BEFORE THE
CALIFORNIA ENERGY COMMISSION

Draft Revisions for Nonresidential Buildings for Possible Inclusion in the 2013 Building Energy Efficiency Standards	Docket No. 10-BSTD-01

CALIFORNIA ENERGY COMMISSION
HEARING ROOM A
1516 NINTH STREET
SACRAMENTO, CALIFORNIA

WEDNESDAY, AUGUST 17, 2011
9:00 A.M.

Reported by:
Kent Odell

APPEARANCES

Staff Present:

Mazier Shirakh
Martha Brook
David Ware
Jim Benya
Gary Flamm
Ryan Ware

Also Present

Attendees

Jim Benya
Mike Keesee, SMUD
Robert Raymer, CBIA
Mike Hodgson, Con-Sol representing CBIA
Mike Gabel, Gabel Associates
Cathy Chappell, Heschong Mahone Group
Jon McHugh, McHugh Energy
Patrick Eilert, PG&E
Dimitri Contoyannis, AEC
Richard Lord, Carrier Corporation
Tom Garcia, CALBO
Daniel Hamilton
Mike McGaraghan
Elizabeth Joyce
Ira Richter

INDEX

P R O C E E D I N G S

AUGUST 17, 2011 9:15 A.M.

MR. SHIRAKH: Good morning. I think we're going to get started. Thank you for coming. It's August 17th, 2011. This is mostly Nonresidential, I think it's entirely Nonresidential topics today. After our introduction, the first item that we're going to be discussing will be the Integrated Measure Analysis; basically, this would be the Proscriptive Package for Nonresidential Buildings, and Martha Brook will be presenting that.

After that is the Nonresidential Air Sealing, and Dave Ware will be presenting that. And around 11:00, we'll be talking about Electrical Power Distribution Systems, and Jim Benya and Gary Flamm will be presenting that topic.

And then we'll break for lunch and, after lunch, the first topic will be the Condenser and Water Reset Controls, and Martha Brook will be presenting. Martha Brook is going to be very busy today.

And after that is going to be Boiler Efficiency Measures again by Martha and Solar Water Heating for Restaurants, again by Martha, and the last measure would be Motor Efficiency Measures, and I'll be presenting that one. And then there will be public comments, and then

we'll adjourn.

I would kind of like to go quickly over the adoption schedule for the remainder of this 2013 Standard Cycle. And we have a new Court Reporter here today, so he doesn't know our names and, again, I'm Mazi Shirakh and my name is up there, and Martha Brook is to my left. So it would be nice when you guys come up, give him a business card so he can have proper names and the work affiliations.

So with that, I'm going to actually turn it over to Martha to go through the schedule.

MS. BROOK: Good morning. I'm Martha Brook. So this is a new schedule. Those of you who have been attending our workshops have not seen this before, we put this together last week to make sure that we can meet our deadlines to get a standard adoption in March 2012, so backing up from that, we're at August 17th, today, we're having our last pre-Rulemaking workshop next week, and then we're going to spend the month of September drafting the Expressed Terms before the 2013 Update. At the same time, we'll be working with our consultants to complete the Impact Analysis Report, and that will give us the foundation to go forward with our Rulemaking Package.

We are planning to have a Committee Workshop in early October so that, before we ever open the

rulemaking, our committee members actually are familiar with our Standards Update proposals and any remaining issues around those proposals. So that's the intent of the early October Workshop with the committee. And then, our target is for the third week of October to complete the –- oh, there's a typo in expressed terms, I don't know why it has the "32" in there, but anyway, the Rulemaking Package includes Expressed Terms, the Initial Statement of Reasons, the Notice of Proposed Action, the Environmental Impact Report, and 399 is the State form that needs to be completed that addresses impact to businesses in California.

So then, we're intending to basically open the proceeding with the Order to Institute Rulemaking at a Business Meeting in early November, and filing the NOPA package to the California Building Standards Commission at the end of November, publishing the 45-day language and the Environmental Impact Report in early December. We'll be briefing our Commissioners -– I changed this date, the August 8th date is not correct, I changed it earlier this morning, I don't know why it didn't stick, anyway, that August 8th date should be February 2nd. Basically, you know, a week before this Business Meeting, we'll be briefing our Commissioners so that they understand our direction and what we recommend for either

adoption or not the 45-day language, and then we anticipate and we are planning for publishing the 15-day language in February, and adopting the standards in March. So, for the near term, we'll be very busy writing code language in September and developing the Impact Analysis Report, and during that time we'll still be working with stakeholders to work through the remaining issues, as we understand them, and that's where we're at.

Are there any questions on the schedule?

MR. RAYMER: Thank you, Martha. I'm Bob Raymer, a Technical Director with the California Building Industry Association. And if we could look at the October 20th description vs. the February 8th, are you saying that on -- well, I'm sorry, December 2nd, look at October 20th vs. December 2nd -- the first time you'll publish 45-day language, that would be the first week of December?

MS. BROOK: That's formally, within the Rulemaking. But we'll have our draft Expressed Terms, so our draft 45-day language at the end of September.

MR. RAYMER: Right. Okay, thank you very much.

MR. GABEL: Good morning, Mike Gabel, Gabel Associates. Since your schedule doesn't go out further, we can talk off line about this, but I'm concerned about the AC Manual stuff, that we get some kind of draft

detailed content outlined before December of next year, but next summer. So I'll have more written comments on that, I just want to sort of file that.

MS. BROOK: No, that's great and, in fact, it's a really good idea to go past March and really nail down those dates so that we don't let them slip.

MR. GABEL: That's all.

MS. BROOK: Thanks. Any other issues about the schedule? Okay, besides my typos. And we'll fix that page before we post this online, so I apologize for that.

MR. SHIRAKH: Okay, Pat.

MS. BROOK: Pat.

MR. EILERT: Hi. Pat Eilert, PG&E. So I just wanted to follow-up on Mike's comment. Does that sound like that's sort of possible to do, to have the manual, you know, some detailed outline by mid-next year?

MS. BROOK: Oh, yeah, absolutely.

MR. EILERT: Great. Thanks.

MR. SHIRAKH: Okay, if there are no more questions on the schedule, why don't we move to the Integrated Measure Analysis? And Martha is going to present that.

MS. BROOK: Okay. So just a clarification, in the workshop notice, it said "Nonresidential Alternative Prescriptive Packages," and that's not what we're going

to talk about today, we're not quite done with that, but this work that I'm going to be presenting really leads up to what our recommendations will be for those packages. So what we wanted to do was, you know, up until now, we've been presenting individual measure recommendations and staff wanted to understand ourselves, and also discuss with stakeholders, the impact of these measures when they're looked at in an integrated whole, so that's what this analysis does.

We took three of the DOE reference building prototypes and the set of DOE reference buildings is what we plan to use for the Nonresidential Impact Analysis Report. They are very well exercised prototypical buildings that DOE has developed and these also have been used to document the expected savings from the last three rounds of ASHRAE 90.1 Standards, so we like the consistency of us also using the same prototypes in order to understand how our standards will relate to those national standards. And because these are all models that have been very well exercised with Energy Plus, we're able to use Energy Plus in our analysis without any hiccups along the way, so that's what we did here.

So this sort of spans the variety of nonresidential buildings we expect to be touched by our Standards. There's the large office building, which is,

I think it is 12-stories. It is a large office building and, as you can see, the relative roof area to the floor area, total floor area, is small compared to either of the retail or the warehouse prototype buildings, and lots of windows. So that's the large office reference building.

The standalone retail is like a big box retail store, you know, the big difference between that drawing that you see there and what we modeled for the standards is that we have lots of skylights on our retail roofs. So those were definitely modeled, even though they're not showing in this drawing, and then the warehouse is large and also largely unconditioned, so a big portion of that warehouse space does not provide cooling. So, as we go through the results, you'll understand the results better knowing that this prototype is sort of the far end of our kind of building sector space, where the large office is totally conditioned and the warehouse is only partially conditioned.

So those are the buildings we used in this analysis. Then, what we did was we tried to bound the diversity of California climates by picking six different weather data locations, and we did modeling runs for each of these six locations. And what I'll be presenting is a straight average of the results of these climate zone

modeling runs and we do have the detailed list of results and a spreadsheet that we'll be posting online.

So the modeling runs that we did, and this is, again, we're just trying to focus on the measures that are going to touch kind of the common building types for nonresidential buildings, so we're not looking specifically at process loads like supermarkets, or data centers, we're really looking at the typical buildings like office retail and warehouses to see how our measures kind of lay out across those common building prototypes.

So our first run was basically setting up those prototypes with the 2008 Standard assumptions in there as our baseline run. And then we modeled cool roofs, we modeled envelope air leakage, which is -– and I apologize, that leak rate in parentheses is actually supposed to tell you what the leak rate is, but Dave is going to give that presentation next and we'll populate that before we post it online, I apologize, I don't actually know what it is right now. But good thing our modelers did, so that's the important thing. So then we also modeled our fenestration update, so a U Factor of .36 and a VT of .42, daylighting controls, and additional skylight area in the retail buildings, indoor lighting controls and lower power densities, and in HVAC we modeled reduce reheat when it applied, and single zone

VAV when it applied, and also chiller and cooling tower efficiency when they applied.

All right, so now I'm just going to present sort of a summary of the results and, again, this was like an average, averages across those six climate regions. So for large office, we have large TDV savings and over 18 percent savings from the 2008, and the important thing that is different about to date how we've done our residential and nonresidential analysis is a whole building metric, so that's 18 percent of the whole building, so assumptions about non-regulated loads are in the total energy consumption, and so that's a percent of a very big number, basically, in comparison to the residential when we've been doing our percentages based on regulated loads, only.

So, in large offices –- the other thing is that, you know, I don't want to over-extend these results because, again, these were really based on those prototype buildings, but I think they bound the results rather nicely, so for a large office where you have those prototypes of a high-rise office building with not a lot of roof area compared to the floor area and the surface area, cool roofs actually isn't zero, it's .1 percent, but it's .1 percent of a very big number. So, when you look at all the other savings, it doesn't look

significant, but it actually is saving a significant amount of energy all by itself, it's just that lighting and daylighting is overpowering the rest of the measures in this sort of combined analysis.

So we are getting great significant savings from the lighting controls and the daylighting controls in the large office building, and I think that is what those of you that have been participating in our lighting and daylighting work have been expecting, and I guess we're just confirming those results here. And our window update is also very significant and, you know, part of that is also daylighting because of the VT requirements for our fenestration update.

And then, basically the air sealing is also significant when you average the air sealing proposal over those six climate regions, and Dave will talk more about that next. And then, the cooling tower efficiency is also another four percent of that total savings number. So, anyway, you can see as we go through the different prototypes that these pie charts change significantly, so that's sort of the picture for a large office. These are some of the details that you can look at when you look at the presentation and we'll also post the detailed spreadsheet that has more results.

MS. CHAPPELL: Cathy Chappell, Heschong Mahone

Group. Are these DOE 2 models or Energy Plus models? I apologize --

MS. BROOK: They're Energy Plus models.

MS. CHAPPELL: They are Energy Plus models, okay.

MS. BROOK: Okay, so just to emphasize that, even though you have some of those smaller percentages for air sealing or for cool roofs, there is still a significant amount of energy in that savings column, and so I don't want people to misinterpret the results just because a percent looks small, but in absolute it is a significant amount of savings.

MR. MCHUGH: I just thought I'd ask a -– this is Jon McHugh, McHugh Energy, clarifying question. So this is for a single building model, right?

MS. BROOK: Yeah, the results are not weighted and the average is also not weighted.

MR. MCHUGH: Right, and that single building model had a chilled water system, right?

MS. BROOK: Uh huh.

MR. MCHUGH: So when we see four percent for cooling towers, that's four percent of buildings that are hydronically cooled, and so the actual statewide average would be some kind of smaller number because something like 40 percent or 30 percent of buildings have water cooling.

MS. BROOK: Right.

MR. MCHUGH: Okay, thank you.

MS. BROOK: And we'll do that, the weighted results, as part of our Impact Analysis Report, and we'll be doing that work starting now through September.

MR. GABEL: Mike Gabel, Gabel Associates. Maybe you can't answer this, it is maybe too detailed, but the daylighting assumptions, did they include sort of the window of VT assumptions and the new LPDs for the new indoor lighting? I mean, did they start with the sort of 2013 projected other features or --

MS. BROOK: No, so each of those are sort of isolated --

MR. GABEL: Okay.

MS. BROOK: -- so the VT would be in the window, the fenestration run.

MR. GABEL: Right.

MS. BROOK: And the indoor lighting run would be the LPD, where the LPD --

MR. GABEL: So, is the 2008 baseline assumptions changing just the variables of each measure with respect to the 2008 Standards?

MS. BROOK: Yes.

MR. GABEL: Thanks.

MR. SHIRAKH: For daylighting, we actually talked

about this quite a bit yesterday, the changes from 2008 are that there's a primary daylit zone and a secondary daylit zone, and in 2008 the secondary was optional, and now it's becoming mandatory, you have to control the fixtures within that. And also, I think in 2008, there were areas of 2,500 square feet or larger had to be controlled and now it's dropping down to 250, so those were the two biggest changes.

MR. MCHUGH: Uh huh.

MR. SHIRAKH: That's where you see --

MR. MCHUGH: Yeah, my comment was really having to do with the fact, if you lowered the LPDs for offices to start with, then the incremental improvement --

MR. SHIRAKH: That's captured under the LPD part of it, that's part of the daylight.

MR. MCHUGH: Okay, thanks.

MS. BROOK: Okay, so the retail results are overall almost a 15 percent savings at the whole building level from 2008, and again, most of the –- of that 15 percent, over 60 percent is due to daylighting, and this is predominantly because we increase the amount of skylights that are required in the type of buildings that a retail building falls under, so large roof areas and – what are the requirements for skylights? It's like 15-feet high?

MR. SHIRAKH: It is 8,000-square-foot under the roof or larger, and 15 foot and higher ceiling, it has to be within the day lit zone, at least 50 percent of it. Is that correct, Jon? Fifty percent, yeah.

MS. BROOK: So you see here that, in the prototypes, and this is where we expect even a lot of smaller and medium sized offices to fall as far as, you know, the relationship between roof area and floor area, in this large retail building, cool roofs are very significant as far as the contribution to the savings over, you know, almost 15 percent, 13 percent for cool roofs. And so, as we do our Impact Analysis, we're going to see that this is one of our best measures across the board because there are so many offices and other building types that have that same type of relationship between roof area and floor area.

And envelope sealing also is significant, and single zone VAV for the HVAC systems, and then also fenestration. So that's sort of how the picture looks for the retail prototype. Mike.

MR. HODGSON: Mike Hodgson, Con-Sol. So, Martha, where is the list of things you did to get to the 14.6 savings?

MS. BROOK: Oh, that is -– that's basically it right there, sorry, I'm going in the wrong direction.

MR. HODGSON: This presentation is not yet posted, correct?

MS. BROOK: No, it's not posted, we had to re-do our baseline assumption last night because we had a bug in it, and so that's why it's not posted. So this is basically the list, cool roofs, air sealing, fenestration, daylighting, and single zone --

MR. HODGSON: Right, but what did you do to cool roofs to say you got 13 percent savings? You went from X to Y.

MS. BROOK: Right, so we went from .55 to .67.

MR. HODGSON: And where is that listed?

MS. BROOK: So that's listed -- it's listed here, but we didn't have time to list all those 2008 Standards, but basically that's what the intent of this slide was, and we can clarify that if it's unclear.

MR. HODGSON: The changes would be 2 through 10.

MS. BROOK: Yes.

