get to develop comments; the analysis was quite robust and it requires a lot of time to go through these in detail.

So thanks again. That's all I have for now.

MR. BUCANEG: Okay. Thank you. And the slides aren't available at this time. They usually go up after the presentation. So, yeah, that's just kind of to say, you did not miss anything on the docket for the presentation slides yet.

MR. BOZORGCHAMI: Thanks Laura.

Any other questions? Comments?

With that, Haile, do you want to move on?

MR. BUCANEG: Sure. Okay, so the second measure I want to discuss is the uninterruptible power supply efficiency measure. This measure requires minimum energy efficiencies for UPSs based on the type and size. The testing procedures are based on the ENERGY STAR Program requirement -- oh, sorry, I haven't advanced the slide yet. This measure requires minimum energy efficiencies for UPSs based on the type and size. The testing procedures are based on the ENERGY STAR Program requirements for Uninterruptible Power Supplies Eligibility Criteria Version 2.0. This proposal does include some exceptions based on the input plug type for the UPS, and those are shown here.

This table is from the ENERGY STAR Program and shows the minimum efficiencies for UPSs -- or shows how the minimum efficiencies for UPSs are calculated. In several cases a specific minimum efficiency is identified. But in other cases, this minimum efficiency is going to need to be calculated out.

As mentioned, efficiencies will be -- will also be dependent on if the UPS is voltage and frequency independent, voltage independent, or voltage and frequency independent.

Two prototypes were analyzed for this proposal, this measure. The first was a direct-expansion computer room air conditioner unit servicing a 200 kilowatt ITE load. And the second was a chilled water computer room air handler servicing a 1,000 kilowatt ITE load. The incremental cost associated with the higher efficiency UPS measure are shown here for both prototypes. And the incremental cost was based on the equipment cost, increases in equipment costs as labor, controls, and commissioning were all expected to be the same.

The savings for the first computer room air conditioner prototype here were based on a combination of higher UPS efficiencies and some cooling savings. The savings were relatively consistent across all climate zones.

The source of savings for the computer room air handler were also the reduced electricity usage from the UPS and for cooling.

And with the larger system, you can see that there was a little bit more variation in savings between climate zones shown here. And, again, this is per kW ITE mode.

Both the prototypes show the benefit cost above 1.0 in all climate zones, which can be seen here for the 200 kilowatt ITE computer room served by the direct-expansion air conditioner. And here, for the 1,000 kilowatt ITE computer room certified air handler. And, again, these savings are per kilowatt ITE mode.

Overall, this measure is expected to save 137 gigawatt hours or electricity and $335 million over the 15-year analysis. And this would be across new construction and additions and alterations. This would represent greenhouse gas reductions of approximately 32,900 metric tons.

This measure did show cost effectiveness over all climate zones. And this measure reduces energy usage over 24 hours and, additionally, does reduce cooling loads. The exceptions included are based on UPS devices which are federally regulated, so we're just kind of avoiding those.

And then that’s it for the UPS, the Uninterruptible Power Supply Efficiency Measure proposal. Do we want to take some quick questions on this measure proposal?

MR. BOZORGCHAMI: Okay, Haile, I don’t see any raised hands or any questions in the question and answer box.

MR. BUCANEG: Okay. Sounds good. The next proposal discussion is going to be very short as well. And after that, we can take questions on the proposal, as well, or on the --

MR. BOZORGCHAMI: Sure.

MR. BUCANEG: -- all the measure proposals. So --

MR. BOZORGCHAMI: Sure.

MR. BUCANEG: -- so, finally, I’d like to discuss a few proposed mandatory requirements for computer rooms. The new requirements pertaining to reheating, humidification, and fan controls are currently prescriptive requirements. The proposals would be move to -- the proposal would move requirements preventing reheating, recooling, and simultaneous heating and cooling to the same zone, and also adiabatic humidification to mandatory requirements.

Additionally, there will be a mandatory requirement for fan controls, for air conditioners exceeding 60,000 Btus per hour, and each chilled water fan system to vary the air flow rate as a function of actual load and have controls or devices that will result in fan power demand of no more than 50 percent of design wattage at 66 percent of design fan speed. So, again, this is just taking the language that is prescriptive requirements and moving this into mandatory requirements.

And then, again, before taking questions on this portion of the proposal, or any other portion of the proposal measures discussed, I did want to bring the one item that we would like to get public input on. This was touched upon earlier but it was determined that air and water economizers would be able to meet the revised temperature thresholds. And the Case Team also identified an example of a refrigerant economizer that could meet threshold. But I'd like to get the public's input on the feasibility of using various economizer technologies at these temperature thresholds.

So if you guys have any information on

that, feel free to submit that to the -- submit it to our docket and we can take that into consideration as well.

And, again, if you have any questions, not just on this portion of the -- or this measure but on anything that was presented, we can discuss that now.

MR. BOZORGCHAMI: Haile, I don't see any raised hands, so --

MR. BUCANEG: Okay.

MR. BOZORGCHAMI: -- I'm assuming folks are going to be submitting comments to the comment -- to the docket by October 7th, so --

MR. BUCANEG: Okay. Perfect. So the link here, again, as I mentioned, if you have any comments or think of any additional questions or comments in the future, you can submit them here by October 7th, 2020.

You can also reach out to me regarding comments. So if you can reach out to me regarding the refrigeration -- refrigerant economizer comment, wherein I can also get back to you on that, just so it would be easier for me to get your contact information? If you send me an email, I can follow up on that one, make sure I get back to you on that question.

Again, Payam is the overall Project Manager on 2022. And Larry is leading the revisions on energy modeling softwares.

And that's it for the Case Report -- the Case proposal regarding computer room efficiencies. And I think we'll be handling -- handing it off to Ronald for the next question, the next presentation questions.

