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Pam Cole: Welcome, everyone. I am Pam Cole with the Pacific Northwest National Laboratory, and I'd like to welcome you to today's webinar on what you need to know about the New Energy Standard for Commercial Buildings: Standard 90.1-2016. We hold these webinars the second Thursday of every other month at the same time, so keep a watch out on the Building Energy Code's training page as topics get added.

And if you have any topic suggestions, we'd like you to send those into us. Please e-mail them in using the same mechanism that you received these webinar reminder messages. So the course today is an overview, and what's new in ASHRAE Standard 90.1-2016, talking about some of the addenda that's been incorporated, and some highlights of the Envelope, Mechanical, and Lighting in Appendix G.

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So the learning objectives of our webinar today, next slide, is we're going to provide an over of the major requirements of 90.1-2016. And some of the interests that might be of interest to engineers, designers, architects, and contractors, and even policymakers. You'll get a better understanding of the significant changes of the Envelope, Mechanical, Lighting Sections, the Performance Compliance Path sections of the standard 2016 versus what is in 2013 edition.

And also, we will provide insights to the appropriate applications of the major new requirements. And, finally, the last learning objectives to receive a better understanding of the design changes needed to meet these new requirements. So let me give a brief overview of the speakers that we have today.

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We have Drake Erbe with us from Airxchange Incorporated. He is the SSPC 90.1 Chair. We also have Dick Lord from United Technology Carrier Coordination. He's also an SSPC 90.1 Vice Chair. Eric Richman; he's with the Pacific Northwest National Laboratory, and he's also a 90.1 Lighting Subcommittee Chair. And then our last presenter today is Mike Rosenberg with Pacific Northwest National Laboratory, and a member of 90.1, the Envelope ECB Subcommittee. Thank you to all of our speakers for taking the time to participate in this webinar. This is gonna be a

great presentation. And I'm gonna hand it over to Drake Erbe to begin his part of the presentation. Thanks, Drake, and go ahead and take it away.

Drake Erbe: Thank you, Pam. Before I begin the actual presentation, I'd like to speak for the leadership of the 91 Committee.

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We want to thank the members, consultants, and ASHRAE staff that work tirelessly to approve and publish ANSI/ASHRAE/IES Standard 90.1-2016 in October. In addition, we would like to thank the Department of Energy Building Energy Codes program, and the Pacific Northwest National Laboratory for their tremendous assistance and support with this endeavor. As we move to the agenda, what you'll see here is that we normally go through in any overview, we go over the sections, and as Pam said, the Envelope, Mechanical, and Lighting and Building Performance.

In addition, I'm gonna go through some overview and objectives, and some results of the standard. And one section that is not usually addressed is Section Four, which is compliance, and that will be addressed in the final presentation. Next slide.

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The objective and goal of each version of the standard is through a consensus process, to create a standard that saves energy, and is technically feasible and cost effective. In addition, in the 2013 cycle, a strategic initiative was developed to look at the standard long range. And we look at the areas of ease of use. We looked at preparation for possibly moving to an interactive electronic environment. We certainly wanted to talk a little bit about the considering energy for the entire building because the focus on the mandatory requirements and the prescriptive requirements, it was getting a lot harder to get energy savings for.

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And then, finally, we wanted a better system for inclusion of climate data because ASHRAE Standard 169 was in revision at the time. And then there's always been consideration and pressure on moving towards performance methodologies within Standard 90.1 in terms of performance, tradeoff, as well as modeling. So what are the results? We've included over 120 addenda in this version. At the same time, we're making major format changes for ease of

use, as we mentioned, and we looked at how this weather data needed to be handled within the standard to get a direct alignment between 90.1 and the cognizant standard for weather data, which is ASHRAE Standard 169.

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We also – we're very happy to include an Appendix G Compliance Path. Appendix G has always been used to look at performance above the standard requirements, and has been adopted for other uses, such as LEED, et cetera. But, finally, we were able to create an Appendix G Compliance Path. And this new Performance Compliance Path, we believe is gonna be providing flexibility, surety, and an opportunity for innovation and creativity, leading to energy savings above that provided by the basic standard. And we believe it's an exciting move towards recognition assistance energy reduction possibilities for the industry and the standard.

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And also the determinations will be based on whole building energy instead of looking at just regulated loads. Moving to the format changes, we have now created a one-column format. We believe this is gonna be easier for easier reading. We believe it's gonna be easier to put in binders because there are more open white spaces. The corrections are clearly separated, indented, and set apart with a smaller font size. And the defined terms, we brought back the italicized of the defining terms. And we have also added an alternating coloring scheme for table rows and columns to show where there are groups, and better identify for grouping. Next slide.