MR. HODGSON: So, if I went to chiller efficiency, you did from base to what on chiller efficiency?

MS. BROOK: So, yes, I mean, there's a lot of detail in every one of the measures, presentations that we've already done, and we didn't have the ability to condense that into one page here, but we can do that. We

can do that before we post this, and so that people can understand the results better. So basically for the chiller efficiency measure, we're basically adopting the ASHRAE Standards.

MR. HODGSON: Okay. That would be really helpful, okay, to be able to track this and explain it. Thank you.

MS. BROOK: Uh huh. Okay, so then the warehouse prototype and, again, just a caveat, this is not all warehouses in the state, this is like the far end of where we would go for Title 24, it's a warehouse that has a very large portion of the space that doesn't provide cooling, so typical of some warehouses, but not typical of others. And you can see that the -- this is one where we didn't even list the cool roof measure because, in this prototype, cool roofs don't apply because it's not trying to reduce the cooling load because the building is largely not providing cooling, so that doesn't actually measure into the savings here. Envelope sealing is a big component of this, daylighting, again, and what's the third piece? There's something wrong with this slide. So, I apologize for this, so we're not actually seeing where the 20 percent comes from because, at least I don't see that color over here on my legend. So I think if we go back to the other one, though, that's actually cool

roofs -– not, it’s not cool roofs -– I don’t know, I’ll clarify that at lunch and let you guys know. So one of our legend bars dropped off on this chart and I didn’t notice it when I pasted this on. Do you think I can? Oh, yeah, we can, next slide. So just overall, though, we’re not getting as much savings in warehouses, which is no surprise since these buildings aren’t -– at least this prototype doesn’t take advantage of all the benefits we have for buildings that are cooled predominantly. So is it the single zone VAV? Okay. Let’s see, we have –- yeah, I’m sorry, so that 20 percent pie is the single zone VAV, I think, but I will clarify that and report back to you guys.

MR. CONTOYANNIS: Martha, can you hear me okay? This is Dimitri from AEC. The single zone VAV gives a little more description of what that measure is, it is a VAV fan control and integrated economizers for the air handling units, and that one had incremental savings of about 2.5 percent on top of what you’re showing there, so I think there’s definitely something going on with the legend there, but that’s what the last measure –

MS. BROOK: Okay, so that makes sense, 20 percent of 8.7 would be around, yeah, so that –- thank you, Dimitri. So we believe that to be single zone VAV and we’ll fix this slide before we post it. So do we have

any questions about this? That's really all we've done to date, and if there is any recommendation for something that is sort of broken about our approach, we'd appreciate comments on that. We do expect to use this sort of framework for our Impact Analysis Report, but, again, then we'll do more prototypes, more climate zones, and also develop the weight of expected construction starts in the state across building types, and also look at the impact of additions and alterations, as well.

MR. HODGSON: Mike Hodgson, Con-Sol. What I'm really curious about is the daylighting analysis in retail and any detail or who the consultant was, if they have a report or something, that would be very helpful because I heard bits and pieces of you and Mazi saying things and I'm curious, it sounds like a lot of roof area that you want to be daylighting, and knowing retail structures, and whether that's typical, and the issues with fire safety on roofs right now, I would like more information as to what you're planning there.

MS. BROOK: Okay, so is your question more about what our proposed measure is? Or that we modeled it correctly?

MR. HODGSON: What you modeled, I'd like to understand as to whether or not it fits within the retail building and how we build retail buildings --

MS. BROOK: Okay.

MR. HODGSON: -- and then I presume the analysis is done correctly, I'm not going to question that.

MS. BROOK: Okay, great. Thanks.

MR. SHIRAKH: Jon McHugh, you probably know more about this daylighting than anyone else. So the requirement would be what? Up to five percent of the roof area has to be skylit?

MR. MCHUGH: Yes. Hi, this is Jon McHugh, McHugh Energy. So, first off, there are certain types of buildings that are retail buildings that the daylighting applies to, so similar to the 2008 standards, this is for building types where the ceiling height is 15 feet or greater, so you know, there is a lot of retail spaces out there that are essentially, whether they're big box or not, they typically have open ceilings, they have higher ceilings, those are the building types that this would apply. There are a number of retail spaces that have essentially suspended ceilings that are typically fourteen feet --

MR. SHIRAKH: Jon, can you talk into the mic?

MR. MCHUGH: I'm sorry. So those buildings, so this particular prototype, I assume, was a prototype with a taller ceiling height. You go to other prototypes that have the lower ceiling heights, you wouldn't see the

savings from daylighting, so, I think as Martha mentioned earlier, you're going to have a broader variety of prototypes in there, so some of those retail buildings will not have that great daylighting savings, and the ones that are essentially with the taller ceiling heights will have the daylight savings. And the primary difference between the proposal this time and what's currently in the Standards, is that the requirement was for 50 percent of the space in the building had to be in the daylit zone under skylights and the new proposal is that 75 percent of that space will be daylit, and there was extensive work done by the Heschong Mahone Group where they looked at a series of buildings to identify were there any sort of feasibility issues.

And then also, to address what Mazi is talking about, the requirements in terms of the amount of skylight area, requires a minimum skylight area, or area of skylights, of at least three percent of that daylit area so, if you multiply the 75 percent times three percent, you get about two percent of the roof area is the minimum required. Now, the State also has requirements that you can't put too much skylights in, and that's at five percent, so the issue that there not being enough roof area or things like that, you know, we're basically following the same sort of limitations

that have been in the Standards since 1992 in terms of the maximums. Thank you.

MR. SHIRAKH: Mike Hodgson, does that answer your questions or --

MR. HODGSON: Mike Hodgson, Con-Sol. Now that we kind of understand it, the question then becomes, what is the impact of cooling, you know, we're looking at TDV cooling savings with lighting, and then what are the lumens on the floor in a retail space, thinking of a big box, which is typically 60,000 square feet, about an 18 to 22 foot ceiling, you know, how does that work? And then, where do we put our lights? So, you know, I'm sure all that has been thought through, haven't seen the analysis, would like to look at it just to understand it, and then I think Jon brought up a very good point, there are other issues of a maximum amount of skylight area that is already in State Code. I heard five percent in the presentation, and if that's what the Code is, then I'm concerned about being right up against the maximum code, then you have a minimum code, and that puts us in an awkward position. But then I heard three percent, which translated to two percent, so, again, we need to understand what is being proposed and we don't get it yet. Thanks.

MR. FLAMM: This is Gary Flamm. I just want to

interject one more cause of the savings, and I believe it's the -– in the current Standards, the daylighting – the lighting and the daylighting area has to be segregated manually at 250-square-feet and automatically at 2,500-square-feet, and so you need automatic controls at 2,500-square-feet. So the automatic control requirements are going down to 250-square-feet, so a lot of these spaces now will no longer suffice just to have mandatory isolated daylighting, they're going to require automatic daylight control shedding, and so I think a lot of the savings is attributed to that.

MS. CHAPPELL: Cathy Chappell, Heschong Mahone Group. We have a draft case report that I believe was submitted during the daylighting workshops that were held in April and we did some analysis that includes simulations, it includes load impacts and so forth on cooling, and we'll make sure that you get a copy and that we send one to the Energy Commission and get it posted.

MR. SHIRAKH: Are you going to email that to me?

MS. CHAPPELL: Yeah.

MR. SHIRAKH: Thank you. Jon.

MR. MCHUGH: Just one last comment at cooling impacts. So the luminous efficacy of sunlight is around 100 lumens per watt and, actually, if you filter it through a skylight, you actually get about 120 lumens per

watt because, actually, there is more visible light transmittance than there is solar heat gain coefficient through skylights. So you're comparing your electric lighting source that is somewhere around 80 lumens per watt vs. 120, and that's why you can, as long as you're essentially hitting your lighting target, you end up with a cooling load reduction with daylighting.

MR. CONTOYANNIS: This is Dimitri Contoyannis at AC. I would also like to add that, in addition to the tables that Martha just presented, there is a more detailed spreadsheet that goes along with that, which will be posted, and it includes the breakdown by end use of energy consumption, and you'll see it kind of confirm what others are saying, that the cooling energy does indeed reduce, based on the daylighting measure and you can see it is actually fairly significant in some climate zones, so I would definitely refer you to that as you are reviewing the analysis.

MS. BROOK: Thank you.

MR. SHIRAKH: Thanks, Dimitri. Any other questions related to this integrated measure analysis, in the room or online? Okay –

STAFF: Here is a comment from Richard Lord from Carrier.

MR. SHIRAKH: Please, go ahead.

STAFF: It says: "Just to let you know, we have found some significant issues with the Taylor Engineering proposal on single zone VAV and we believe the energy savings are significantly overstated, as well as the costs have been extrapolated beyond what AHRI-based --

MR. LORD: Actually, I'm online, so I don't know if I can be unmuted. Can you guys hear me?

MS. BROOK: Yeah, go ahead.

MR. LORD: We're doing further studies on that and hopefully we'll have them done in the next few weeks, and I'll submit them to you guys, as well as to Jeff Stein.

MS. BROOK: Okay, as early as possible?

MR. LORD: Yep, trying to get it done as quickly as we can. I understand.

MS. BROOK: Great. Thank you very much.

MR. SHIRAKH: Thank you. Any other questions? All right, so why don't we move to the next topic, which is Air Sealing. And Dave Ware is going to present that one. I want to take this opportunity, we have another workshop coming up on Tuesday, the 23rd, that's going to be mostly residential topics. We have developed an agenda, I think I emailed it, the draft, to the team, and we'll be posting that pretty soon. Later this afternoon, I'll probably present that agenda for those who are

interested in attending. We'll be talking about the series of compliance options for photovoltaics, for solar tradeoffs, we'll be talking about the refrigerator charge procedures, and so forth. Ready, Dave? Okay.

MR. WARE: I'm Dave Ware with CEC staff. I'm going to provide an overview and a general discussion of where we are going with the air sealing proposal related to non-residential buildings.

On June 10th of this year, Architectural Energy Corporation provided a general summary of the analytical approach that they were working on in support of the activity for air sealing and air and filtration control of nonresidential buildings. One of the reasons why we are looking at this is because there has been considerable work both at the national level at research institutes and by individual consultants and manufacturers, as well, trying to better capture the air leakage effects from both infiltration and ex-filtration of nonresidential buildings. And it is a fairly complicated issue because of the various types of skins that are used on buildings and the various kinds of nonresidential building types that are used within the state and, of course, throughout the country. There has been a lot of studies that have quantified the general amount, the average amount, that air and filtration

contributes to heating loads in nonresidential buildings, and there's been quite a few studies by NIST and others, now, looking at a number of buildings throughout the country and trying to get on aggregate what is about the average air and filtration rate that is used, and actually the rate that you see down at the bottom, 1.5 CFM per square foot, is fairly representative of what the ASHRAE baseline – ASHRAE 90.1 -– baseline air and filtration rate is, and which we assume in our modeling programs, as well. It's fairly close, surprisingly. There's been considerable action throughout the country in adopting of air and filtration standards. A number of states have already been in the forefront of fairly progressive standards, and there are both national reference standards and codes, as well, for which we here in California can use as a baseline for setting a platform for a standard going forward. ASHRAE 90.1 and ASHRAE 189 have both been in the forefront of these and project committees at ASHRAE, in particular, has been extremely helpful in the development and coalescing stakeholders in the development of the IECC new standard that has gone forward.

One of the largest databases that is out there related to actual performance, blower door kind of testing results of nonresidential buildings by the Army

Corps of Engineers, and anyone can go online and look up retail, look up hotel/motel kind of occupancies, high-rise from the Army Corps of Engineers, and they have a database of at least 5,000 to 8,000 buildings, and it's growing daily.

One of the things that is interesting in the context of California's 2013 revision process is the activity that was just recently approved at IECC, an air barrier requirement was adopted for the 2012 IECC Commercial Standards, it was based on the ASHRAE 90.1 Addendum requirements, but it really only applies to climate zones 4, 5, and 6 of the IECC climate zones. So that doesn't really -– and basically the 4, 5, and 6 categories of the IECC ASHRAE climate zones are in the colder climate areas of California. So, one of our objectives was trying to identify whether, because of some of the modeling differences that we have in the Title 24 compliance procedures, whether that would make –- the schedules are different and things of that sort –- whether that would drive the potential savings of air and filtration control for nonresidential buildings any different than what the ASHRAE climate zone requirement would dictate.

So the infiltration rate that is required by IECC and ASHRAE is .4 CFM per square foot at a pressure

differential of .3 water gauge, and so when we use that as a target in our own modeling, we have to compare that against the baseline. What we're trying to do is basically see if there are any benefits to air leakage controls over and above what the IECC's climate requirements would dictate here in California. The nonpresidential ACM manual currently assumes that, when there is conditioning, depending upon the load of the building, 100 percent of the air and filtration is made up by conditioned air, so essentially there is no infiltration degradation impacts assumed in our current ACM process; however, the PNNL work that went into both supporting ASHRAE and the IECC's development of the 2012 Code uses different assumptions. So we, Architectural Energy Corporation, used that as a baseline for the analytical approach that we used, that report is, I believe, posted online and, as I mentioned earlier, on June 10th, we provided an overview generally of the kinds of structure that was going to be taken to do the analytical portion of the analysis.

Three things really are affecting our analysis and that is building height, wind speed assumptions, and temperature across the climate zones. This was provided last time, on June 10th, but I think it's useful just to illustrate the potential savings, or the potential

reduction in heating and cooling loads that can be achieved when there is a reduction in air and filtration from various kinds of potential requirements.

The graph on the left is basically looking at current assumptions based on floor sizes and whether there is a plenum in the building, and the graph on the right is the potential reduction in load due to a stack effect when you are controlling your air infiltration and leakage. Six climate zones were analyzed, the same climate zones as Martha expressed earlier. In the proposed building, they looked at an air leakage rate, a reduced air leakage rate, of .4 CFM per square foot, and one of the things that we are still completing is looking at the cost-effectiveness and feasibility of certain kinds of measures that can be used to reduce air leakage.

The report that is posted online looks at three types of office buildings, small, medium, and large. As Martha explained earlier, there are potential savings that accrue in almost each of the climate zones, depending on building type and the effects of stack and other things related to that building. While the percentage savings looks small, the actual savings for the incremental measure are fairly large across the state. We have a question.

MR. EILERT: Hi Dave. Could you just explain how

you get a stack effect in 12-story office building?

MS. BROOK: That is Pat Eilert asking.

MR. EILERT: I mean, how does it work, basically?

MR. WARE: Well, every building has a different – I don't know if Dimitri is still on the line, he might explain how the modeling, the details of the modeling, that was done. But the analysis showed -– let me go back a slide –

MR. EILERT: Dave, I'm saying this is between floors or --

MR. WARE: Between floors and plenums and stairwells, there is a greater stack -– the stack has a greater impact based on wind speed and the dynamics of the building, and the skins that were assumed on the outside of the building. So there is greater leakage associated with higher buildings, you might say, but it's a function of temperature, as well. Is that making sense, Pat?

MS. BROOK: I think Pat's question is where does the pressure differential come from if there are individual floors, because there are leaks in between the floors, or there are plenum and other things that are --

MR. WARE: There is leaks between the floors, whether there are elevators, whether there's plenums, there are open spaces. And so you're getting a pressure

difference between the top and the bottom and so that was -- and the program deals with those stack and looks at the effect of air leakage across building height.