MR. BALNEG: Yeah. Hi. Hey, Payam, can you move to host? I can't share my screen. I guess I'm considered a participant right now.

MR. BOZORGCHAMI: Oh. Sorry about that. Let me -- give me one second.

MR. BALNEG: Yeah. That was my fault. My internet disconnected for quite a bit this morning. I just got it back on. I apologize. There you go.

MR. BOZORGCHAMI: So, Ronald, you're now a co-host also. So, Ronald, we can see your screen.

MR. BALNEG: Okay. Can you guys hear me?

MR. BOZORGCHAMI: Yes.

MR. BALNEG: Okay. So I'm going to be talking about the Nonresidential Integrated

Pumped Refrigerant Economizer Proposal.

This proposal was submitted to the Energy Commission by Vertiv. The is a company that manufacturers pump refrigerant economizers for computer rooms. This proposal seeks to add integrated pump refrigerant economizers to the section as a prescriptive, along with air and waterside economizers.

So here are the affected sections. A definition will be added for pump refrigerant economizers, and a prescriptive requirement for Section 140.9(a)(1). They have also proposed to model refrigerant economizers equivalent to airside and water economizers, considering this is a prescriptive requirement.

So here are the existing requirements. As mentioned earlier, for air and water economizers in Section 140.9(a)(1), currently, pump refrigerant economizers are a compliance option as an alternative pathway to comply with this economizer requirement section.

So in this slide, this is the proposed addition of the definition, as well as the prescriptive requirements.

So what is a pump refrigerant economizer?

So here is an example of a system. During the economizer mode, compressors are turned off and the refrigerant pump moves refrigerant through the circuits for economizing. In partial economizing mode, one circuit will operate the compressor while others will -- while the other circuit will operate the refrigerant pump. And so this was taken out of the Staff Report for the compliance option.

And here is the integrated refrigerant pump. This is where the refrigerant pump is integrated within the unit where it eliminates an added footprint.

So modeling assumptions. The modeling assumptions include a 14,000 square foot data center with 85 watts per square foot. The same low profile was added to all climate zones. And the energy savings were compared to a waterside economizer that minimally complies with the current 2019 Code.

And so here are the energy savings from the modeling. You can see the peak electricity demands and the TDV savings for each climate zone.

So this proposal assumes an incremental

cost of zero dollars compared to chilled-water equipment. So here's a real-world example that was taken from Vertiv's report. And independent contractor did cost estimates for 200 tons of cooling. You can see the price differences in the initial costs and difference in maintenance costs per year between a pump refrigerant system and a chilled-water system.

And so for the cost-benefit ratio, the cost-benefit ratio is greater than one for all climate zones. With an incremental cost of zero, any amount of energy savings would cause the cost-benefit ratio to be infinite.

So pump refrigerant economizers have been installed and operating for the past six years. It's estimated these systems are estimated to save 4.3 million gallons of water annually. And this proposal shows it's cost effective in all climate zones.

So some Staff questions that I had, that I would like to get some input on from the public, is are the incremental cost assumptions compared to waterside -- sorry, that shouldn't say economizer, it should be system -- waterside system, are they accurate to assume a zero dollar incremental cost?

Should the term "integrated" be included in the prescriptive requirement? In other parts of the Code we have the term "integrated" but it's used differently. Or would this limit other methods of this type of economizer?

Other stakeholders, in the previous Case Report, they pushed to change the term "refrigerant" to "fluid" for another proposal regarding refrigerant economizers. Should this term -- should the term, "without using any water" be removed? And should we change "refrigerant" to "fluid," the term "fluid?"

And should these -- should the style of economizer be modeled equivalent to an airside and waterside economizers?

And so with that, I'll take any questions.

MR. BOZORGCHAMI: Hey, Ronald, this is Payam. We have one question from Mr. Jim Marsh, and his question is, "Following the spirit of law from AHRI," this is his question, "are there any vendors of integrated pump refrigerant economizers in the marketplace, other than Vertiv?"

MR. BALNEG: That is a good question. I am not familiar with other economizers. I guess Laura can -- she's raising her hand. Maybe she, ARHI, might have more information on that.

MR. BOZORGCHAMI: Is this a question that Lisa may be able to answer?

MR. BALNEG: Yeah, possibly.

Lisa, are you there?

MS. SAPONARO: Yes, I am. This is Lisa Saponaro from Vertiv.

So I can speak to the specific technology that we use as something that Vertiv has. There are other manufacturers of refrigerant-style economizers but they may not be exactly the, you know, same exact technology.

MR. BOZORGCHAMI: So there's -- sorry, you broke up a little bit. So there are other manufacturers but just, pretty much, maybe not the same type of technology; is that what you were saying? I apologize. This is Payam again.

MS. SAPONARO: That's okay, Payam. Can you hear me now?

MR. BOZORGCHAMI: Yeah. Yeah.

MS. SAPONARO: Okay. Maybe it's my end.

So there are other manufacturers of

refrigerants economizers, period.

MR. BOZORGCHAMI: Okay. Wonderful.

MS. SAPONARO: Yes.

MR. BOZORGCHAMI: Okay.

MS. SAPONARO: Um-hmm.

MR. BOZORGCHAMI: Thank you.

Laura, I'm going to un-mute you again. Please state your name and affiliation again. Thank you.

MS. PETRILLO-GROH: Hi. This is Laura Petrillo-Groh with Air Conditioning, Heating, and Refrigeration Institute.

Yeah, we absolutely support any proposal that allows manufacturers of different products to compete fairly in the California market, and any proposal that is not excluding competitive product types, so I think that will be the one differentiation. I'm trying to make sure that proposals allow for multiple product types, as I was concerned about the temperature requirements. And, you know, anything that allows newer and more innovative products, not at the detriment of any other products to be -- to participate in California is -- it would be an option for California designers.