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In the area of climate, there's a number of things that have gone on here. The system that we've created is a Reference Standard Reproduction Annex number one. It's located at the back of the standard. It has the information directly from AHSRAE Standard 169, Climatic Data for Building Design Standards. It includes climate zone information for the United States, Canada, and other international locations. And the point here is that we have identified, certainly, the 169 as the normative reference, but we've lifted a number of tables, maps, et cetera, and put them in this Reference Standard Reproduction Annex. This can be used for other standards references as well. Right now, currently, it's being used for 169.

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There is a new climate map, as you see in this slide. Approximately ten percent of the counties in the U.S. have changed weather zones. And what we had to do is we had to go through all of the weather-dependent tables and make sure that those were updated for the new weather information, and the splitting of Zone 1 into Zone 0 and 1; 0 being 0A and 0B for very hot and dry, and very hot and moist. And all of those tables then had to be basically reconstituted so that we made sure that all of the weather data for all of the sections, the Mechanical, Lighting, and Envelope, clearly identified these weather zones. And this material is now normatively cited in Section 5.1.4. Next slide.

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So now moving to the envelope, there's a lot of work been done in the area of fenestration, the prescriptive requirements in tables in 5.5.1 through 5.5.8. We reduced the U-factor for the northern zones by eight to 22 percent, and in the southern zones, zero to ten percent. The solar heat gain coefficient was reduced to 12 percent in the extremely hot zone 0, and five to ten percent in 4 and 5. There is a lot of looking at the orientation requirements. In this case for vertical fenestration, they were tightened based on climate zones. And provided the flexibility to comply using either the solar heat gain coefficient external shading, or window distribution.

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And if you look at the shading by the permanent projections in Section 5.5.4.4.1, it was modified because one of the things that needed to be looked at was how we were addressing north-facing fenestration orientation. And so now the table only applies to south, east, and west orientations, and the north is an average of the other orientations, as you can see in the graph. Next slide. There's a lot of work that has been done, and is continuing to be done in the area of metal buildings; walls, roofs, and doors, et cetera. And sections of Appendix A have been adjusted to reflect the new metal building wall requirements in 5.5.1 through 5.5.8. And, prescriptively, there have been some look at the personal doors and oversized garaged doors in those sections.

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And the section 5.5.5.4.5 has been modified to reflect that. There is ongoing work in this area for the next version. Looking at

infiltration, the maximum air leakage threshold values have been added for sectional garage doors. This is new for 2016. We've also added a whole building air leakage testing. Now, this testing is an option, in addition to the air barrier requirement. But if the whole building testing is not performed, then an air barrier design and installation verification program is required. Next slide.

A couple of additional items. In the last four cycles, there's been a significant reduction in loads due to the greater building envelope efficiency.

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And to align with that, the thresholds for conditioned space that are located in Table 3.2, which is in the definitions, have been lowered. And, finally, a new section 5.9 was added to the standard to increase delivered performance to verify the requirements of Section 5 are adequately met by inspecting and verification. So I'd like to hand this over to Dick Lord for the mechanical.

Dick Lord: All right. Thanks, Drake. Yeah, let's dive right into mechanical. So let's go to the next slide. So mechanical, we've done a lot of work in the last three years that included over 52 addenda. But in addition, a lot of things in the mechanical are date-sensitive, especially on a lot of the HVAC efficiency tables.

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So I'm gonna try and highlight some of those because some of those have come and passed, so they now go into effect. And we'll hit those, and just bring you up to speed. Primarily, what I want to do is go through Section 6, Section 7, and Section 10. Most of the changes are in Section 6. So let's go to the next slide. So one of the things we did, and this is really for all of the sections in 90.1. At the beginning of each section, there's a flow chart.

And a lot of those flow charts are out of data. One of the things we've tried to do is update those flow charts, and I've got this one in here. It's kind of highlighting there's now five compliance paths for mechanical ranging from the Simplified Approach, Prescriptive Path, Alternative Compliance, Energy Budget, and the new Appendix G, which Mike will cover.

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One of the sections that we really never have used much is Section 6.6. And there is one product in there now for datacenters with a PUE metric. Hopefully as we progress forward, we're gonna have more sections that use that alternative compliance path. But I just want to make you guys aware of what the various compliance paths are, and that we've updated those flow charts. Let's go to the next slide. So as Drake indicated, one of the things we did is we updated climate zones.