MR. CONTOYANNIS: This is Dimitri from AEC. You know, in the report that is posted, along with the other materials for this workshop, we go through the methodology of how we modeled the stack effect, and essentially I think the key driver here is the variation in wind speed as you move up the building, you know, the wind speed near the ground floor vs. the wind speed at the top floor are going to be quite different, and you know, there are a number of reports that we based our analysis on, including one by PNNL and a handful of methodologies described in the ASHRAE handbooks, which talk about how the wind speed varies, and ultimately we've correlated that to infiltration rates at different floors of the building. Now, the stack effect in terms of air movement from floor to floor, that's a much more difficult thing to model in energy cost without doing detailed bulk air flow analysis. So, we haven't modeled it to that level, it's really the key driver of differing infiltration rates from floor to floor, based on wind speed at different floors. So I would ask you to take a look at it, it's in the first couple of pages of the report that's been posted, and they describe the

methodology in quite a bit of detail. So if you have any follow-up questions, by all means, feel free to contact us.

MS. BROOK: Thank you.

MR. WARE: If we look at the savings, so moving forward here, the analysis that AEC first did showed savings across the various six climate zones based upon the office building prototypes that they initially ran the analysis for. And, again, the savings actual percentage numbers in the middle column is a function of the building size and certainly the climate dynamics that were looked at. The latest analysis that AEC has done in the integrated analysis for which Martha had slides up earlier, I pulled out just the air leakage TDV savings from those across those same six climate zones, and plotted them so you could see the potential savings. Again, in this set of analysis, they looked at a large office, basically a 12-story office retail building and a warehouse building, so the dynamics of the building were a little bit different in the stack, and the temperatures were the same across the climate zones, but the stack dynamics were slightly different in this analysis, but, again, we're showing savings across those six climate zones that were looked at.

MS. CHAPPELL: Cathy Chappell, Heschong Mahone

Group. So these six climate zones on this graph are the ones that were used in the relevant roll-up analysis, but if you go back one slide, there were different climate zones listed --

MS. BROOK: Yeah, they are slightly different.

MS. CHAPPELL: Were they mapped to each other?

MS. BROOK: No, there was never any intent to make them the same. We did the air sealing measure analysis first, and when we were thinking about how to bound and select regions for the integrated analysis, we revisited the heating and the cooling degree days to make sure we had a really better representation. So there's not a big difference, like six goes to seven, and --

MS. CHAPPELL: Oh, yeah, yeah, okay, but these numbers in this table weren't used in your analysis, they were re-run.

MS. BROOK: Right.

MR. WARE: Correct.

MS. CHAPPELL: Okay.

MS. BROOK: The other thing I'd like to note on the next slide is that, even though the percent difference is smaller in a large office, the actual number of TDV savings is undoubtedly larger because the overall TDV for offices dwarfs that for retail or warehouses, and in just absolute energy. So it's still a

big number of TDV savings, it's just that it's a percent of a much bigger number.

MR. WARE: And Cathy, in response to you, as well, adding on to Martha's comment, what we wanted to do was ensure that the air leakage analysis was consistent with the overall integrated analysis, and we didn't necessarily want to present two different things, and so, while the initial analysis looked at a slightly different set of climate zones, very similar, however, and the building prototypes were somewhat similar, they were a little bit different, overall savings trends are about the same. So this, AEC's analysis related to this activity on air infiltration control measures is a little bit more robust now, and then captures all the other things related to the integrated analysis. So, that's essentially what this table is presenting.

So going forward, what we intend to do is continue to refine the analysis and the cost-effectiveness approach, look at the effects of air leakage control measures across all 16 climate zones, instead of the subset. We will look a little bit deeper into building height and building type prototypes to see what are some major drivers in air leakage control for the nonresidential sector of construction, and so, from a compliance requirement air barrier control, we're really

looking at three things, and really it's falling in line with both ASHRAE and the IECC's recent adoption of Code, and Seattle's Energy Code, Washington State's Energy Codes, we're looking at requirements that affect materials, some requirements that affect assemblies and building testing, which is essentially the performance air leakage rate testing.

So the proposal going forward, staff proposal, is to limit air leakage through a requirement for continuous air barrier. Those of you who have been following other activities that staff has been involved in might note that there was a recent activity related to open cell spray foam and, in staff's package of proposed revised – proposed QII, Quality Insulation and Inspection Control Measures, there was a definition of an air barrier in there, which currently lacks in both the Standards and is lacking in the QII procedure. So our intent is to embellish upon that air barrier definition and provide it into the standards. Compliance alternatives related to, then, that requirement would affect materials and the use of ASTM E2178, and like ASTM standards for testing of materials, and verifying materials meet a particular air leakage rate, and air permeance, there would also be an assembly test similar to ASTM E2357. Both of these tests are also referenced in other Codes, ASHRAE and the 2012

IECC, and then the building testing and performance rating would be set at the .4 CMF per square foot level. Basically from an enforcement standpoint, then, that means that you would have three different types of alternatives that would occur in the field. There would be, on your upper left a materials kind of verification by the site inspector. If that approach was used down on the lower bottom, there could be an assembly test and both of those would be supported by test reports or ICCES Reports, and manufacturer specification sheets and things of that sort, or for particular building types, the designer or architect might decide to use performance testing. Any other comments? That concludes the general overview of the air and filtration proposal, where we are now. Anything I can add? Mike.

MR. GABEL: Mike Gabel, Gabel & Associates. So going back several slides, I noticed in the really mild climate zones, 3 and 6, there was from negative savings and those are the climate zones which have very little heating. Would staff proposal consider omitting these new requirements in certain climate zones for certain building types? Or have you guys gone that far in thinking that through?

MR. WARE: The short answer is yes. The longer answer is, what we want to do is look at a few more

prototypes. We want to look at all the climate zones, but some of the analysis is implying that the benefit or the expense of an air and filtration requirement may not be warranted in particular climate zones, or for certain building types, so we're trying to flesh that out a little bit more.

MR. GABEL: Okay, thanks.

MR. CONTOYANNIS: This is Dimitri from AEC. I'd just like to make one point, too, about the results shown here. These are all TDV savings and, you know, as Dave mentioned at the beginning of this discussion, a lot of the savings from air and filtration reduction is heating energy savings, which doesn't have as strong an impact on TDV savings as electricity savings because it's often natural gas. So, you know, again, in the report that are some additional details of the simulation results which break down the energy savings, as well as the TDV savings, both in terms of electric savings and gas savings. So, when you look at the actual energy savings, not counting TDV, in every climate zone there is savings shown in terms of site energy. What we're seeing here on this slide is TDV savings where, you know, because of the weighting of electricity savings, there are indeed a few climate zones that are slightly negative, so hopefully that gives you a little bit more insight into the

results.

MR. SHIRAKH: Thanks, Dimitri.

MR. HODGSON: Mike Hodgson, Con-Sol. I'd like to compliment the study on getting those results in Table 1 and Table 2, that was published on the website so that we could understand some of the building infiltration results. But I have a request that, we're talking about small, medium and large office buildings, and they're not defined, and so, in that report, if you could add kind of a description and then how it relates to the prototypes that Martha was talking about earlier, it would really help us understand the results a little bit better.

MS. BROOK: Okay, yeah, and we can actually post all of the – PNNL has a report on all the DOE reference buildings and these are the same reference buildings, so we can post that.

MR. HODGSON: That would be helpful, too, if you could point to that direction with in the report, so that we could tie that together.

MS. BROOK: Okay.

MR. HODGSON: Thank you.

MR. GARCIA: Hello, this is Tom Garcia representing CALBO and I just wanted to make one comment again, it's kind of the continuous comment, as we look at this air infiltration and options, and so forth, we need

to make sure that we keep the complexities clear and clean in the language, and so I'm curious when we would see some of the actual language that would be proposed, that we could review?

MS. BROOK: I'm guessing that's probably a couple weeks away. On this slide that Dave showed where there was definitely different compliance options, would you support having those multiple options?

MR. GARCIA: Yes, I would, but again, we just want to make it very clear as to building size and where -- and not having something that we're going to get crossing over and people misinterpreting.

MS. BROOK: Right, so my best guess is that, and Dave can bonk me over the head, but I would guess we'd be about three weeks away from actually having draft Code language.

MR. SHIRAKH: Any other questions related to air sealing? Not online? Well, we're in a position where we're actually ahead of schedule. And Jim Benya is driving here -- he's here?

MS. BROOK: Why don't we take a five or 10-minute break?

MR. SHIRAKH: Well, actually, what I'd like to do is show you the agenda for Tuesday.

(Recess at 10:20 a.m.)

(Reconvene at 10:21 a.m.)

MR. SHIRAKH: This is the agenda for next Tuesday, which is going to be our last staff workshop. This is going to be largely residential topics and in the morning, we're going to be talking about compliance options for integrating photovoltaics into the Building Standards. And there's some interesting, basically using renewables to meet some of the requirements of the Standards, so that would be the topic. After that, we'll be talking about residential compliance options for builders and appliances. And then we'll be talking about the residential indoor ventilation requirements. In the afternoon, we'll be talking about refrigerant and charge -- I'm sorry, in the morning will be refrigerant charge at 10:45, then we'll break for lunch and, after lunch, we'll be talking about mechanical ventilation for residential units. And at 1:15, we'll be talking about administrative changes to Sections 10-103 to 10-14. Tom Garcia, you would probably be interested in those topics, that's where we're going to talk about all the changes. We're also going to actually be restructuring the Standards, the numbering system is going to change, mostly because we're actually running out of sections, you know, sections 110 through 119 around tech, and 140 to 149, we're introducing new sections and we need to

find homes for it so that the structure of the Standards are going to change, the numbering system. So we'll be talking about that, and also -– we've already talked about the package D is going to become Package A and all the alternatives are going to follow, so we'll talk about that, and also possibly the forms are going to change, the name of the forms. So there will be a discussion on that and I'll be interested in hearing what CBIA and Con-Sol and the Building Departments have to say about that, and before we actually embark on this. And then we'll be talking about the REACH Standards at the end of the day. So that would be the agenda for Tuesday. Mike.

MR. HODGSON: Yeah, Mike Hodgson, Con-Sol, would you explain the 10:00 a.m. presentation on builder supplied appliances?

MS. BROOK: So we heard at the IEPR workshop that there was some interest in exploring whether or not there could be compliance tradeoffs between efficiency measures and builder supplied appliances, so for example, if a builder provided an Energy Star dishwasher, or whatever, then the differential between a baseline dishwasher and an efficient dishwasher could be used to meet the energy budget in a performance approach. But to be honest with you, we're not sure how much there is there, so that's what we'll talk about.

MR. SHIRAKH: Okay, so Jim Benya is here, so we're going to resume our presentation and he's going to be talking about electric car power distribution system and nonresidential buildings. Hey, Jim, how you doing?

MR. BENYA: Hi, Mazi, how are you? Thank you. Good morning, everyone. My name is Jim Benya. I'm a member of the Architectural Energy Corporation team supporting the Standards Development process and I'm here this morning to present a new section that we have conceived to the Standards, temporarily at least numbered 135, I guess that may change in the future.

The principal title of this is Things Having to do with Electrical Distribution Systems, and as you'll see in a second, there is just a little tiny bit of lighting stuff in this, but some other proposals that have been made over the course of the last several months, going back to our April 4th hearing, we migrated into this section so that we could capture this slightly different topic area. So the purpose of the proposed measure, and by "measure," I mean this section, is to provide these required provisions in a building's electrical distribution system that will ensure relatively easy implementation of advanced metering control, including Demand Response in the Smart Grid. We're, in fact, looking forward to a future in electrical

distribution in buildings where it will be able to be intelligently connected to everything in the outside world and all the future measures that we're likely to see. So, you could say most of this proposal is to capture a future proofing opportunity that bears very little cost to the developer and builder of buildings, but it gets us prepared for what we think is going to be coming.

We have some precedent in going into this area. ASHRAE IES 90.1, ASHRAE IES USGBC 189.1, IECC 2009, and even the California Electrical Code 2010 bear relevance to this material. So we didn't kind of invent this idea as much as we borrowed the notion that we should have a section like this from other Standards.

Here are the proposed requirements, and this is not the Code language that has been proposed, this is a summary of it, Code language will be available in a Case Report that has been submitted, and you can take a look at it in detail. There are six major points, Point 1 or A, as listed here, it requires the addition of energy read-outs to the metering of services. These requirements are progressive, with simple metering provisions up to services of about 250 KVA, larger services would require some additional logging capabilities. And these are basically improvements to

the meters provided by the utility company, although they could also be independent of that. The idea is that the owner of a building should be able to go to the meter and see how much energy they're using relatively easily. So this, I've already seen installed in meters already from the California utilities, and this is not a big deal. I don't see any significant cost related to this. We'll talk more about that in a second; b) disaggregating the load types in an electrical system such that major load types can be easily measured at a single point. The actual measuring equipment is not required. This is very important because we see a future where someone is going to ask their building management system, "How much energy did my lighting use last month, last week?" "How much energy did my plug load system, my HVAC, how much did they use in a period? Or how much are they using right now? How might we manage it better?" If you wire a building in a particular way, this is easily done. The points are easily identified, metering equipment is easily and inexpensively measured, and everything works great. If it isn't done this way, then you end up with a much more costly installation in terms of measuring equipment that might cause some sort of action to occur, so I've already done this in a number of projects in which I've worked, there was literally no cost impact,

but we know doggone well that the measuring capabilities later will be important; Point c) feeders to have no greater than two percent voltage drop, and branch circuits do not have more than three percent voltage drop. This is as recommended by California's Electrical Code 2010, and of course, the National Electrical Code from which the California Electrical Code is based; Point D) Automatic shutoff of about half of all receptacles in offices and related spaces to save energy. This is a cost impact and we'll talk more about that in a second. But it's migrating our philosophy of turning lights off when they're not needed to turning off some of the receptacles, as well, for loads that can be shut off when people aren't present and don't need them; Point E) all buildings to be enabled to receive and act upon Demand Response signals. At this point, it's a fairly modest proposal, this was actually put forth previously by case reports presented at the April 4th meeting that we had here, and so this is not new to the process, but we have moved it into this section; Point F) building automation systems that are allowed to provide required control functions of several sections. This was added more or less to clarify the fact that many of the requirements we have, not only in lighting, but in other sections, specify certain types of controls, and it's been, I think

I can speak for myself, anyway, over the years that we've worked on the Standard, we've tried to anticipate the lower class of buildings that are simpler and many of the lighting controls, at least, have been done by devices and components, rather than systems. We've never really made it clear the building automation systems would actually be a very welcome improvement to that, so this has been added for that reason. The type of changes, first of all, it adds mandatory measures. These aren't optional, these aren't prescriptive, and you don't have any choices, you have to do them. It would slightly increase the scope or direction of the current standards. We've never regulated electrical distribution before, this would be the first time. It would not require the implementation of systems or equipment that are not already readily available on the market and for use in the proposed applications. For example, the electrical systems are already considered to be good practice in electrical construction. Some of these systems are already regulated and included in the current Standards, this would relate more to the means by which we do the automatic shut-off.

The Standards manuals would be modified in order to include the new requirements, the change would require this new Section 135. Parts A, B, E and F don't really

directly save energy; Part C saves energy by preventing voltage drop in feeders and branch circuits. Voltage drop is direct energy lost as heat, so anything we can do to minimize it is good. Part D of the measure saves energy by shutting off receptacle circuits when the space is unoccupied. We think this is actually going to have some pretty significant energy savings we'll talk about in a minute.

The non Energy Benefits of A, B, E, and F require basic construction, enabling the addition of controlled measurement technologies as in the future their cost-effectiveness improves, and as the need for control measurement becomes important due to Demand Response, time of use rates, and other functions of the future Smart Grid. I think the California utilities already have an idea what the Smart Grid might look like, but I think, from a practical standpoint, nobody knows exactly what it's going to look like, or how it's going to be implemented. We strongly believe that these measures A, B, E, and F, future proof the project without adding in any significant cost, but there would be significant cost later to the building owner if these were not taken care of in the first place.