MR. BOZORGCHAMI: Wonderful.

MS. PETRILLO-GROH: Thank you.

MR. BOZORGCHAMI: Thank you, Laura.

Jon McHugh, I'm going to un-mute you, sir.

MR. MCHUGH: Can you hear me?

MR. BOZORGCHAMI: Yes. How are you?

MR. MCHUGH: Yeah. I actually have a question about this. And I know this came up earlier with the performance approach, which is when thinking about what the base case should be, you know, there's lower hours of economizing when you use a waterside economizer. But, to some extent, that is made up for the fact that water-cooled equipment has a substantially higher CoP tan air-cooled equipment. And it seems to me that, you know, the refrigerant economizer, in general, it's serving air-cooled equipment. And as a result, from my point of view, it seems like you would want to compare that to an airside economizer, you know, with the more hours of cooling because that airside economizer with more hours of cooling helps partially offset the fact that the airside -- or I'm sorry, the air-cooled equipment is so much less efficient.

So, hopefully, that's, you know, I think raising the question that was brought up during the pump refrigerant economizers.

MR. BOZORGCHAMI: So this is Payam again.

Jon, so you're saying that the comparison should have been compared to airside versus waterside?

MR. MCHUGH: Right, because the --

MR. BOZORGCHAMI: Sure.

MR. MCHUGH: -- because the air-cooled equipment is less efficient, you know, when it's actually operating in the mechanical cooling mode.

MR. BOZORGCHAMI: Okay. Thank you.

MR. MCHUGH: Thank you.

MR. BOZORGCHAMI: That's a good point. Excuse me.

Any other comments or questions?

With that, Ron, do you want to move on to your next slide?

MR. BALNEG: Yeah. Sure.

MR. BOZORGCHAMI: Yeah.

MR. BALNEG: I'm sorry.

MR. BOZORGCHAMI: So, yeah, Ron will jump through those loops real quick, but there he had two slides, one on, again, comments on this proposal, please by October 7th. And I apologize. You're going to see a lot of that coming up, and contact information. I'm just trying to emphasize, we need your comments sooner than later, so you'll see a few of these slides over and over and over again.

MR. BALNEG: Yeah. Sorry about that. I don't know what happened to my screen share. It just ended.

MR. BOZORGCHAMI: Don't worry. You're all -- you're good. You're good.

MR. BALNEG: Okay. Thanks everyone.

MR. BOZORGCHAMI: So with that, I think, we're going back to Haile, who is going to do his presentation, I believe, on pipe sizing and monitoring of compressed air systems.

MR. BUCANEG: Good morning, again, everyone. Yeah, I'm un-muted. Okay. Great. Good morning, again, everyone. Again, this is Haile Bucaneg with the Building Standards Office.

Moving on from computer rooms, I'll now be discussing the Codes and Standard Enhancement Initiative for Pipe Sizing, Monitoring, and Leak Testing for Compressed Air Systems Proposal.

Before I begin, I would like to thank M M Valmiki, Val, Joseph Ling, Keith Valenzuela, Regina Kahlua (phonetic), and Teri Cokley (phonetic), who were the primary authors of this proposal.

Staff received proposals for measures pertaining to compressed air systems. And three proposed measures I would like to present for the 2020 Code update process focus on pipe sizing requirements for compressed air systems, leak testing requirements for compressed air systems, and compressed air system monitoring.

In the current 2019 Energy Code, the Compressed Air System Requirements are located in Section 120.6(e). This will also be where the proposed Code changes will reside. Additionally, there are proposed Code changes to reference Appendix NA7.13.

So, first, I will start off discussing the Pipe Sizing Measure Proposal, including pipe size design requirements and the energy savings associated with this measure.

This measure provides several requirements associated with compressed air system piping. First, compressed air piping greater than 50 adjoining feet in length. For that type of piping, service line piping must have an inner diameter of three-quarter inch or greater. And service line piping is just the piping that delivers compressed air from distribution piping to the end uses.

For compressed air piping greater than 50 adjoining feet in length, one of the following requirements must also be met.

The first option is to design the compressed air piping based on piping section velocity where the maximum air velocity in the compressor room interconnection and main header piping does not exceed 20 feet per second and, also, the average velocity in distribution and service piping is 30 feet per second or less.

The second option is to design compressed air piping based on total pressure drop where the frictional pressure loss is less than five percent of design operating pressure between the compressor and end use or end use regulator.

So to analyze energy savings, four prototype compressed air systems were used. These systems represent various compressed air system sizes. The appropriate compressed air pipe sizing for these systems was determined based on total pressure drop of the system. Once the optimal pipe sizing was determined based on five percent pressure drop, the system was modeled using the appropriate readily-available pipe size. And, typically, in most cases, that readily-available pipe size was a little bit larger than the optimal pipe sizing that was capsulated.

So the difference in pressure drop between the baseline compressed air system and the system with the compressed air pipes based on the proposed pressure drop requirement can be seen here. In all cases the proposed system had a pressure loss lower than the five percent requirement which, in this case, was 5 psig as the design suggestion was 100 psig.

The energy savings associated with this measure can be seen here. And these energy savings are based on load profiles for each prototype over a year period.

The material costs and labor costs for the installation of piping is shown here. The material costs were based on aluminum pipes, which is generally cheaper than steel welded pipes. But the Case Team did reach out and found that more and more compressed air systems are being designed with aluminum piping. So this represents a slightly conservative cost for the piping equipment.

Labor costs were based on the labor cost rates associated with installing steel welded pipes since those labor cost rates were more readily available. Installing aluminum pipes, the labor rate for that would be a little bit less. So, again, a higher cost was used. A higher than typical cost was used for the labor rates here.