The cost of the measures, the metering requirements, we believe, this is at the service, now,

little or no cost impact because most meters in commercial applications already do these things; all we're doing is we're making sure that, if the service is large enough, that the customer can also get a little bit more information such as how much energy did I use last month, or how much energy did I use for a certain sample period that I defined, a week, or a month, and this is easily done with today's metering technology.

The disaggregated wiring method, like I said, is already considered to be good practice. One of the points made in the case report is that the requirements with disaggregated wiring is progressive; that is, in other words, as the building gets bigger and the loads get bigger, the more requirements are involved. I've chosen 25 KVA as sort of a minimum step level at which we change the requirements, so, for example, we do require you at some level to measure receptacle and plug load use separate from lighting use, but the chunks are 25 KVA chunks, which represent 100 AMP three-phase panel. We think that's a large enough chunk that it will have no significant cost impact to the project, it's just a different way of doing things.

Voltage drop requirements are already considered to be good practice. I think the primary reason why we'd like to put them in the Standard is to prevent future

practices where people might cheat on the feeders and branch circuits, and use smaller wire, or use aluminum instead of copper, or other things that would increase the voltage drop, still meeting the California Electrical Code, but no longer considered to be good practice by the Code. This prevents them from not doing bad practice.

The auto receptacle shut-off, I believe, is going to add somewhere in the neighborhood of $.25 to $.50 a square foot, this is only for office buildings and related occupancy, so you have an office in another building type, it does apply to the office, but it doesn't apply to the other building type. It's going to add a little bit of cost, and that is actually –- there are case studies that were previously submitted on that, and the DR provisions, as well, from the April 4th meeting, and the references to those are in the case report, so you can go back and look at what research was done.

In the case of the task lighting and plug load control, HMG developed a very specific one that I've reviewed, it does prove cost-effectiveness, and I've also tested it my own way, and it still is cost-effective.

The DR provisions were reported both by HMG and LBNL, in reports for that hearing, and both proved cost-effectiveness for the DR provisions.

Finally, the use of building automation systems energy management systems is already considered to be good practice, to allow them is simply to clarify the intent of the Standards to make that happen. I may not totally understand all the background behind that one, that came from staff and if Gary or Mazi would like to explain that a little bit more, if you have questions, we can do that. This, in particular, I focused for a few minutes in this presentation on the receptacle automatic shut-off because this is a significant change that is going to incur some costs on projects. At the April 4th hearing, again, here is the reference to the paper developed by HMG for the California IOUs, it's pretty solid stuff. What I did is I also said that 2007-2008, I developed a report for Southern California Edison, for the Office of the Future Project, which is still ongoing. The Phase I pilot, which was essentially a pilot study that Nancy Clinton and I did, found some very interesting things out about office buildings, and what people are using that is plugged in, and it was kind of fun and surprising. Using the values that I found in a survey of like 16 buildings from Sacramento, down to Southern California, this type of receptacle switching would have enormous energy savings. It would be saving on – the payback period for the installation would be on the order

of nine months if we consistently found the types of loads we found in that pilot study. Assuming for a moment that that was too small of a sample group, and that my conclusions are way off, even if my conclusions were off by 90 percent, the payback period would still be five years, and that beats the statutory requirements. So I believe that, no matter how you look at it, this is a very cost-effective solution, and one of the reasons, of course, is because you can use the same sensor that turns the lights on and off can be used to turn the receptacles on and off by the addition of a relay. So, for many reasons, this is a really good idea and I'm glad we're finally getting it into the Standards.

A few exceptions were required, a few specific things need to be said. First of all, it requires hard wired shut-off circuits, not portable ones, and there's an exception if a motion controlled plug strip is permitted, and it is permitted if you install it as part of a furniture system installation. There are some very good products on the marketplace that do this, and we didn't want to discourage people from using them, so there is that one exception. Receptacles have to be marked so that there's a different color, or a different way of identifying those that are controlled from those that are not, and there's a lot of things you don't want

to control at your desk, like your base computer, for example, you don't want that being turned off when you're not at your desk, you may lose data. But you may want to turn off other things such as task lights that are needed when you're away. Split receptacles allow the wiring to be proceeded so that the top receptacle could be controlled and the bottom receptacle would not be controlled, that sort of thing. Again, it's only required for offices and related space types, you're not required to do this for any other space types. There are also specific exceptions for outlays having a specific purpose, network appliances such as network copiers, network printers, etc., shared by a number of people, do not have to be automatically shut off. Appliances, kitchen refrigerators, etc. do not have to be shut off, as well.

So, in summary, Section 135 adds new requirements, it increases the scope, but it's consistent with other Energy Codes and Electrical Codes and I think its strongest point, other than savings energy with receptacles, is it prepares buildings for the future at a minimum cost, later, and now, as well. That's a summary of Section 135. Do we have any questions? Or comments?

MR. SHIRAKH: Jon.

MR. MCHUGH: Jon McHugh, McHugh Energy. So just

to go back to the California Electrical Code, currently the Code has a recommendation and not a requirement for the voltage drop for feeders and branch circuits?

MR. BENYA: That's correct. It's stated in a fine print note in the Code, this is the National Electrical Code, adopted by the State in the 2010 California Electrical Code, and it's been a fine print note for a long time, it's not an absolute requirement. And there's a good reason for that. Many times, buildings could arguably because they might use energy in bursts, or there's particular loads where it doesn't matter, where you could save a little bit of money, but that was then. I think it's time to make it a requirement from an energy perspective because, if you allow, again, every percent of voltage drop represents a lot of energy. You know, we go to a lot of trouble to regulate .1 watt per square foot in various spaces and lighting, this could easily account to that if it were a relatively large feeder.

MR. MCHUGH: And from an implementation point of view, is there trade-off –- do you feel it is more desirable to have it in Title 24, you know, Part 6, as opposed to in the California Electrical Code? I mean, what would be the tradeoffs between placing it in Part 6 vs. the Electrical Code, which has essentially a broader

application?

MR. BENYA: Electrical Code, Part 3 --

MR. MCHUGH: Something like that, it's part 3 or whatever, yeah.

MR. BENYA: Yeah, in my opinion, this is a jurisdiction question, electrical systems are generally not harmed by five percent aggregate voltage drop or more, but energy is lost. And so I think it is appropriate for it to be in this part of Title 24, rather than that part.

MR. MCHUGH: Okay. And in regards to controlled plugs, what sort of proposal do you have about, for instance, someone is working late and their monitor goes off, or these non-essential loads are shed, do you have any proposal around how to address sort of those periodic --

MR. BENYA: Yeah, the best implementation of this is going to be occupancy-based, probably occupancy-based, that is, you sit down at your desk, your receptacles come on, you leave your desk after 30 minutes, your receptacles go off, not all of them, just the controlled one. So it would be occupancy-based. You want to wait until -– unless you are sound asleep at your desk, if you are there at midnight, they will be on at midnight.

MR. MCHUGH: Okay. That is your intended to

occupancy-based. Thank you.

MR. FLAMM: So I want to clarify -– this is Gary Flamm -– the reason that we proposed creating Section 135 is because Sections 130 through 134 are mandatory requirements for lighting, and we didn't have a section for electrical only. And so we decided we needed a subsection that only addressed non-lighting electrical issues. Now, the plug load proposal that Jim is talking about was actually already presented on April 4th, and it was a case report developed by HMG for PG&E, and –- pardon? And for Edison, I'm sorry, Edison, I love you, too. So it was something that was proposed to be put into one of the lighting mandatory measure chapters, and it didn't belong there. So all we did between April 4th and now was to move that language to Section 135 because we're talking about plugs that may be lighting and may not be lighting, so it's the same proposal, it's just that we moved it to a different subsection.

MR. BENYA: And if I might, just to add, we added a little bit more testing to it and the reason why is that, at that time it was envisioned as emphasizing task lighting. From my office of the future, phase 1 study, we found that task lighting was way down the list of connected power to plugs in buildings. There are many things way above it on the list that could be switched

off, and so the whole idea is to capture all of those loads that could be switched off when people aren't sitting there. For instance, you know, I mean, I can remember finding one office where I found three computers sitting there drawing, you know, screen saver patterns all over the place, there wasn't a chair at that desk, and nobody sat there. And they just sat there drawing the screens, oh, we could at least turn off the CRTs, and that's what this system would do. I could tell you lots of other fun stories, let's just leave it at that.

MR. GABEL: Mike Gabel, Gabel Associates. So this is a question for both Jim and Gary. So, how would you guys -– do you envision that the Code language might give some guidance as to what indications of which outlets are going to be turned off? Or are you going to leave it wide open, or do you start thinking about whether the Code should specify some general guidelines about how they should be marked for the -– I'm concerned about standards, some standardizations of people using this stuff will kind of go into a new office and go, "Oh, yeah, this is that outlet that gets turned off."

MR. BENYA: Do you want to do it? Go ahead.

MR. FLAMM: I think that HMG actually already looked at this, there are some companies already have some color differentiations that they've chosen, and I

think the choice -– what was proposed was let the market sort that out, you know, if there would be any conventions developed, so I don't think that we intend to say what that shall be. But the requirement is that a switched receptacle shall be -– or a controlled receptacle shall be within six feet of an uncontrolled receptacle, so, you know, they could be adjacent to each other, or they could be six feet apart. So we were going to let the market sort that out, and I believe that was the recommendation.

MR. HAMILTON: Daniel Hamilton, Sacramento Municipal Utility District. When do you expect to have TDV numbers from Measure C or Measures C and D?

MR. BENYA: The TDV numbers were already published in the HMG report.

MR. HAMILTON: Not all -– I didn't think the two percent limits were --

MR. BENYA: Oh, two percent -– we're proposing not to do that analysis since it's already considered to be good practice, all we're doing is capturing good practice and –-

MR. HAMILTON: So it's turning the lights off.

MR. BENYA: -- you know, it's we could do a more extensive study if people object, but I see no reason for us to do that study unless there is enough objective. I

mean, if it's already good practice, why do we have to study it anymore.

MR. HAMILTON: That's pretty minimal, I just wanted to make sure we weren't leaving something out there in terms of –

MR. BENYA: No, to be honest, you know, since we had three established case reports on the things that I felt were going to be the ones over which there might be some concern over cost, I chose not to introduce anymore extensive studies for the things that I think are prima facie --

MR. HAMILTON: It probably goes without saying, but SMUD is overall very supportive of these measures, especially those with the non-energy savings with regards to Smart Grid and DR.

MR. BENYA: Oh, yeah, you know, this is one of those where I felt I could see the future coming and I could see the frustration in people because, you know, it's part of what I do in my design work, is we want to go back into existing buildings and put in measurement metering and management systems, and you know, the more aggregated things get, the harder it is to separate them out without very expensive instrumentation. And I know doggone well, if you can put three CTs on and get the data you need for all your lighting, wow, that saves so

much money and so much hassle, and it makes it so easy to put in and understand, and that's the key. Thank you for your comment, that's good.

MR. MCHUGH: This is Jon McHugh. So are you proposing a particular threshold for segregation of loads?

MR. BENYA: Yes. The thresholds work more or less like this: it's first of all based on the service, and then it becomes based on the group of load; so, for example, if it's a relatively small building, one meter, okay, you don't even disaggregate it because you're going to have one panel, you really can't. This really says, the minute we get to the point where the building and load are big enough to justify, in many cases, at least, a 60 AMP circuit, three-phase, or, in the case of a panel upwards of 100 AMP, that becomes a manageable number now. You know, I think it would be crazy if we put it any lower because then you have all these little toy panels all over the place, and it would add a lot of cost. So it was broken down basically on chunks that arguably don't increase cost as much as they define a particular way of doing things.

MR. SHIRAKH: May I interject because I'm just surprised that we didn't present actually those tables, it is in the case report and we can bring it up, so

everyone can look at it. I think that would be really helpful. Yeah, I think we have plenty of time.

MR. GARCIA: This is Tom Garcia, I just had one quick question. I was curious about the $.25 to $.50 a square foot. How is this done? Are you running a circuit for the regular wiring, and then you're just adding another outlet on that circuit and controlling it by low voltage sensors? Or are you running all new circuits on additional circuit-breakers that will be controlled? Because it just seemed like you're doubling the number of wiring if that's the case, the amount of wiring if that's the case?

MR. BENYA: Good comment. In terms of doubling the amount of wiring, under some circumstances, you might be doubling the amount of wire, but not necessarily wiring, because wiring to me includes junction boxes, or conduit, etc., which actually is a more expensive part, so it may require some more wire, but not necessarily more wiring.

MR. GARCIA: Well, if it is for more wire, then it's a larger conduit, and it's more --

MR. BENYA: No, you're still in the branch circuit size, pretty much a standard half inch, three-quarter inch stuff. The primary way this is going to be applied is probably a better way to look at it, you're

going to have an office building and this applies to like lobbies, and conference rooms, and private offices, and open offices. In the private offices and other places, what you'll be doing is you'll be putting in a low voltage, probably, ceiling matted sensor, connected to a power pack, and the power pack will have an auxiliary relay. Now, an auxiliary relay may cost about twenty bucks, so the auxiliary relay will switch the receptacle circuit, it will split it, and switch half the receptacles, and you'll probably come out of that junction box with two wires, one a switched hot and one an unswitched hot. You'll go to split receptacles, and that will be the most likely way to do it in most spaces. In open office areas, most likely way they're going to do it is either they'll have ceiling mounted motion sensors, and relays in the electrical closet, or more likely, they're going to put in motion control plug strips in open offices.

MR. GARCIA: Okay, good.

MR. MCGARAGHAN: Can I ask you something while they're pulling that up? This is Mike McGaraghan with Energy Solutions. Thanks, Jim. I wanted to ask about the analysis on the plug load controls. You mentioned that you re-ran it with your own method and plugging in some of the values that you dug up in the study from

2007-2008 about what plug loads are actually in use. Is that an analysis that you are making public? Or was that kind of your own back of the envelope calculation to verify savings or --

MR. BENYA: It's my own back of the envelope calculation that is in the case report.

MR. MCGARAGHAN: Oh, it is in there, okay.

MR. BENYA: Yeah. To put it simply, and as we're trying to find the document we want to put up here, just to give you a little bit of background, there were some very interesting findings and, of course, you have to separate out the issues of energy vs. power, you know, Title 24 has historically been a power standard, watts per square foot, watts related. Obviously, watts are not energy. There's always been the inference of energy through assumed hours of operation, but we've been struggling with that for quite a while now as to how we're going to do energy better, other than full building modeling. Setting that whole discussion aside for a second, my survey showed that the -– this is one of my favorite lecture points when I talk about this –- my survey showed that the largest power density, connected watts, connected watts per square foot in office buildings throughout California was portable space heaters, okay, number one load; number two load,

information technology, computers, printers, plotters, etc., etc., etc.; load three, lighting, so lighting was number three to those two, and the differences were fairly significant. After that, there was still, you know, a quarter and a half a watt a square foot for the other stuff, from chargers and clock radios and all the other things, the fans, and miscellaneous things you find around offices, and this is a pretty good cross industry, cross state survey, so I don't think there's any regional emphasis on the outcome. I found those space heaters in Southern California; I found them in Northern California. I found them at SMUD in the SMUD Headquarters. So, you know, this is something that happens, whether we like it or not, and I just wanted to point out that that is a great load if I were to pick on one, and I've also seen it at the Pentagon, too, if I were to pick on one load that I would say this would have great impact, it would be that. People would be, okay, if you're going to have one, at least plug it into the controlled receptacle.

MR. MCGARAGHAN: And one more question following up on that. The 2007 study, did it actually look at sort of the percentage of time that these various things were left on or how many people were away from their desk?

MR. BENYA: No, this was a pilot study, it was a very simple study, that's why I'm not claiming -– it's a

good enough database, but I'm not sure I know of a better one at this point, is the problem. It's not a good enough database to rely totally upon because we don't know what the energy use was, we don't know what the energy savings are going to be, and that's why in the report I said, "If I make certain assumptions that the duty cycle of the space heaters is 30 percent of the time, etc., etc., etc., then the payback period is almost instantaneous." I also said if I were off by 90 percent and it was like, you know, 10 percent of what I estimated, the payback period is still five years, and so my common sense testing is what it boils down to.

MR. MCGARAGHAN: And that's all in this case report?

MR. BENYA: It's in the case report.

MR. MCGARAGHAN: Thank you.

MS. BROOK: So if you could just walk us through, you have two good summary tables in your case report and you might have to move around a little bit just so that we could see it, and you're not going to be able to see the whole table at once, but maybe you could walk us through it.

MR. BENYA: Yeah, this is the first of two tables that is part of this proposal, 135A, this sets minimum requirements for metering of electrical load, so you have

to be able to go to the electric meter, or to a meter adjacent to the electric meter, and if your service is rated 50 KV or less, are the least demanding requirements, more than 1,000 KVA or the most demanding requirements, but you can see in all cases, you've got to be able to go and look at your meter and you'll know how much demand you're using right now. Obvious reason is, if you're going to do any type of demand thinking, you've got to be able to get an idea what you're using. The second one is some sort of historical peak demand ability, this is only required of the larger services, so your ability to go back and say, "Okay, tell me how much I used last month, or last year" is only required in services more than 250 KVA. The third one, a resettable kilowatt hour reading, so you walk up to the meter and you say, "Okay, reset it," you come back a week later and read your kilowatt hours for the last week, so you get an idea how much energy you're using, that's required of all meters. But your ability to take a look at kilowatt hours per rate period -- and by "rate period," I mean on peak, off peak, or any other period we might get into -- is only required of the largest services. Again, this is common sense-based, you're not going to see any type of economic test because I don't think this is expensive. I don't think you would even see it in the cost of a

project, but it does provide the building owner/operator with a useful amount of totally aggregated information that might help them discover whether or not their building has any issues. There is a separate table for the disaggregation. I'll be glad to stop here if you want to talk about this particular table before we move on. Jon?

MR. MCHUGH: Jon McHugh. So, from this first table, so basically all systems have to provide instantaneous KW demand and resettable kilowatt hours. Is that something that the standard utility meter is providing now free of charge? Or is that an additional feature that's going to be required by the building owner to install?

MR. BENYA: I'm not an expert on electrical meters, but the mechanical meters we've had over time with some special provisions can do this, but the electronic meters, this is easy. And as we move from mechanical to electronic meters, which is going to be a necessary part of the conversion, of building future buildings and systems, I think this is a feature of every electronic meter I've ever seen.

MR. MCHUGH: Okay, so you're saying every meter that you've seen has this feature, and we just need to make sure we coordinate with that.

MR. BENYA: At least. Most of them have more features than we're asking for.

MR. MCHUGH: And that this is available to the user on-site to do these things.

MR. BENYA: Yes.

MR. MCHUGH: Okay, thank you.

MR. BENYA: Any other questions about 135A? If not, we'll move down to Table 135B. Table 135B, as before, breaks the building down into service rated sizes. The reason why we picked service rated size is because this is the first good way to indicate the relative size of the distribution system. If it's a service rated 50 KVA or less, that's a relatively small service. That would be, for example, a 200 AMP single phase, 240 volt, would be a service like this, otherwise it's doggone near residential size. That would apply to small businesses, primarily, smaller properties. The second group, 50-250, is taking you from that 200 AMP single phase to 240, all the way up to, well, five times that, so 1,000 AMPs, 240 single phase, which would be more like 600-800 AMP at 12208, that's pretty substantial service for a building and we're probably looking at buildings that are 25,000-square-feet, would be the approximate standard commercial building size that that would run up to. The next group is probably buildings

for about 25,000-square-feet up to 100,000-square-feet or so, maybe larger, maybe smaller, it depends on the building type and the efficiency of the building, and that's the third category, and the fourth category is relatively big structures.

So the requirements are for lighting to disaggregate the data starting with the second building class. The first building class probably has one panel board, and so asking people to get in and wire their building differently than that just doesn't make any sense. But in the second group, you probably can aggregate all your lighting onto a single panel board, maybe a small one, maybe it only has a few brain circuits, but you can do it. From there on, you are really required to start to disaggregate that information. By the time you get to the third level, you really –- we want to further disaggregate the lighting by floor type or area. Some of the definitions here are going to have to be worked out, but the idea here is that, for example, now you're talking about buildings with spaces 25,000 to 100,000-square-feet, you're likely to have distinct building masses, or distinct floors; in a multi-floor building, this would be a small multi-floor building that would be typical of this. And so we do want to know what per floor, that's how if you're going

to be managing a building trying to find issues, you'd sure like to know what floor to look on. And obviously, this continues on up to the larger building.

The next group is HVAC systems, very similar to lighting in pretty much all respects. The other thing we want to do is make sure there is some way to easily identify big HVAC loads, chillers, big fans, and other things, so that they might independently be metered, 50 KVA kind of being the size that requires an independent ability to identify that. Now, this is kind of a non-brainer because those loads are fed by their own breakers and their own feeders, anyway. So it's kind of a gimme. It doesn't really have any impact whatsoever, but it's nice to say.

The next one, domestic and service water systems, pumps and related systems and components, we're just saying, if the building is big enough, you can aggregate those loads, put them altogether, water pumps represent a small percentage of the building, but the bigger the building, the more we'd like to know it.

Plug loads is where this is going to get to be kind of exciting because we want to talk about two things, one would be all plug loads in aggregate starting at that 10,000-square-foot or so project, and it also requires groups of plug loads exceeding 25 KVA connected

load in an area less than 5,000 square feet. Read between the lines, this means at least two space types I can think of right off hand, server farms and commercial cooking kitchens, also some light industrial uses might fall into that category, as well, but 25 KVA is a reasonable chunk of power and especially if it's in an area that small, so this is not, I don't think, an onerous requirement, it just says you've got to have a feeder for that, a feeder and a subpanel. Now, frankly, in commercial cooking kitchens, you already have a subpanel, that's the way you wire them for Code reasons, so this is again –- a lot of this is a gimme, but it's saying that, if you have a chunk, you have to put in a subpanel for it, you can't just grab a bunch of existing circuits. And likewise, this continues up to the floor level, or area level in the larger buildings. Elevators, moving walks, transit systems can be aggregated, again, they represent a relatively small percentage and, frankly, many times there's not an awful lot you can do to manage them, anyway, they're need-based. Other individual non-HVAC loads or appliances above 25 KVA, you can aggregate all of them, not in the smallest building, again, we're assuming everything is on one panel; but in the next larger building on up, you have to identify these loads and load groups, and by the time you get to

the larger buildings, it's in each, rather than in all.

Industrial and commercial load centers, actually this brings up commercial kitchens, again, specifically, also theatrical lighting installations, these are some common ones that I could think of, I'm sure there are a list of other things that I didn't think of. Renewable power source, here we want to be able to identify it. Now, frankly, you already have to do this by Code, again, it's kind of a gimme, but you need to know where it is, so when your PV system connects, there's almost invariably one or two disconnects for safety reasons, you already know where to put it. Loads associated with renewable power source, if the load is specifically associated with it, for whatever reason, all those loads should be in aggregate. I can only imagine what this might mean, the motors to turn your photovoltaic array or something. Finally, charging stations for electric vehicles, again, if you're going to put in a number of these, they could have a relatively high power use, either instantaneous or, depending on the number of vehicles, KWH, as well, but it's one use, and I don't know what you'd learn by saying, "How much more did Charging Station use than Charging Station 2?" Plus, charging stations have brains in them, so you can learn that information if you need it, anyway. So that's the

summary of the requirements for the disaggregating by wiring of loads. Questions? Jon.

MR. MCHUGH: A clarifying question -– Jon McHugh. So for each of these disaggregated loads, you're looking at having like a CT, a Current Transformer, and some monitoring and storage of the data. Is that what you intend here?

MR. BENYA: No. This only requires that there is an easy place for you to add that later.

MR. MCHUGH: So currently, so just going back to the metering requirement, what are you specifically requiring metered?

MR. BENYA: The only thing we're requiring to be metered at this point is the service.

MR. MCHUGH: The entire building?

MR. BENYA: The entire building, an aggregate number, and so that the owner can do the simplest of measurements and the simplest of uses of this information. It's not much information, but there's going to be a lot of people who don't care, they don't want to put a measurement and metering system in, they don't want to manage their load, they don't want to make that investment, and we're not making them. But if the next guy who buys the building comes in and wants to put in all that stuff, or if Smart Meter technology, Smart

Grid technology, dramatically encourages them to do it, they won't have great expense in doing it later.

MR. MCHUGH: Okay, so metered-ready, essentially, is what you're proposing.

MR. BENYA: Yeah, sub-metered is maybe not technically the correct term because sub-metered implies tenants or other uses like that, there is also the legal definition of what is a sub-meter, and some limitations the CPUC places on their meters, I didn't want to get into that.

MR. MCHUGH: And related to tenants, do you envision any sort of disaggregation of loads by divisions in the building, in terms of tenanted spaces, that sort of thing?

MR. BENYA: This can deal with that if the tenant is big enough. The problem is, of course, let's say I'm a tenant, I'm going to rent a retail store in your mall, every common situation, the service to the mall is well over 1,000 KVA, so the mall itself is required to do a certain amount, but once it gets to me, I'm now an identified -– I'm one of those load groups, okay? As a tenant panel, I would get a tenant panel, I'm a load group. So I would then be able to say, "Hey, look, as a tenant, I'm under 25 KVA, so I could just have a panel." See?

MR. MCHUGH: Thank you.

MR. SHIRAKH: Any other question or comments for Jim? Are you all done? So we're ahead of schedule. We have a choice of having a nice long lunch, or we can actually do one of the afternoon ones and get out of here earlier. I vote for getting out of here earlier.

MS. BROOK: Okay, so we can do the Condenser Water Reset?

MR. SHIRAKH: Right.

MS. BROOK: Okay. So this measure is Condenser Water Supply Temperature Reset Controls, and this was brought to Commission staff from the IOU case team and Michael McGaraghan and I think Elizabeth is online? Okay, that's okay, that's fine, and you can probably cover for her.

So just the origins of this proposal, those of you that were paying attention to all of our past workshops, we did talk about developing an acceptance test for condenser water reset controls, and in the process of that research, we identified a lot of savings opportunities for the controls, themselves, and there's been a lot of success in retro-commissioning projects across the state and using this measure to achieve significant savings, and we want to consider and discuss actually having the controls as part of our standards

update. There are definitely issues that we'll present here and we will want to discuss and get some feedback on.

So, basically the idea of this proposal is to reset the condenser water supply temperature downward during times of low load, to allow the chiller to operate more efficiently. And as I mentioned, it was based on an acceptance test and case proposal that proves that there are significant savings, potential savings. And so the idea of the -- I think I can just keep going here -- so basically the idea is to prohibit fixed supply temperature and to allow the supply temperature to be reset according to relevant control sequence. And also, as we presented earlier, there is an accompanying acceptance test protocol developed.

So we have had some early feedback from the design engineers that are part of our support team, and their initial concerns are that this measure is great at saving energy if it works perfectly and if the control sequence is very well developed, and specific to the application. But the issues are that these controls could be set improperly or retuned to provide -- to change the control sequence, and there are significant and real energy penalties if the reset controls team doesn't work correctly. So there's a potential for

chiller surge at low condenser water supply temperature, so obviously that's a real concern for equipment reliability, performance, and sustainability. These optimal control sequences are very site-specific and so the concern is that the control sequences themselves couldn't be specified in Code because they are so site-specific, they couldn't be generalized in the Code implementation. And the wet bulb sensors that are used in one type of strategy to reset the supply temperature may be unreliable, so that would obviously cause the control system to not work as planned. And if we are going to go forward with this, then we need to think about integrating the waterside economizers if they are provided, and provide for the appropriate head pressure control of the chillers.

So I don't know how much work we've done on how often the condenser water reset controls are implemented in practice, so the team is still looking into these feasibility concerns, and we're actually here today to invite more, so we really do need to hear from more designers and manufacturers. We have a very limited sample right now that we're considering and reacting to, but we need a broader community to come in and tell us what they think about this proposal.

So the way the team estimated energy savings for

this measure is they looked at energy modeling parameters, two building types for each chiller type, office and a hotel schedule, five climate zones, and a reset strategy that followed the outdoor air wet bulb temperature. They used a fix condenser water pump speed and a cooling tower control, 80 degree design wet bulb within 66 degrees minimum condenser water supply temperature, so it was a standard reference for comparison.

So the modeled energy savings show potential energy savings higher in the warm dry climates and lower in the mild wet climates, with a variation across the three chiller types, but you know, still some significant savings there. The estimated cost for overall sort of the present value total cost per plant would be over $2,000, it includes the sort of estimates of material, install, and maintenance costs. Next slide.

The cost-effectiveness net TDV savings ranges from $.10 to $.20 per square foot across these three chiller types. So, basically, we would be proposing to require reset controls for water cooled chiller plants that are served by cooling towers, so these would be required to have automatic reset control functionality of the condenser water supply temperature, and we would exempt chillers serving constant loads, including

facilities operating 24-hours a day.

The acceptance test was part of an earlier workshop and case report and the reference for that is provided here, and there is also recommendations for at a glance guides in form that are relevant to the acceptance test for condenser reset controls. So that is the presentation and we would like to know if anybody here or online has opinions about whether it's appropriate to include this as a prescriptive requirement in our Code, or not, and what the potential issues might be. Anybody have any questions, come up now, otherwise, check online, if there is nobody online, then we'll continue to pursue other feedback from the designers and manufacturers. Jon.

MR. MCHUGH: Could you go back to the Code language? This is Jon McHugh. I have a question about -– this is condenser water supply temperature reset, and I was wondering why, for a chiller with constant load, that it still wouldn't be desirable to have -- this is not chilled water reset, this is condenser water reset, and so not clear why a chiller with a constant load, it might still be desirable to have a variable set point, depending on the ambient temperature conditions outdoors. So, for instance, you know, a wet bulb following time control, or something like that, where essentially your

set point is being adjusted based on ambient conditions.

MS. BROOK: Good question, I don't know the answer to that. So, I'm guessing that there were comments from the people that Elizabeth reached out to, that explained that maybe nobody does it, or maybe there are issues with –- or maybe there's just a real limitation in energy savings, but I agree with you that it seems on face value that there still might be some potential there, but maybe Mike wants to speak to that.

MR. MCGARAGHAN: Mike McGaraghan, Energy Solutions. And I actually don't have an answer for you, Jon, but I do think Elizabeth is trying to call in, so I just wanted to see if Elizabeth Joyce is on the line there and, if so, I don't know if she is muted or if we can --

MS. JOYCE: Hi, yeah, this is Elizabeth Joyce. Can you hear me?

MS. BROOK: Yeah, great.

MS. JOYCE: Okay. So, Jon, the intention behind that language, and there might be other exceptions that come up, but the thought behind that is that, you know, reducing the condenser water temperature is going to reduce the capacity of the chiller, and it will make it more efficient, but the idea being that if the chiller is serving a constant load, or is running at near constant

capacity all the time, then it won't see savings from this kind of a measure. You know, or you can risk not being able to deliver full capacity to your loads. So that was the intention behind that. You know, it might need to be worded a little bit differently.