So based on the associated costs and savings, the benefit-to-cost ratio was shown to exceed 1.0 for all four prototypes.

Looking statewide, the pipe sizing requirements -- requirement measure is expected to result in 13.6 gigawatt hours of electricity savings in the first year, and a reduction in 3,275 metric tons of greenhouse gases. Over the 15-year analysis period, cost saving is estimated at $34 million.

The pipe sizing measure would be effective in all climate zones. And this measure also helps to standardize best practices for compressed air pipe design and the velocity and pressure drop design options were provided for flexibility in meeting this requirement.

So are there any questions? We can stop and take questions for the first measure proposal pertaining to compressed air. Are there? If you have any questions, please raise your hand, or you can type them into the Q&A.

MR. BOZORGCHAMI: Any questions? Concerns?

MR. BUCANEG: And, again, if you do think of questions after the fact, you can always submit it to our docket, as well, and you'll see that when it comes up at the end of the presentation again.

MR. BOZORGCHAMI: Haile, go ahead and move on.

MR. BUCANEG: Okay.

MR. BOZORGCHAMI: Folks, and I you feel uncomfortable submitting them to the docket, you can always communicate directly with Haile, and he will answer your questions also.

Oh, we've got one question that came up from Beth. "How does this compare to the

Plumbing Code?"

MR. BUCANEG: For this, I'm not sure how this would compare to the Plumbing Code. I didn't really think about that. Yeah. I would have to look that up.

I think we have Val on the line. I'm not sure if he would have any insight into that. Val. Let me here if I can find him.

MR. VALMIKI: Yeah. Hi. I'm here. Can you hear me?

MR. BUCANEG: Yes. Now we can hear you.

MR. BOZORGCHAMI: Yeah.

MR. VALMIKI: Yeah. Hi. This is Valmiki with (indiscernible).

So the Plumbing Code doesn't have specific requirements for compressed air piping that we are aware of, except in the case of healthcare and hospitals. And those were a bit more safety related, and would take precedence in that regard, and are more than sufficient to achieve the energy requirements regardless. So, as far as we've seen, there's not any conflict or significant overlap with what we're proposing.

MR. BOZORGCHAMI: Thank you, Val.

MR. VALMIKI: Yeah.

MR. BOZORGCHAMI: So with no other questions or comments, I don't see any raised hands, so go ahead, Haile.

MR. BUCANEG: Okay. So the second measure I wanted to discuss for this -- from this proposal is leak testing for compressed air piping. This measure proposes testing requirements for new compressed air piping greater than 50 adjoining feet and, also, different testing requirements for new compressed air piping for 50 feet or less.

So, first, for new compressed air piping greater than 50 adjoining feet, pressure testing at design pressure is reqd. if necessary, the compressed air piping being tested can be isolated from supply air and end uses. The new compressed air piping must hold pressure for the length of time identified by the authority having jurisdiction but not less than 30 minutes.

For new compressed air piping for 50 feet or less, leak testing is required. The system must first be pressurized, then connections must be tested using leak detecting fluid or other leak detecting methods at the discretion of the authority having jurisdiction.

So the same four prototypes -- prototype systems were used to estimate savings associated with these testing. Here you can see the annual energy savings associated with reducing system leakage by two percent.

And then the costs associated with leak testing are shown here. The labor costs were based on pipefitter rates. And it is assumed that the installer of the compressed air piping will be performing the leak tests as well.

Based on the cost and saving associated with leak testing, the benefits-cost ratio for all four of our prototype systems exceeded 1.0. Please note that these costs here and the benefit-to-cost ratio are slightly different from what is included in Table 42 of the report. There was a slight calculation in putting in the labor rates in the report. So the corrected numbers are shown here.

So over the first year, this measure is expected to save 1.4 gigawatt hours in electricity and reduce greenhouse gas emissions by 339 metric tons. Over the 15-year period of analysis, $3.5 million in energy cost savings is expected.

Again, this measure is expected to apply to all climate zones and be effective in all climate zones. Again, this will standardize another best practice procedure for compressed air. And it should be noted that the testing procedures here are based on testing of natural gas systems.

So are there any questions regarding the leak testing measure proposal?

MR. BOZORGCHAMI: Haile, I don't see any raised hand or any questions in the question box.

MR. BUCANEG: Okay. So the final -- the last measure I want to discuss is a proposed measure for compressed air system monitoring.

So these requirements would apply to all new compressed air systems, and also additions with capacities of 100 horsepower or greater. In these cases, a compressed air monitoring system, which can measure system pressure, amps of power of each compressor, airflow of each compressor, and provide data logging of pressure, power, airflow, and compressed air specific power at intervals of five minutes or less are required.

Additionally, data must be stored for at least 24 months. And a visual trend display --

trending display of each recorded point will also be required.

There are several testing requirements associated with this measure.

First, it must be verified and documented that the compressed air monitoring system meets the identified monitoring requirements during construction inspection. And these are all of the requirements that would be required for the monitoring system to monitor, and also display.

And second, a functional test must be performed where the data observed during testing is being recorded to a log file that can be opened and reviewed to see trend or airflow, power, and specific efficiency in intervals of five minutes or less, and also airflow and compressor data very -- with loading and unloading of the compressor within typical performance expectations. All measures should be observed across various loading, whether manually, varied, or in response to actual operational loads.

Before prototype systems were analyzed assuming that the monitoring system reduced compressed air leakage by eight percent, so if you take into account both the leak testing and, also, this monitoring, that would be a total leak reduction of ten percent on a compressed air system.

There were several costs associated with compressed air system monitoring. This included both single-time equipment costs and labor costs, as well as annual service costs for storing information, storing the data that's being recorded.

Overall, the benefit-to-cost ratio was above 1.0. It should be noted that this analysis also included a 20 percent derate to the savings to account for any behavior issues in regards to fixing leaks associated that were identified through the monitoring process.

Statewide, this monitoring measure is expected to save 29.3 gigawatt hours of electricity and reduce greenhouse gas emissions by 7,000 tons.

Again, this measure is expected to be cost effective in all climate zones. And as with other compressed air measures, it is expected to standardize best practices for compressed air systems. Also, there are a number of compressed air monitoring systems on the market. And there are a number of -- or there are studies that have been made regarding the effectiveness of monitoring systems at compressed air sites.

Before taking questions on this measure or this proposal as a whole, there are a few items that I would like to get public opinion on regarding these measures. And you can answer now or you can provide comments to our docket.

First, regarding pipe sizing, is verification of compressed air piping required to ensure appropriate piping was installed? This isn’t part of the proposal. And I know that there are concerns about how much it would cost to do this verification. And we just kind of wanted to reach out to the public to see what they thought about that.

For compressed air monitoring systems, are the identified monitoring points and procedures adequate to identify compressed air system issues?

And, also, just if you would like to weigh in regarding the 80 percent realization rate for compressed air monitoring savings, please feel free to do so on that end as well.

We'd like to hear comments about that.

But with that, if you have any questions or comments regarding this part of the measure, or anything, any other proposal associated with the compressed air systems, we can take those now.

MR. BOZORGCHAMI: Oh, we have one raised hand. Meg Waltner.

Meg, you are muted. So if you un-mute yourself, you're -- there you go.

MS. WALTNER: can you hear me now?

MR. BOZORGCHAMI: Yeah. Perfect.

MS. WALTNER: Hi. Meg Waltner with Energy 350.

Overall, just wanted to voice support for this measure. I think both the sizing and testing requirements, as well as ongoing monitoring, will ensure that compressed air systems reduce their energy use.

And, you know, we do a lot of leak detection in compressed air systems for the Energy Trust of Oregon and do find that these systems leak over time. And so the monitoring, in particular, will help catch those leaks and stop unnecessary energy use.

I did have one question. For the less than 50 foot new compressed air piping, did you consider ultrasonic leak detection as a potential means of verification of that?

MR. BUCANEG: I believe we did. I know that previous versions of the draft language did, I believe, identify ultrasonic.

You would still be able, under the proposed Code language, I believe you would still be able to use that if jurisdictions would allow -- the jurisdiction having authority would allow for it.

But, yes, I believe that was also one of the leak detection options that were originally proposed.

MS. WALTNER: Okay. That's how we typically do leak detection in existing systems. I think for less than 50 feet length, as you have it proposed, makes sense, but it's something else you could consider adding for flexibility.

MR. BUCANEG: Okay. Thank you for the input on that.

MR. BOZORGCHAMI: Thank you, Meg.

Any other comments? Questions? Concerns?

With that, Haile, I think we're going to pass it on to Cheng to do his part of the presentation.

MR. BUCANEG: Yup.

MR. MOUA: All right. Can you guys here me okay, Payam?

MR. BOZORGCHAMI: Awesome. Thank you.

MR. MOUA: Okay. And you're able to see my screen; correct?

MR. BOZORGCHAMI: Yes.

MR. MOUA: Okay. So, okay, thank you and good morning everyone. Hopefully everyone is doing well. My name is Cheng Moua and I am a Mechanical Engineer here in the Building Standards Office. I will be going over the refrigeration system opportunities, the proposal for 2020 Nonres Covered Process sections.

So these are also proposals submitted by the Case Team, so thank you, Case Team, for doing so.

So there are two measure proposals relating to refrigerated systems in commercial refrigeration and refrigerated warehouses. They introduce new mandatory requirements for the design and control of transcritical CO2 systems.

And they also specify requirements for automatic door closers. So I'll be going over each one in detail.

The sections affected by these two measures are those for Covered Process, Section 120.6(a) for Refrigerated Warehouse, and Section 120.6(b) for Commercial Refrigeration. There will also be new acceptance tests introduced in the Reference Appendices NA7 for the Transcritical CO2 Measure.

So the first measure we'll cover is Design and Control Requirements for Transcritical CO2 Systems.

So I'm sure many of you on the line are already familiar with what transcritical CO2 systems are, but I'll try my best to briefly introduce what they are and how they operate.

So transcritical CO2 systems are refrigeration systems that use CO2 as the working fluid. They operate at much higher pressures than the common halocarbon refrigerants an ammonia refrigerants.

Transcritical CO2 systems are somewhat unique because they operate in one of two modes, supercritical operation or subcritical operation.

And supercritical operation is where the system is operating above the critical point after the vapor compression stage. So this occurs during higher ambient temperatures, typically when ambient temperatures are 75 degrees or above. And during supercritical operation, the system efficiency decreases. During lower ambient temperatures, they operate below the critical point, similarly to your common refrigerants.

And here's your vapor compression cycle. On the left is the pressure-enthalpy diagram for the conventional refrigerant. You can see, the whole cycle occurs below the critical point versus the pressure-enthalpy diagram on the right side for CO2 systems. And this shows, during supercritical operation, the compressions stage from one to two, as you can see, ends up that much higher pressures and much above the critical point.

And the process from two to three, which is the condensing stage for conventional refrigeration, you're actually not condensing at all during supercritical operations, so that's known as the transcritical process. So for CO2 systems the equipment there is a gas cooler and not a condenser.