MS. BROOK: Good, thank you.

MS. JOYCE: No problem.

MS. BROOK: And, Elizabeth, maybe you could just briefly mention what effort you're making now to try to reach out to additional designers, and maybe -- I don't know, do you happen to know, one of the things I was wondering about is, is this measure incented through the Savings by Design Program? Do you know if anybody has experience using this control technology to achieve better than Code savings?

MS. JOYCE: So I know that this technology, this control mechanism, rather, can achieve better than Code savings. I haven't looked into Savings by Design or any other program. My understanding is that, you know, if somebody is doing this on a performance compliance basis and applies the Savings by Design via that pathway, that they could get an incentive for it. I don't know of any programs that explicitly intent it. As far as outreach, we're trying to reach out to different mechanical design and mechanical engineering firms to get their take on

whether this is something they frequently recommend or implement, and what kinds of benefits or drawbacks they see from it. We're also trying to reach out to manufacturers and industry groups to get a sense from manufacturers on, again, what some of the pros and cons of this kind of reset are. You know, some of the feedback that we've received includes that, you know, this is a pretty complex measure to implement, or it can be if you have a complicated chilled water plant, and that, if done correctly, it can achieve great energy savings; but if done incorrectly, you know, there can be an energy penalty or there can be operational problems. And so, in my mind, at least, it kind of boils down to how feasible it is perceived as a measure by the design community. Is it something that people perceive to be actually pretty simple to implement? Or, you know, is it something that people think is actually really difficult, or they've had difficulty implementing it in their own experience or practice? And that's what we're trying to figure out, you know, just sort of, again, the pros and cons and the prevalence is what we're still trying to research and, you know, we would definitely appreciate any feedback. I think, if people want, I think my contact information might be up there. I'm happy to listen to anyone who has opinions on this measure.

MS. BROOK: Okay, so the idea that I had was, can we actually find out from the Savings by Design Program if this measure is used to claim Savings by Design savings.

MS. JOYCE: Uh huh.

MS. BROOK: Because, you know, if it's not ready for Code, but it's being used in every beyond Code program, well, then you have to really wonder why isn't it ready for Code. So that's what I was wondering about.

MS. JOYCE: Sure, and that's something that I can definitely do. Thanks for the recommendation. Yeah.

MS. MCGARAGHAN: So this is Mike again and I just wanted to point out, I just gave an email blast out to a handful of people that may have just called in, I don't know, I gave a heads up to a train company and PECI and AEC, and a few others. So if there are others online that may have just joined for this conversation and want to contribute, you know, I think the best way is to -- what do they do? Raise their hand, you know, send in a chat to the host of the call?

MS. BROOK: And then the other thing we can do, if they were planning to come and join after lunch to talk about this, we could definitely get their comments, so if you could just remind us to open up the lines again after lunch to see if anybody else wants to talk about

this measure?

MR. SHIRAKH: Yeah, we'll check in after lunch and make sure there are no outstanding comments before we move on. Jon.

MR. MCHUGH: Jon McHugh. A couple more comments. My understanding is that, as part of the case study, this was one of the larger retro-commissioning measures, so whether or not someone is using it for new construction, there is also the issue in terms of whether some of the programs are also using this for retro-commissioning.

MS. JOYCE: Uh huh.

MR. MCHUGH: The other issue I'd like to bring up is that this type of control has been since 2008 required for refrigerated warehouses.

MS. BROOK: Oh, okay, thank you. That's very good. One other thing that I shouldn't have to ask, but I do, is do we allow this in the performance approach as a tradeoff now, or are we not allowing that as a way that we can comply with the standards in the performance approach? Does anybody know?

MS. JOYCE: My understanding is that it can be. I know, at least it can be modeled, so presumably, but I'd have to check the ACM.

MS. BROOK: I'll double-check, I just wanted to know if anybody had the answer in their head, but that's

fine. All right, thank you, Elizabeth.

MS. JOYCE: Thank you.

MS. BROOK: And I think that is a good point of context, so it basically is a prescriptive requirement for refrigerated warehouses, and so it is -– maybe it’s different because of the way that loads either do or don’t vary between building types, but definitely an interesting thing that we’ll need to pursue.

MR. GABEL: Mike Gabel. I’m about 99 percent sure that it is under the performance approach a current modeling tradeoff.

MR. SHIRAKH: Any other questions related to this topic, the Condenser Water Reset Controls? So we’re at 11:30. I would suggest we break for lunch and then meet back here at 12:35, and resume -– 12:45, okay.

(Recess at 11:32 a.m.)

(Reconvene at 12:57 p.m.)

MR. SHIRAKH: Okay, since we discussed the Condenser Water Reset topic before lunch, I want to make sure that, if there is anybody online who has a question or comment about that before we move to the next topic. We’re kind of ahead of schedule, so we jumped into the afternoon session before lunch. Are there any comments related to Condenser Water Reset Controls? Okay, what is the name again? Mick? Mick Schwedler, are you online?

MR. BROOK: You know what we can do, we can just -- we have plenty of time, maybe we can --

MR. SHIRAKH: Yeah, we will come back during the public comment and try to address it if there is somebody online who wishes to revisit this. So we'll move on to the next topic, which is boiler efficiency measures, and Martha is going to do this.

MS. BROOK: Okay, commercial boilers. We're proposing three mandatory Code changes so that they would be mandatory requirements for commercial boilers of a certain size, combustion air positive shutoff, combustion fan variable frequency drive, and parallel position control. So the proposed Code language is that there would be mandatory requirements for service water heating systems and equipment, combustion air positive shutoff would be provided for all natural draft and forced draft boilers with an input capacity of 700,000 Btus per hour and above for all boilers where one stack serves two or more boilers, with a total combined input capacity of 700,000 Btu hours, and then also for boilers where combustion air positive shutoff would significantly reduce air flow and consequently boiler heat loss during standby and shutdown periods. And when I was reviewing this proposal, I mentioned that Item C potentially difficult or impossible to enforce, so we are looking for

recommendations for maybe how we meet this intent in a better way, or decide that we wouldn't go forward with C, because we don't think it's enforceable, but the idea is that there's many instances where there is significant standby and shutdown periods that aren't addressed by the first two, just by boiler size, so we're looking for recommendations there.

So for the fan variable frequency drive, boiler combustion air fans with motors 10 horsepower or above, will need to be driven by a variable speed drive, or include controls that limit the fan motor demand to no more than 30 percent of the total design wattage of 53 percent of the design air volume.

And the idea of the next proposed language is to limit the amount of excess air that's provided into the combustion, so boiler systems with input capacity of 5 billion Btus per hour or larger shall maintain excess oxygen concentrations less than or equal to five percent by volume on a drive basis over the entire firing range. And the combustion air volume would be controlled with respect to firing rate or flue gas oxygen concentration. So use of a common gas and combustion air control linkage or jack shaft is prohibited.

And the energy analysis for the air positive shutoff is that this saves 30 percent of the total

standby losses and the standby losses are two percent of the rated fuel input per the modeling results. There's 2,722 hours per year of boiler operation and so these are sort of the background assumptions and the price of fuel is listed there for natural gas, and then the payback threshold is 11.9 for a year, that's the present value of the 15-year building lifecycle.

For the same measure, the assumptions for installed cost provided by a flue damper manufacturer, the incremental cost to a boiler manufacturer is about $750.00, their mark-up was conservatively estimated at 100 percent, so the cost that was used for this analysis was assumed to be $1,500.00. Maintenance cost is assumed to be $50.00 per controller replacement every 10 years, and with an hourly labor rate of $100.00 per hour, and the present value maintenance cost of $112.00 using our three percent discount rate. The lifecycle cost results using an input capacity of 700,000 Btus per hour, this is a summary of what I just mentioned on the cost and the present value of the energy savings is calculated to be almost $2,000.00, the lifecycle cost savings of $122.00, and the benefit cost ratio of 1.1.

For the fan variable frequency drive, the same assumptions about hours of boiler operation, the motor load factor was assumed to be 70 percent, the cost of

electricity is $.13 per kilowatt hour, and the same lifecycle assumptions about the equipment. So this is a boiler run time Histogram over the different -- each of the bars is a different climate zone, and there is also a highlighted bar at the end of that group, that is the average of all climate zones, and that lists the different boiler firing rates as – and the fraction of the time that the boiler is at that firing rate.

Incremental installed cost is shown here in the table that is provided by the RS Means and verified by the Statewide Retro-Commissioning Program that is run by PECI. The incremental maintenance cost is a conservative estimate of half an hour per year at a labor rate of $100.00 per hour, and the present value of the annual maintenance is discounted by three percent over 15 years and is $597.00. The lifecycle results are shown here in this table, it’s got a benefit cost ratio of 1.3 with the listed energy savings and incremental costs in the table.

The energy analysis for the parallel position control is that it is standard with low and ultra locks, so our industry research says that this type of control is standard with low and ultra-low NO_x burners. The base cases of a boiler with a single point control without low or ultra-low NO_x burners, the case that we propose for this measure is a parallel positioning control and

without low or ultra-low NO_x burners. The base case excess air ranges from 40 percent at high fire to 80 percent at low fire, and the measure case excess air is 28 percent.

The net temperature difference, which is the stack temperature minus the intake temperature, is 170 degrees; the same assumptions about average per year of boiler operation and fuel costs, and lifecycle.

The incremental installed costs was provided by four boiler control representatives, manufacturer representatives, the total installed incremental costs from all four sources ranged from $8,000 to $9,000. The price does not vary with boiler capacity, at least between 50 horsepower and 1,500 horsepower. The maintenance cost of boilers air to fuel ratios adjusted during boiler tuning, this occurs for both the base case and the measure case, but requires more time for the measure case, so those additional labor costs were included. It's a conservative estimate of four hours per year at the labor rate of $100.00 an hour and this turns out to be $4,775.

So lifecycle cost results for the parallel position control, it's got a benefit cost ratio of 1.2 and lifecycle cost savings of over $2,000. And that's all we have. So this work was done by Matt Tyler at

PECI, who couldn't be here today, but we are here to get any comments that anybody has on commercial boiler efficiency measures that we're proposing.

MR. SHIRAKH: Any comments on commercial boiler project? Anybody online?

MR. SMELCER: This is Jim Smelcer of Lochinvar Corporation. If I could ask that we back up the slides to the beginning of the presentation on the boilers, the one that specifically was the excess air ratio of less than 10 percent, could we go there?

MS. BROOK: So just help me find where that was.

MR. SHIRAKH: It was when we talked about –-

MR. SMELCER: Yeah, combustion air positive shutoff saves -– no, that's not it.

MS. BROOK: Okay, so I'm hunting, so if you know where it is, then let me know. Of course, you don't, because I'm jumping around and all you have are these slides, so….

MR. SMELCER: It was earlier, early in the presentation.

MS. BROOK: All right, let's just go one at a time until we find it. This is the Draft Code language, so it won't be there, it's in the stated assumptions?

MR. SHIRAKH: Uh huh.

MS. BROOK: Okay.

MR. SHIRAKH: Yeah, one was 40 percent, the other was 27 percent.

MS. BROOK: Oh, okay.

MR. SHIRAKH: The base case was 40.

MS. BROOK: Okay, yeah, I'll get there. I just want to make sure I'm not skipping any of them. Is this it?

MR. SHIRAKH: That's the one.

MR. SMELCER: No, that's not it either. That's with low NO_x burn, I think it's still upstream.

MS. BROOK: Okay. I think I'm back to Code language now. So was it in the Code language, no, it's not in there. Do you think it's closer to the end?

MR. SMELCER: It's closer to the beginning.

MS. BROOK: I was at the beginning.

MR. SMELCER: Well, my question, what I heard was that the set-up for the operation is that it was based off of operating at a 10 percent –- I'm not sure if it was a maximum or up to this ratio, I've wanted to question that and how that was arrived at.

MS. BROOK: Okay, so this is the only slide that I can find 10 percent on it and it's the oxygen percent at low fire for the base case. Is that what you're questioning?

MR. SMELCER: Let's see, from point percent at

high fire to 80 percent at low fire, uh, excess air oxygen ranges from 40 percent, and then a 6.5 percent. Explain the 40 percent.

MS. BROOK: Okay, so what Matt has done here is that excess air is the percent that's outside of the parentheses, and it's oxygen percent is inside the parentheses.

MR. SMELCER: Oh, okay, now I understand. Now I understand, so he's running at considerably high excess air ratios in order to achieve the NOx, okay. That explains that. Then, my other question is with respect to flue damper, itself. Is it the intent that a flue damper be, in fact, a mechanism that is installed on the exhaust vent of the boiler that shuts off all flow to the heat exchanger?

MS. BROOK: I don't know the answer to that. Can you – Jon thinks he has the answer and he's going to come up and tell us what the answer is.

MR. MCGARAGHAN: Maybe Matt will come tell me that I'm full of it, but as I remember why he's using the term -– was it positive shutoff, or something like that –- is that there's multiple ways of achieving, you know, stopping the air flow through the heat exchanger, so whether you use a flue damper or you do something that is upstream of the boiler, he doesn't care how you do that.

MR. SMELCER: Okay --

MR. MCGARAGHAN: You make it more generic is the intent.

MR. SMELCER: Yeah, why I was stating that is that, just using the term “flue damper” since the Federal Government stopped recognizing flue dampers for any benefit with respect to efficiency calculations 20 something years ago, dampers basically don’t exist that are generic in nature, it’s something that the manufacturer does on his own and customizes for his own product. There are vent dampers out there, but they do an entirely different job. Flue dampers in the United States, there isn’t one vendor source today in the United States that makes what we would call a flue damper that is designed to shut off flow on the boiler, there isn’t a manufacturer that does that. So the cost analysis that came out of that, I don’t know what basis was used to arrive at those numbers. We’ve been investigating the cost of a similar appliance in Europe that is available there, but nothing in the States that’s available, so those cost analyses would have to be based off of us designing something to shut down, the flow to the heat exchanger, be it upstream, or be it downstream, or somewhere in the middle.

MS. BROOK: Okay --

MR. SMELCER: For a gas boiler, that analysis, I'm not sure where that came from.

MS. BROOK: Okay, that's fair and we do -– do we have a case report posted for this, Mike? So we do have a case report that has more detail about where those costs, how those costs were derived, and we can also -– we can ask Matt to get back to you and resolve any concerns you have about those costs, and make sure that Commission staff is aware, as well, whether your issues have been resolved.

MR. SMELCER: Yeah, my point is that you just can't go out and buy one, a lot of times we have to correct to adapt this.

MS. BROOK: No, that's a really good point. Now, are you commenting also that we shouldn't use the word "flue damper" in this case because it doesn't actually shut off the air?

MR. SMELCER: Yeah, that was my original question and I believe flue damper is used inappropriately in the context.

MS. BROOK: Okay.

MR. SMELCER: It would be a means of shutting down the flow to the heat exchanger in a generic sense, I think, is what may be intended, but a flue damper by definition is something that describes that, but that is

not a defined appliance that is manufactured in the United States today.

MS. BROOK: Okay, and Mike wants to comment.

MR. MCGARAGHAN: Jim, this is Mike McGaraghan again, thanks for your comments and Matt Tyler is actually out of town now for a few weeks, and I want to make sure we do follow-up with you about your question. Do you have -– have you been in email contact with anyone here at the Commission?

MR. SMELCER: No, I'm the recipient of the CEC stuff that's coming out through AHRI and those interested, that want to participate, and I was one of them, and I actually posted my comments through AHRI that relate, this is one basic question. I had others, but this is the first one. We got this one out of the way, then we can move on. But I would tell you from a Lochinvar standpoint, there isn't a flue damper designed today that we can go buy for $750.00 and adapt it to put on our boiler, it doesn't exist. We'd have to design something, and that is design cycle time, and that just doesn't happen.

MR. MCGARAGHAN: So what I'd like to do is just follow-up with you and also make sure you get a copy of the case report, and we can see if that answers your question. I believe that Matt Tyler actually, for all of

these measures, did the field testing in California, so maybe it's just a terminology issue here. Can you give me your phone number and I'll follow-up with you?

MR. SMELCER: It's 615-889-8901 ext. 2259, and I can also give you my email address.

MS. BROOK: Please do.

MR. SMELCER: It is jsmelcer@lochinvar.com.

MR. MR. MCGARAGHAN: Great. Thank you very much, Jim.

MR. SMELCER: You're quite welcome.

MS. BROOK: So am I also correct in understanding that this is one of several issues that you have and you want to get this one resolved first before we move on to the others?

MR. SMELCER: We can go ahead and discuss the others, but from the time cycle standpoint, the availability standpoint, all of those things, put everything out, so it's kind of fruitless to discuss the rest of it until we get to that.

MS. BROOK: Okay.

MR. SMELCER: Or do you agree?

MS. BROOK: If it's on the air positive shutoff proposal, I would agree. If you have comments on either of the other measure proposals for commercial boilers, then we'd like to hear them.

MR. SMELCER: I think anything associated with the vent damper was one. The other, I had one other comment that was related to the parallel positioning –- there's another one –- I'm not sure what that is, I really don't know what that is. I heard the description, I read the description in the reference information that we had gotten to study prior to this phone call, but I really don't know what that is. I don't know what I would do with it. It says it's cost of between $8,000 and $9,000, and I have no clue. I really don't know what that means, so somebody out there in the boiler business is doing this, but I don't think it's shared knowledge, it's not common knowledge to the boiler industry. So how do we take advantage of knowing how to apply a parallel position control when we don't even know what it is?

MS. BROOK: Okay, well, excellent comment, and Jon is coming to the front to try to help a little bit, but we definitely will want to get Matt back in touch with you as soon as possible.

MR. SMELCER: All right.

MR. MCHUGH: This is Jon McHugh again. I would recommend that you talk with Matt. Basically, this is an actuator, so a stepper motor, or other type actuator that adjusts the gas valve and adjust the speed of the variable speed drive, so that you're getting the proper

gas and fuel mix over the range of your boiler.

MR. SMELCER: I think from what you just described, I can say that our boilers work off of a negative pressure principle and they really, the induce air at a given pressure and the pressure dropper across the valve itself is what dictates the flow, and the speed of the blower is what dictates the flow. You can't regulate it any other way, other than by blower speed. If you do, you get a flame mount. So these things don't apply to modern technology of boiler set.

MR. MCHUGH: And your particular boiler set that you use as principle, are there a particular size range that this applies?

MR. SMELCER: We're headed up to five million with them.

MR. MCHUGH: Okay, thank you. So we'll take this information back to Matt and we'll get you in contact with him.

MR. SMELCER: Yeah, I think what we need to decide is to make sure we know what your intent is and if there's another way to get there, either by description, you know, this describes a specific thing, if it's a generic description, then we need to change -- to get to where you want to get to, then I'm all for that.

MS. BROOK: Right, and I think that is the intent

and it could be that we are using inappropriate terminology for our desired intent, and we can definitely work with you to clarify that. And we really do appreciate you calling in because we really need to hear experts' feedback for us to be able to develop a successful proposal, so we really do appreciate your time.

MR. SMELCER: Well, I can say we definitely appreciated the opportunity to be able to be on the WebEx now, that was definitely free and open to the public and that's why we participated.

MS. BROOK: Good, great. Do you have any other comments right now?

MR. SMELCER: I -– you know, I have others, but if he's going to get in touch with me, let's not waste it here, but just keep going.

MS. BROOK: Okay, that sounds great. Thanks. So we do have one more proposal for process boilers, which I'm going to bring up real quickly.

Okay, so just to kind of ground this a little bit, we did have a process boiler set of proposals back in April and at that time we didn't bring this 02 trim part of the proposal forward because we still were working out some issues, or potential issues, so now we're just trying to bring this into the fold for the

rest of the proposed process boiler recommendations. So this proposal basically would apply to process boiler systems greater than 10 million Btu hours, or larger, and so the proposed Code language is that these boilers will maintain an excess oxygen concentration less than or equal to three percent by volume on a dry basis over the entire firing range, and the combustion air volume will be controlled in respect of firing rate or flue gas oxygen concentration and, again, the use of a common gas and combustion air control link or jack shaft would be prohibited.

MR. SMELCER: Here again, if I may, I think the comment is going to be the same. That particular language is very specific, and I think we just need to put that in generic terms of what you're ultimately wanting to achieve by gained efficiency, to increase performance of the boiler, rather than that very specific language because that's going to be difficult for a lot of modern boilers today.

MS. BROOK: Okay, so I think that is what we wanted to hear about and why we wanted to bring it forward. So, you are suggesting that, rather than prescribe several different measures, that we suggest an overall efficiency improvement?

MR. SMELCER: Just pick a number that we need to

get to and we will decide how to get there.

MS. BROOK: Uh huh, okay.

MR. SMELCER: What we're dabbling in, we're dabbling in specific boiler designs that may be 30 years old right now. They just don't operate this way anymore, they don't use these things anymore –- a majority of the boilers don't use these things anymore.

MS. BROOK: Well, I think maybe that's the intent is that we're bringing up the floor here, that while your boilers and other boilers that you know of, that this isn't even an issue, but maybe there are some laggards out there that we would be improving if we had these requirements. Are you saying the problem is they are so prescriptive that there's no way even the best efficient boilers can comply with this?

MR. SMELCER: No, no. I'm saying this, I'm saying the intent is to improve the efficiency. How much do you want to improve it? We'll figure out how to get there. To use flue dampers, for instance, wouldn't be relevant to us, we'll go condensing, we don't need to have it prescribed to us or we'll be using somebody else's boiler to get there.

MS. BROOK: Okay, okay.

MR. SMELCER: Do you get where I'm going?

MS. BROOK: Yeah.

MR. SMELCER: But what is your gain you want to get? What does this interpret in the terms of improving efficiency, what that is, and that would be the voltage, and we'll --

MS. BROOK: No, that's an excellent comment. I think we've definitely heard that before, that some of our standards are overly prescriptive, and therefore constraining the market in ways that are inappropriate, so we appreciate –-

MR. SMELCER: Uh huh. You need more efficiency and we know we can get you there, we just need to know how much gain you want to get.

MS. BROOK: Okay, all right.

MR. SHIRAKH: That's a good comment, thank you. Jon.

MR. MCHUGH: I have a clarifying question. So, is your issue with the 02 trim control –- is your concern about that it spells out a term of art called "02 trim control?"

MR. SMELCER: Yes.

MR. MCHUGH: And so would you actually have a problem with a requirement that requires that you actually get a particular 02 target over the firing range and under different atmospheric conditions? Because the intent of this particular measure is that, depending on

humidity, air pressure, etc., you know, fixed type controls may not be producing the right mix of gas and air to hit the particular combustion efficiency targets associated with this particular control, but that if the requirement was that, over the full range, and over the various atmospheric conditions that you're able to hit this target, is that generic enough? Or are you saying that you actually don't want to be -- you don't want to see something that looks at combustion efficiency, but looks at the overall thermal efficiency of the boiler?

MR. SMELCER: Oh, we're always in favor of thermal efficiency, whether we actually put the water. What I can say is, if we play with those other numbers, the design of a boiler has gotten so precise these days that, when we're designing a burner, a particular burner, it's not nearly as flexible as the old days in the old atmospherics. We're doing powered burners, induced strap type burners, we're doing direct vent burners, and those just don't have the flexibility, especially on pre-mix burners, that can operate in the manner that we're describing. You just can't tweak them like that, they don't like to be tweaked. They run at a given sweet spot, and they run all day, but if you try to lean them out, they'll give you bad performance. If you try to rich them up, they give you bad performance. But they

will give you a great efficiency if you design for that. You have to use the burner, you're not as liberal in the burner as you can in other aspects of the boiler, but the burner, you can't tweak that CO_2 as evenly on a lot of the modern day burners these days. That, again, is something that is generally around atmospheric burners, and all of the other type of language that we've discussed here is with reference to atmospheric burners, and yes, they're quite flexible, you can do a lot of things to get where you want to go with the flue damper and the 02 control, and whatnot, but not in powered stuff.

MR. MCHUGH: So just to clarify a little bit, you're talking about atmospheric burners –- this here is all talking about forced draft boilers.

MR. SMELCER: Yes.

MR. MCHUGH: And the target is essentially the no greater than three percent 02 in the stack gas, and the question is, would it be appropriate to have a standard that actually sets an 02 limit across the firing range and across different atmospheric conditions?

MR. SMELCER: And I'm saying to you that I would not go there.

MR. MCHUGH: You would not go there, okay. You would focus just on thermal efficiency over the broad range of atmospheric conditions, and thermal efficiency

over the broad range of firing rates?

MR. SMELCER: Yes. It's far less –- I mean, it's far easier for us if you say, "All right, I need to improve the efficiency by X." You know, "I need to get there. Give me that." I can get there in a variety of ways, rather than having to take the steps that you've given me because I may not be able to achieve it through those steps. My boiler won't allow me to do that.

MR. MCHUGH: I see. And, again, you don't really have a problem with trying to hit a certain thermal efficiency at different firing rates, that's not a problem, it's you'd rather be lumped into thermal efficiency whether there's multiple points that thermal efficiency is measured and that sort of thing. Is that correct?

MR. SMELCER: I wouldn't say I wouldn't have a problem, that's not the proper choice of words, I would say it would be far less difficult. I would have work to do, but it would be far less difficult than having to go at it in the way that is being prescribed. We'll figure out how to get there, but it's going to be work, it's not going to be it just happens tomorrow, it's going to be work, but it would take me a long time to take the prescription here and try to go at it in that sense. At best, I'd have to redesign the whole boiler.

MR. MCHUGH: Okay, thank you very much. I now understand your issue, I appreciate that.

MS. BROOK: Okay, I don't think we need to go into detail on this proposal, it's part of the larger process boiler proposal, and that will be posted online. I think we have heard excellent comments on this already. Just to quickly walk through the appropriate slides, these are a similar set of assumptions for the energy analysis and also the installed costs, very similar to what we saw for the commercial boiler, as well as the maintenance cost assumptions. It does, at least in this analysis, look to be very cost-effective with a benefit cost ratio of almost two. And that's really all we have, unless somebody else wants to make comments.

STAFF: An online comment from Joe Wallace. He wanted to be included in the follow-up that Jim was supposed to get. In addition, he wanted to point out that there was a difference in process boilers and commercial boilers. In addition, I think that A.O. Smith would have a problem with any added, the changes to gas and air mixtures, also think that third party certifying body would have a problem with it, as well.

MS. BROOK: Okay, great. Thank you. So we will connect Joe with the communication that we have and Matt has with Jim.

MR. SMELCER: Who was that name, please? Would you repeat the name?

MS. BROOK: Joe Wallace.

MR. SMELCER: Joe Wallace.

MS. BROOK: Does he have a company?

MR. SMELCER: If you could get his name and information so that Matt could also --

MS. BROOK: Yes, we'll do our best to do that. Thank you.

MR. SMELCER: Uh huh, thank you.

MR. SHIRAKH: Okay, if there are no comments, we're going to move to solar water heating for restaurants.

MS. BROOK: All right, this is another proposal that was put together by the case team and do we have Nate online in case we need to answer detailed questions? We'll find out. So, this is a proposal to add solar water heating requirements to commercial restaurants. So the suggestion in the base code is to add a required solar fraction of 25 percent for restaurants 12,600 square-feet or larger and to introduce a restaurant hot water demand profile into the F chart or equivalent solar fraction calculator, and to update the compliance manual and compliance forms to provide guidance on this new measure.

The other suggestion is to introduce an hourly solar model and restaurant hot water demand profile and integrate it into our performance compliance software, the nonresidential alternative calculation method, and change it from an optional capability to a minimum capability. Energy savings and energy cost savings were modeled, the proposed standards case, using the TRNSYS solar calculation method used in active indirect Glycol with natural gas storage tank technology across all 16 climate zones, and compared it to a base case with no solar in the hot water system. And the detailed assumptions and formulas are in the case report, which should have been posted.

So this is just an explanation of the solar fraction and so it includes the energy delivered to the hot water load and the annual amount of energy used by the auxiliary water heater or backup element of the solar system, and it includes the parasitic energy in the calculation. So this explains how to get at the annual solar fraction using the solar -- I knew this yesterday, but I don’t know what the “R” stands for. Thank you, Solar Rating Council is the source for this annual solar fraction calculation. So this is hard to read, but it is in the case report, it basically shows that, in all of climate zone 1, this proposal for solar component to the

hot water system for commercial restaurants is cost-effective, so our proposed standard language is that all service water heating systems will comply with the applicable requirements of our hot water sections of the Code, and that service water heating systems providing hot water to restaurants that have a conditions floor space greater than 12,600-square-feet will have a passive reactive solar system complying with the freeze and overheat protection guidelines given by the Solar Rating Council and complying with either of the following options, either the solar system is sized to provide 25 percent of the energy for water heating, and if it uses a pump, the pump shall have an electronically commutated motor, or the active solar system has all of these prescriptive characteristics.

So the idea here is that you don’t have to go to a full performance compliance approach using our software, but you could do either one of these and meet our prescriptive requirements, either size it to meet 25 percent, or have the system be a glazed flat plate collector with an area of at least one square foot of collector per 50 square feet conditioned floor space, have the solar storage tank have an internal volume of at least one gallon per square foot and collector and insulated according to Section 113(C)(4) and the

collectors would have a Rating Council rating with a Y intercept no less than .706 and a slope no less than negative -.865 Btus per hour per square foot per degree Fahrenheit, and that the collector shall face within 35 degrees of due south and have it tilt angle of at least 14 degrees from the horizon. And that over 95 percent of the collector area will be unshaded for at least eight hours of the Equinox and pumps will have an ECM loader. So the idea here is to be very prescriptive, but not have to prove that you get a 25 percent solar fraction, or to basically meet it in a more performance-based and not meet all of these prescriptive requirements. And this would apply to every climate zone except for climate zone 1.

In the Nonresidential Compliance Manual, we would add information about this new measure, explaining what our new Code language would be, and how to comply with it, so this basically repeats the information that was, I mentioned, in the Code language. This is another recommendation for our Compliance Manual to help people do their solar water heating calculations using the Solar Rating Council methodology and it sounds like there's a calculator that is undefined at this point, unless you know of a solar calculator named XXXX.

On the compliance forms, we will need to add the

building area and the restaurant or dining categories and solar fractions to help with compliance for this new measure. And do we have any questions or comments? And do we have Nate on the phone, by any chance? Oh, okay, thanks, Nate.

MR. GABEL: Mike Gabel, Gabel Associates. So one question is do you guys have an idea of the magnitude of this 25 percent service hot water requirement in the performance approach? I mean, is it –- what percentage of TD Energy, roughly, are we talking about? A couple percent? Or --

MS. BROOK: I don’t know and I don’t know if you could tell -– I mean, I would have to look at the table of TDV saving and compare that to -– are you looking for just the portion of the water heating budget?