And this is a diagram of a CO2 booster system. There's the booster stage that serves low-temperature loads. And that load temperature compressor discharges into the section suction of the high stage. And the high stage serves medium temperature loads and compresses the gas into high pressures. Heat is then rejected into the gas cooler. So under subcritical operation the gas cooler is -- again, operates just as a normal condenser. The CO2 then cycles through the flash tank in gas or liquid form, depending upon the conditions. CO2 gas would cycle back into the medium temperature compressor. And CO2 liquid would cycle back down into the evaporators.

So why are requirements for CO2 systems being proposed?

Over the recent years, transcritical CO2 systems are gaining popularity due to technology innovation. Not only that but traditional halocarbon refrigerants are being phased out due to their high global warming potential and GWP. So many types of refrigerants will no longer be allowed for use in supermarkets and cold storage in the future.

Part 6 has no current requirements for transcritical CO2 systems, so this is an opportunity for energy savings.

And the proposal also aims to provide clarity for the design practice of CO2 systems during this transition to low GWP refrigerants. So some of the requirements proposed are really to clarify what is considered standard practice and already being done for CO2 systems.

And the proposed requirements are applicable to refrigerated warehouses that are greater than or equal to 3,000 square feet, refrigerated spaces with a sum total of 3,000 square or more that are served by the same refrigeration systems, retail food stores that are 8,000 square feet or more, new construction, additions, and alterations where an entirely new refrigeration system is installed. So these criteria are pretty much existing in the current code for refrigerated warehouses and commercial refrigeration.

So this table shows the estimated new construction that could be impacted by the CO2 systems proposal. As you can see, 1.6 million square feet is estimated for refrigerated warehouses, 8.4 for commercial refrigeration. And the Case Team estimates that new construction, for new construction, 10 percent is estimated to be transcritical CO2 systems in the future for refrigerated warehouses. And 30 percent would be estimated to be transcritical CO2 systems for commercial refrigeration. And the statewide new construction impacted is there on the column on the right, a million square foot.

So here's a table that estimates the existing building stocks' square footage. It's assumed that existing refrigerated warehouses and commercial refrigeration will not be impacted by this proposal, simply because it's not expected to -- it's not expected that exiting refrigerated systems be converted to transcritical CO2 systems.

So what requirements are being proposed?

It does mandate the use of transcritical CO2 systems but it does establish mandatory design and control requirements for CO2 system when they are utilized. So these include design specifications for air-cooled gas cooler restriction, gas cooler sizing and specific efficiency, supercritical optimized head pressure control, subcritical ambient temperature reset control, minimize saturated condensing temperature setpoint, and heat recovery.

So to get into a little bit of the details, the air-cooled gas cooler restriction requirement restricts the use of air-cooled gas coolers in high ambient temperature climate zones in order to reduce the number of supercritical operating hours. And these Climate Zones are 9 through 15 for refrigerated warehouses and 10 through 15 for commercial refrigeration.

Alternative options to air-cooled gas coolers are water-cooled condensers, adiabatic gas coolers, and evaporative gas coolers.

The gas cooler sizing and specific efficiency requirements ensure that cost-effective design of the refrigeration system’s heat rejection equipment, balancing first cost of the equipment and the additional energy saving that are achieved with larger heat exchanger surfaces.

The supercritical optimized head pressure control allows for the head pressure setpoint to be reset in response to ambient conditions.

And the subcritical ambient temperature reset control strategy aligns the head pressure control strategy with existing Code language.

The minimum saturated condensing temperature setpoint applies to systems with design saturated suction temperatures of less than 30 degrees Fahrenheit.

So heat recovery in supermarkets, refrigeration equipment in supermarkets create a heating load to maintain comfortable space temperatures for shoppers. So as a result, this requires heating for more hours than most occupancies. And, in most climate zone, waste heat from the refrigeration system can be recovered to provide heating more efficiently.

So apologies as this is kind of really getting into the weeds. But this is probably the best way to share exactly what's being proposed for the transcritical CO2 measure. This is the language that is being proposed for Refrigerated Warehouse, Section 120.6(a)5. So A here is the restriction for air-cooled gas coolers; B is specification designs for leaving gas temperature for air-cooled gas coolers; C, design leaving gas temperatures for adiabatic gas coolers; and D, requires all gas cooler fans to be continuously variable speed.

Continuing on, while operating the below the critical point, the gas cooler pressure shall be controlled in accordance to 120.6(a)4F. So that section is, basically, covering condensing temperature reset.

While operating above the critical point, the gas cooler pressure setpoint shall be reset based on ambient conditions such that the system efficiency is maximized.

The minimum condensing setpoint shall be less than or equal to 60 degrees Fahrenheit for gas coolers.

And fan-powered gas coolers shall meet the gas cooler efficiency in Table 120.6-F. And here is that table for 120.6-F, the Minimum Efficiency Requirements. And this is for refrigerated warehouses.

So for commercial refrigeration, this is the proposed language, Sections 120.6(b)2. It's very similar to the refrigerated warehouses with some minor tweaks to it. I'm not going to read it all over again. But I included it here as part of this slide deck since these will be posted. And this language is also in the Case Report.

Continuing on in that section. And, similarly, 120.6-H for refrigerated warehouses

So getting into the energy savings, two prototype buildings were modeled to estimate the energy savings, a large refrigerated warehouse and a large supermarket at 92,000 square feet and 60,000 square feet respectively. If you're interested in the detailed layouts, these can be found in the Case Report.

DOE2.2R software was used to estimate the energy impacts. And per-unit energy impacts were calculated for each of the submeasures. The table here shows the submeasure name, and the parameter, and the standard and the proposed for each of the submeasures.

So for air-cooled gas cooler restriction, for example, the standard design was the air-cooled gas cooler type, and the proposed was an adiabatic gas cooler. For the minimum air-cooled gas cooler sizing and specific efficiency requirement, the standard design was eight degrees Fahrenheit rated approach temperature. And for the proposed multiple parametric, analysis was done at different temperatures but six degrees was the one selected.