MR. GABEL: Well, no, actually just the idea of what kind of a tradeoff would be necessary to trade out of this thing and just try to get a feeling, so and some kind of a future report or summary of this information, that would be kind of useful, just as a quick table, a study to show what that magnitude is. The other thing I was thinking about as far as a trigger goes, there are some kind of buildings which use service hot water or process hot water loads that are equal or greater than restaurants, and I’m thinking certain kind of laundries,

or -- I'm wondering whether there is a trigger besides restaurants that you could put in there, a building that uses more than so many gallons per day per square foot, or something, if you're going to be using processed hot water, it would trigger the same requirement.

MS. BROOK: Yeah, so it's a process hot water requirement, not a restaurant requirement.

MR. GABEL: Yeah, I like the way generally because restaurant is simple, it's clear-cut, it is an occupancy-based, but to leave the door open to include other buildings that might meet the requirement. I don't know how you'd do that in the ACM, but you would have to figure out how the ACM would handle that, you know, sort of just logistically in terms of the inputs. If you don't select restaurant occupancy in the ACM, how does it know you've exceeded the process hot water requirement? Just little details like that, that you have to think through, so….

MS. BROOK: Okay, thank you. That's very good suggestions.

MR. HODGSON: Mike Hodgson, Con-Sol. Just a quick information question. I think Tako and Grumpus are the two solar pump manufacturers and I see ECM motors required. I haven't played with Tako and Grumpus in a long time and I don't know if they have ECM motors, maybe

your consultant knows that, but I'm just curious.

MS. BROOK: Okay.

MR. KEESEE: Mike Keesee from SMUD. Just to echo the comments of Mike Gabel, I think we would look at the same thing, other high water use buildings, maybe hotels, the other one, they have lots of flat roofs, some of them anyway.

MS. BROOK: Good, thanks. Okay, so we will definitely get back to you and help you understand the magnitude of this measure in regards to what would be needed to not do it in the performance approach, and also see if our analysis would support moving towards a process hot water requirement rather than a restaurant specific requirement. And then we'll also check to make sure that the dominant motor manufacturers would be able to provide ECM motors for this application. Anything else?

MR. SHIRAKH: I wonder if the roof area is going to become a problem with the requirements for this and skylights and future photovoltaics, with the fire issues, and so forth. Is that going to be a limitation?

MS. BROOK: Okay, I mean, I don't know that we have to have it on the roof, but I think that's a good point.

MR. MCGARAGHAN: Mike McGaraghan, Energy

Solutions. And that did come up in our stakeholder workshops and originally we had put together an analysis based on 30 collectors, or something, and the solar industry told us that that's really unrealistic for restaurant applications, so I believe the 25 percent solar fraction is only about six collectors and it was a big jump down to address the roof space issue.

MR. SHIRAKH: Thanks.

MR. KEESEE: Mike Keesee from SMUD. We didn't look at this specifically, but when Enrel did some work for us on zero energy commercial buildings, they used sort of a rule of thumb about 75 percent of the roof area.

MS. BROOK: Is available or not available?

MR. KEESEE: Available for solar, period, and then the rest would then be reserved for mechanical equipment or skylights. It does run into a problem when you get above two stories because then things start to -- the other part of it would be that, although it's very very limited now and we have very little experience in it, there is at least one product that I'm aware of that is a combined solar thermal PV product out there, I'm hoping to get some of it and take a look at it, and see how it really does. It comes with quite a pedigree, according to them, anyway, so I mean, that's another

place where we want to ask the industry to start looking at what to do, so that could be a good PIER project.

MR. SHIRAKH: Thanks, Mike.

MR. GABEL: Mike Gabel again. The reason I ask the question about the magnitude is I think where you have substantial cooling loads, I mean, we have a big TDV energy use in general, and I think this is not going to be that big a deal to overcome with the performance approach --

MS. BROOK: For water heating dominant --

MR. GABEL: I think if you have a low TDV energy building in a mild climate without much cooling, that the roof issue might possibly come into play, I don't think it's going to be a big issue, but that's the only place where I would look at it as being potentially a problem, as far as tradeoffs go.

MS. BROOK: Okay, okay. Any other issues with solar water heating for process loads?

MR. SHIRAKH: Anyone online? Okay, we'll move to the -- sorry, Cathy.

MS. CHAPPELL: Cathy Chappell, Heschong Mahone Group. We are also, as was presented before, we're working on the multi-family water heating, solar water heating, and there had been some discussion about also applying that to the analysis back to hotel/motels, and

so I was trying to confirm whether we had actually gone through and done that, but that might be incorporated into that case work, so it wouldn't need to be part of this, but we need to confirm and coordinate.

MS. BROOK: We need to make sure that they're consistent, right?

MS. CHAPPELL: Yes, exactly.

MS. BROOK: Okay.

MR. SHIRAKH: Any others? Okay, we'll move to the last topic of the day which is – this was a case project done by the IOUs and Taylor Engineering, Mark Hydeman, he's the author of this, he's not here, so I'll present it. This has been presented several times in the case holder meetings. So we'll talk about the current Code requirement 2008 which basically, you know, mostly they regulate either larger motors and the type of motors that we are considering under this initiative, which are the ones at the bottom; the permanent split capacitor PSCs and electronically commutated EC motors or brushed EC motors are not really regulated under the current Standards in 2008. The new energy policy in the conservation act requirements for small motor does not cover motors that are part – equipment that is covered under other efficiency requirements. So basically, if there is a device, an appliance that is regulated, then

it's covered by those regulations and it wouldn't be covered under the requirement that we're proposing today. For fractional motors below one horsepower, there's no California Standards except for series fan power and VAV boxes. And the Code language for that is repeated here, that's basically as Title 24 2008 Section 144(C) and it reads, basically it says, "Fan motors with series fan power one horsepower or less shall be EC Motors." Sorry, I can't read that when I have to read the screen behind me. So the requirement is motors that are less than one horsepower shall be EC motors and shall have minimum efficiency of 70 percent.

The other requirement is in Section 126 of the Standards, which is the refrigerated warehouse, which basically says that, for evaporators, the fan power operator using coolers and freezers have two requirements, it says single-phase fan motors that have less than one horsepower and less than 460 volts shall be EC motors. So it's very similar to the other one. So those are the only requirements in the existing Standards.

So there are two types of motors, there is electrically commuted motors and DC brushless motors with permanent magnet and rotors built in, they're both DC motors, and DC motors tend to be more efficient than AC

motors and they tend to be easier to control. They do have higher efficiencies which range from 65 to 85 percent. They do have drawbacks, though, they tend to have lower power factors, which is in the 40 to 60 percent range. And they also tend to have higher total harmonic distortion than the PSC motors. The PSC motor is the Permanent Split Capacitor Induction motor and efficiencies are extremely low in 12-45 percent range, again, you know, the range for the proposed motors is 65-80, much higher.

And this graph basically illustrates the difference between the PSC motor and this is the watts per CFM, this axle, and it clearly shows that the ECM motors are far superior in efficiency than the PSC motors.

And this graph pretty much demonstrates the same thing. Originally when we were developing this, we were thinking about limiting the size from one over 12 horsepower to one horsepower, but later on we had some discussions to remove the lower end and basically make this requirement applicable to all motors less than a horsepower, so this range is not very relevant anymore, but it does demonstrate the different efficiencies for EC motors, depending on the number of polls, the efficiency range is between -– it could be as high as 85 percent, or

as low as -– I think that's 70 percent if I'm reading it correctly, so much more efficient motors than the PSC.

This is some cost data that Mark collected from different sources and the other costs here are additional costs relative to the base case. And it actually holds fairly constant over the range of different motors, for instance, the three-quarter horsepower motor is about 170 for one-half, it's about 160 for a quarter, it's 130 and for one-eighth, for some reason, it goes back up, so maybe it's not a very common motor. And for a little bit larger motors, one and one half, it's about 185; for one-eighth, it is 185 again, this is from a different source, which is within the ballpark of what we had up here, and for a quarter, it is about 140, it was 130 up here, so I think that pretty much brackets the cost, gets the cost.

So for the preliminary analysis, he looked at two different cases, the case A is a direct drive with no balancing, which means basically no adjusting speed in the field. And for this case, there was no start-up costs, you basically put the motor in there as you always would, and the system would run, and in this case, the motor horsepower would be equal to the brake horsepower would be equal to the motor horsepower for the EC or the brushless EC. The difference between that scenario and the base case is that, here, you actually are required to

do some balancing to make sure that the speed controller works, and he added $100 additional cost because of this balancing that is required. And he assumes that he brake horsepower is equal to 80 percent of the motor horsepower.

Hard to read this one, but it's essentially -- this is the base case here and this is proposed A and proposed B, different motor sizes, this is 1/12, this is 1/8, and 1/4. And the costs are down here. And pretty much for 1/12 for proposed A, it's about $241.00, and for proposed B it's $341.00. For the 1/8 horsepower, pretty much the same thing. For 1/4, again, it's just a little bit less. So the costs are anywhere from about $182.00 to $340.00, depending on the size of the cost and which scenario.

This graph in this column, it's average cost, the PV value, Present Value Dollars per kilowatt hours, climate zones are here, and you know, the motor sizes are listed up here, and what these are, are the period, the life of the motor, if you will. And if it was five years, 10 years, or 15 years, how many hours the motor would have to run for this to be cost-effective. So if you're talking about a five-year period, for a given climate zone, let's take 12 as an example, the motor would have to run 2,354 hours for it to become cost-

effective. For a 10-year scenario, it would be $1,174, for 15 years, it would be 783 hours per year. And down below, there is the average hours for each lifetime and, again, it changes, goes down, the prices vary. So this one, this whole table was for no balancing, the next table is the same thing, except it adds $100 for the balancing so that the costs go up somewhat. But it still shows that it is very cost-effective, almost for all motors and for different lifetimes.

And I guess he concludes here that the EC motors and the brushless EC motor is cost-effective for systems greater than 1/12 horsepower that run during the normal occupied hours. Again, subsequent discussions with stakeholders basically demonstrated that it's even cost-effective for motors that are less than 1/12. Essentially, if any of these motors run for more than 2,500 hours a year, they're going to be cost-effective.

The analysis is somewhat conservative because he doesn't take any credit for reduced cooling energy and most systems and conditions are balanced, so that $100 that he assumes for the scenario B may not even be applicable because they already have to do this anyway. Title 24 reviews 15 year life for HVAC, so obviously the longer the life, the more cost-effective this becomes.

The parallel fan powered VAV boxes should be

exempt because they only work in a heating mode, not the cooling mode, so there will be an exemption for that. And, again, this is the difference between the series fan and the parallel fan and the main difference being that, for the series fans, it works in both cooling and heating mode, the parallel fan only works in the heating mode.

The EC motors have lower power factors and higher total harmonic distortion and PSC motors which is probably not a good thing, but the total current draw will still be less than PSC motors because of the much higher efficiency. And that's what the second bullet is describing because there is no electrical premium for EC motors as they have higher efficiency, so even though the power factor is lower, the total current drive is still less than the PSC and typically, if there is a power factor problem with the facilities, you know, they can be easily fixed with additional capacitors. And there is no transformer penalty for EC motors because this fraction of motors, they really don't contribute much to the total building load. Okay, Mike.

MR. MCGARAGHAN: Mike McGaraghan. On that last point, I just wanted to add that this research found that some EC motors have lower power factors and that some have comparable power factors, so the hard part was figuring out which for which, it was really hard to get

data from manufacturers about the power factors of their motors, so that could be another component of this project, or it could be applicable to Title 20 to actually test and list them so that everybody has that information, but not all EC powers necessarily have lower power factors, is my understanding.

MR. SHIRAKH: Thank you, Mike. So this is the actual proposed Code language, the underline and strikethrough is basically saying fractional HVAC motors for pumps and fans shall meet the following requirements, and the HVAC motors for pumps that are less than one horsepower shall be electrically commuted motors and have a minimum motor efficiency of 70 percent. So that's basically the Code language. There are two exceptions to that, motors and parallel fan powered terminal units because those work in heating mode only, and motors installed in space conditioning equipment certified under Section 111 or 112, so those would be the two exceptions. And he is deleting the definition for the series fan powered terminal units and adding a definition for parallel fan power terminal units. I'm kind of inclined to actually keep both definitions in there and I talked to John yesterday about this, so we'll probably keep both definitions. And he is also making a modification to Section 126, which is the refrigerated warehouses, and

the difference is here, that he is striking out the electric commuted motors and replacing it to meet the equipment efficiency of Section 144(C)(4), which is the section we just looked at, so instead of having requirements repeated here, he's just referring back to the other section. So that's it for that topic, unless there are any questions in the room or online.

MR. RICHTER: Yeah, this is Ira Richter from Heat Craft.

MR. SHIRAKH: Go ahead, please.

MR. RICHTER: Yeah, the comment was made about the power factors for PSC motors on the small horsepower were in the high 90's, close to 100 percent, and on the ECMs in the 50-55 percent.

MR. SHIRAKH: Right.

MR. RICHTER: But I do have a question about the low end of this, the 1/12 horsepower and lower. I don't know what efficiencies you used for these calculations, but on EC motors that are that small, there really isn't that much of a difference in efficiency between an ECM and a PSC motor, but there is a significant cost penalty and I just was curious what kind of efficiencies you used.

MR. SHIRAKH: Jon, do you know? The base case motor efficiency was 29 percent.

MR. RICHTER: Okay.

MR. SHIRAKH: And it was 69 percent for the EC motors.

MR. RICHTER: The EC motors on -– yeah, we're running around 70 percent and about 29 percent for shaded pole, but a PSC could push you all the way up to the mid-50's, and I'm just really wondering if you would consider keeping the 1/12 horsepower and put a prescriptive in there for a PSC motor. I'm just thinking it might be more cost-effective to take that approach.

MR. SHIRAKH: So for only 1/12th?

MR. RICHTER: 1/12th or lower.

MR. SHIRAKH: Okay. Your name was again?

MR. RICHTER: Ira Richter. Also take into consideration that the stakeholder meeting for the refrigerated warehouses is going to want reduced run time on those motors at off cycle, they're changing the wording on the exception.

MR. SHIRAKH: Okay.

MR. RICHTER: So that's going to affect the economic analysis, as well.

MR. SHIRAKH: Okay. Any other comments? There's a question in the audience. Ira, can you give us your phone number?

MR. RICHTER: Yeah, 770-465-5832.

MR. SHIRAKH: Thank you. Jon.

MR. MCHUGH: Hi Ira, this is Jon McHugh. The table that is shown here is for air-conditioning equipment, not refrigeration equipment, so what I think you'll find is, for the calculations here, you'll actually find lower hours of operation than in refrigeration equipment. The other issue is that, for the refrigeration industry, I know that there are differences between list prices and contractor prices, and what we've heard is that the incremental costs for the fairly small evaporator, the incremental cost for an EC motor on evaporator can be as low as 25 bucks for a $1/20^{th}$ horsepower motor. And my understanding is that this has to do with the transformation of the market associated with EC motor requirements in ISA and in Title 24, and so I was wondering if these kinds of costs actually match what your expectation is in terms of the cost to contractors.

MR. RICHTER: I can't speak for the contractor costs, but I think the $25.00 adder, especially between shaded pole and ECM is a bit low.

MR. SHIRAKH: Okay, thank you. Any other questions or comments? Online? Okay, that was the last topic of the day and, again, we're going to do this again on Tuesday at 9:00. It will be all mostly residential

topics plus the administrative stuff which is both Res and Nonres. So, thank you so much and we'll see you on Tuesday.

(Adjourned at 2:10 p.m.)

REPORTER'S CERTIFICATE

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 24th day of August, 2011.

Kent Odell

Kent Odell
CER**00548