For the heat recovery submeasure, there was also a spreadsheet analysis that was performed, in addition to the simulations.

And the submeasures for supercritical optimized head pressure control, subcritical ambient temperature reset control, and minimum saturated condensing temperature setpoint, the Case Team considered as standard practice. So these submeasures are included in the proposal to, basically, provide clarity on what's already occurring in the industry. So they are assumed to have no additional energy savings or no additional costs to transcritical CO_2 systems.

And this is getting into the results. So energy impact, again, per square foot were calculated. And this is the large refrigerated warehouse prototype for the air-cooled gas cooler restriction requirement for a submeasure.

And next is the same prototype but for the air-cooled gas cooler sizing, again, at six degrees.

And then this is now looking at the energy impacts per square foot for the large supermarket prototype from the air-cooled gas cooler restriction.

And for the same prototype, large supermarket, air-cooled gas cooler sizing.

And, lastly, this is the heat recovery requirement for a large supermarket.

So getting into incremental cost, so this is the first cost, the air-cooled gas cooler restriction requirement. The price difference between and air-cooled and adiabatic gas cooler was used to determine a percent cost increase. That was then applied to each climate zone for each prototype. So pricing data was collected from multiple manufacturers and found to be approximately 30 percent more for adiabatic gas coolers and estimated a $3,000 difference for labor. So for the large refrigerated warehouse prototype, a total of $83,000 was the incremental first costs. And for the large supermarket prototype, a total of $34,000 was the estimated incremental first costs.

For the minimum gas cooler sizing and specific efficiency, the Case Team established an average cost per unit of heat rejection capacity. This incremental size increase associated with the change in the rated temperature difference between the gas cooler outlet temperature and the ambient air temperature was converted. So $5,000 per degree approach temperature difference was for large refrigerated warehouses. And $2,500 per degree approach temperature difference was for supermarkets.

And for the incremental first cost of the heat recovery requirement, equipment was considered, materials, labor, taxes, et cetera, a total of $51,000 for the supermarket prototype.

And this is going into the maintenance and replacement cost, incremental maintenance and replacement cost over the 15-year analysis period. So for the air-cooled gas cooler restriction measure, maintenance needed for pre-cooling pads and control strategy estimated at $64,000 for large refrigerated warehouse and $32,000 for a large supermarket.

So this is considering replacements and maintenance needed for the proposed adiabatic gas cooler, so three replacement costs for the pre-cooling pads estimated at $120,000 and $60,000 for each prototype.

And water usage and sewer costs were also considered.

For the gas cooler sizing and specific efficiency, there was no incremental maintenance replacement cost for this measure.

For the heat recovery submeasure, and estimation of $800 per year for maintenance, and that totals to approximately $9,500.

So with the energy cost savings and the incremental costs, we now could calculate the benefit-to-cost ratio, and that's what this table shows here, broken down by climate zone. And this is for the large refrigerated warehouse prototype for the air-cooled gas cooler restriction submeasure. As you can see, it's cost effective in Climate Zones 9 through 15 where it's being proposed, cost effective meaning having a benefit-to-cost ratio of over 1.0.

And then, also, for the large refrigerated warehouse, for the gas cooler sizing submeasure, it's cost effective in Climate Zones 1, 3, 5, 6, 7, and 16, where it's being proposed. And for zone -- I mean for Climate Zones 9 through 15, it's great out here because it really doesn't apply due to the previous submeasure for the air-cooled gas cooler restriction, so it's being restricted in these climate zones.

For the large supermarket prototype under the air-cooled gas cooler restriction submeasure, it's cost effective in Zones 10 through 15 where it's being proposed. And then for the large supermarket prototype, the gas cooler sizing submeasure is cost effective in all climate zones but restricted in Zones 10 through 15.

And this is the cost effectiveness summary for the heat recovery submeasure. It's cost effective in all climate zones except for Zone 15 where it's being excluded.

So the first year statewide energy impacts, so all the requirements for our transcritical CO2 systems is estimated to have electricity savings of 1.51 gigawatt hours per year and 1.13 megawatt hours of demand reduction. This converts to a TDV energy savings of over 7 milk kBtus per year. And those the energy savings convert to a 140 metric ton CO2 emissions reduction, or avoided.

So that's it for transcritical CO2 systems. We could go to questions.

Payam, do you see any questions?

MR. BOZORGCHAMI: Yeah. I'm going to

open up the dialogue for Mr. Nick Harbeck. He has a question. And I'm just going to ask him to answer it out -- question it verbally.

MR. MOUA: Sure. And just to let everyone know, Trevor Bellon should be on. He's the case author for this measure proposal.

MR. HARBECK: Thank you. Can you hear me okay?

MR. MOUA: Yes.

MR. HARBECK: Hi. Yeah. This is Nick Harbeck with AHRI. Thank you again for this presentation. I just wanted to quickly ask a few question that, maybe, you might be able to answer.

Can you please explain what sort of criteria was used to list the different design and control requirements in the Transcritical CO2 section of the report?

And then as a follow up, why was that criteria chosen? And if it was based on like a minimum of energy savings, what was the basis for that determination?

Thank you.

MR. MOUA: Yeah, I believe the Case Team reached out to manufacturers and did surveys.

But Trevor could probably add more to that. I know all that information --

MR. BELLON: Yeah. This is --

MR. MOUA: -- is in his report.

MR. BELLON: This is Trevor. Can everyone hear me okay?

MR. MOUA: Yes.

MR. BELLON: So, yeah, we did review available technologies that would contribute to energy savings for CO2 systems, so that included things not included in this report, like parallel compression for gas ejectors. It really wasn't a criteria of energy savings, necessarily, but in part due to feasibility and making sure that we are not implementing something that isn't widely adopted yet or may have issues with wide-scale adoption. And also, of course, looking at he cost effectiveness of the measures was extremely important as well.

MR. BOZORGCHAMI: Thanks Trevor.

Nick, do you have any other questions or comments you would like to make on that?

MR. HARBECK: No. That helps. Thank you very much.

MR. BOZORGCHAMI: Okay.

MR. HARBECK: I appreciate your time.

MR. BOZORGCHAMI: You're welcome. Thank you.

MR. MOUA: So anything else, Payam?

MR. BOZORGCHAMI: Anybody else?

How about, Cheng, let's move on to your next topic, please, the door.

MR. MOUA: Sure. We can move on and always come back at the end.

So the last measure that I'll be covering, well the last submeasure for this workshop today, also, is Automatic Door Closers.

So there's two main types of automatic door closers. The first is a mechanism that closes the door from standing open position. And the second is a mechanism that tightly seals the door to the from to eliminate air leakage. And this is picture examples of what some of those looks like for a spring hinge, cam hinge, and the snap type.

So what requirements are being proposed? So this measure proposal would define, specifically, the types of door closers and require them for refrigerated spaces 3,000 square feet and over. So this aligns Part 6 with Title

20 and federal requirements for refrigerated spaces less than 3,000 square feet. And this also applies to new construction, additions, and alterations.

So this table, basically, summarizes what I just mentioned. Less than 3,000 square feet, automatic door closers are already required under federal and California Title 24. Part 6 doesn't apply. And nothing is being proposed in Part 6. But then over 3,000 square feet, there's no federal standards. California Title 20 does not apply. What the current existing Part 6 allows for is option for automatic door closers, an air curtain, or strip curtains. And then what's being proposed, of course, is a requirement for automatic door closers.

So why are these requirements being proposed? Simply because people forget to close doors or don't shut them all the way. Infiltration barriers reduce cooling loads by preventing warmer air from entering the refrigerated spaces. Automatic door closers are one of the most cost-effective ways to save energy in a grocery store and refrigerated warehouses.

Regarding technical feasibility and market availability, it's already required for spaces less than 3,000 square feet. So the door closer market is well established, having multiple manufacturers producing different types. And many supermarkets already use them. And it's cost effective in all climate zones except for 16.

So similarly to the previous measures, prototype buildings were modeled to estimate the savings with a large refrigerated warehouse and a small refrigerated warehouse prototype. And the table on the bottom shows a breakdown of that refrigerated space to calculate the energy savings.

And DOE2.2R was also used for this measure. And the table here summarizes the parameters that were considered for the energy savings. So if you look at the column under parameter name, there's infiltration for each exterior door, passage time per door opening, stand-open time per hour for each interior door, and leakage when door is closed. And then under the standard design values and the proposed design values, you can see those numbers there.

So per-unit energy impacts were calculated and this is the results. This is the first year energy impacts per square foot. So there's electricity savings and TDV energy savings in every climate zone.

Getting into the incremental first costs, this is per door, snap closer mechanisms, spring/cam hinge mechanism, labor, taxes, totaling $707 per door. So that per-door estimate was estimate was converted into a first cost per square foot. So number of doors per prototype is ten, multiplied over by the cost that we just went over, divided by the square footage. So an incremental cost per square footage was calculated to be $0.077 per square foot. And the energy cost savings and the total incremental (indiscernible) costs, we just covered, resulting in benefit-to-cost ratios for all climate zones, except 16, to be cost effective.

And this is a table summarizing the statewide energy and energy cost impacts for new construction. So approximately 1.6 million square feet total for all climate zones. First year electricity savings, 109,000 kilowatt hours, estimated to produce energy cost savings of 279,000 expressed in million dollars present value.

So for additions and alterations, it was estimated that five percent of the existing building stock would be impacted by this measure. So the square footage was taken and, for here, electricity savings were estimated for that percentage. And that's where you see the middle row for additions and alterations at 252,000 kWh. And then adding both new construction and additions and alterations results in approximately 260, kWh per year. And this is estimated to reduce GHG emissions by 86 metric tons CO2.

So that's it for the submeasures. But in closing, a copy of the Case Report can be found on our docket here listed at this link. It has all the information I covered, plus more.

And how to submit comments, the preferred method is to use our docket system to submit an e-comment. And you can also submit by email. Include the Docket Number 19-BSTD-03 and the subject line for 2022 Building Energy Efficiency Standards. And as Payam mentioned, comments are due for all the submeasures today by October 7th, 2020.

So we'll get back into questions again.

And here's my contact information, as well as Payam's and Larry's.

Payam, do you see any questions?

MR. BOZORGCHAMI: No. Any questions on what Cheng has proposed and/or what you have heard today?

Again, you can either contact the presenters directly or -- if you have any questions, or you can submit your comments to the docket. And the docket information is provided with the PowerPoint presentation. I will make the PowerPoint presentation available tomorrow, probably first thing in the morning.

And with that, I thank you. Thank you for your time.

(The workshop concluded at 11:04 a.m.)

CERTIFICATE OF REPORTER

I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were reported by me, a certified electronic court reporter and a disinterested person, and was under my supervision thereafter transcribed into typewriting.

And I further certify that I am not of counsel or attorney for either or any of the parties to said hearing nor in any way interested in the outcome of the cause named in said caption.

IN WITNESS WHEREOF, I have hereunto set my hand this 5th day of October, 2020.

ELISE HICKS, IAPRT
CERT**2176

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I certify that the foregoing is a correct transcript, to the best of my ability, from the electronic sound recording of the proceedings in the above-entitled matter.

Martha L. Nelson

MARTHA L. NELSON, CERT**367

October 5, 2020