And what that did, that adjusted a lot of the weather data. And in general, most of the climate zones got a little bit warmer, so that changes some of the criteria. So I'm just kind of warning you guys, you know, don't go by memory, and say, well, I used to have to do this because I was in Climate Zone 3A. You might now be in Climate Zone 2A, you know, as you go through. So one of the things we did in the mechanical section, we went through and updated all the tables, primarily adding the climate zones 0A and 0B, and both those climate zones are outside the United States.

But if you do any work internationally, one of the things that we've done that's really nice to use is you can see the map down in the right-hand corner, which shows we now map the whole world, which has been very, very useful.

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What I've highlighted here, I won't go through each of these in detail. I just wanted to make you aware of what tables have changed, and where the requirements are. And you can see quite a few tables got impact by the climate zones, as we revised those. Let's go to the next slide. One of the important things that we tried to do in this update is, especially for mechanical equipment, there wasn't really specific requirements on replacement equipment. And that market is huge. It's 60-70 percent of, say, the rooftop market.

And in the past, you only had to meet the machinal efficiencies. Now, we're specifying a lot of the other prescriptive requirements, like economizers, fan efficiency, the new two-speed fan requirement, ventilation control. And you can see all the sections that are listed there. You should just take time and get familiar with those because it's important to consider when you're going into replacement equipment, there are some exceptions, too, that if it's a particular type of design, you may not have to do it.

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So take a close look at those, but you can kind of see the sections that were impacted by that. Let's go to the next slide. The other thing that happened is there's a lot of efficiency tables, you know, for mechanical equipment. They start at 6.8.1, and we now are up to the 16. Some of these changed; some of them didn't. So what I did is I put a little table in here just highlighting which ones have changed. We'll dive into a little bit of details on each of the ones that have changed. I won't cover the ones that haven't changed, and we have some new tables.

So you can see Table 1 changed. That's our unitary air-conditioning equipment. Table 2, which is the heat pumps. Table 3, which is chillers. That's date-specific one that went into effect. You can see down there on Table 7 on heat rejection equipment. Those are cooling towers. Go to the next slide. And then a lot of new requirements on VRF equipment, which is a growing segment in the U.S. You can see there's some new efficiency levels.

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These are date-specific, so I just wanted you to take a look at those. Some go into effect in 2017. Some in 2018. Under Table 11, which is computer room units, there's a whole bunch of new categories. We'll dive into that. And then we have three new tables, 14, 15, and 16, which cover pool dehumidifiers. And then two tables for DX-DOAS system, and then we'll dive into those in a little bit of detail. Next slide.

So Table 6.8.1 and 2. This involves our unitary air-conditioning equipment, and this is a little bit of a complex situation here. One of the things the industry has done is we've developed a new metric called IEER. That went into effect in the 2010 Standard replacing old IPLV. As we did the 2013 Standard, we raised the IEER levels because that's really where the energy savings are to be had. And they were supposed to go into effect on 1/1/16. In parallel with that because these – anything up through 760,000 is a federally covered product.

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That means DOE has to rule on those. So they did a rule making on them, and they didn't totally agree with the revisions that we changed. So we went into a negotiated rule making, which is kind of a new procedure the industry goes through. And, again, we

came up with an agreement, and I'll tell you in a minute what that is. But one of the things that DOE did is they said they're only allowed by federal law to have one primary metric, and it was EER. And as part of this rule making, they said they're gonna change their primary metric from EER to IEER, realizing that's where the really the energy savings and the future improvements are gonna occur.

So they did that. And then what we ended up doing is we came up with two levels. One level goes into effect on 1/1/2018, and that really is adopting the ASHRAE 90.1 efficiency levels that were in 2013. It became effective 1/1/2016. And then there is a second set of levels that are defined for 2023 that will go into effect on January 1 of that year, raising the IEER levels higher.

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In addition, there are some other changes to less than 65,000 3 phase that went into effect on January 1, 2015. But, again, DOE effectivity date is delayed two years in 2017. One of the things I want to make you aware of, and I'm not sure everybody is always familiar with federal requirements, preempt state, and local requirements. But there is a little clause that once DOE has approved ASHRAE 90.1 efficiency levels, it can be enacted in a state on just new production.

So that will occur in a few states, notably on January 1, 2017 in California, which has adopted the 1/1/2016 efficiency level. So a little bit complex, but I just want to make you guys aware that's what's going on. Show the next slide. So I put in here just as a reference. It's a little bit small, but a lot of times people have a hard time finding what's in the federal register.

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This is the agreement that we reached with DOE on the efficiency levels. So you can see the January 1, 2018 levels, and the January 1, 2023 levels, and then we actually have an agreement on what we're gonna do beyond 2023. So it's really actually helpful to the industry to know where we're going on this. Let's go to the next slide. So on chillers, on Table 6.8.1-3, chillers are not a federally-controlled product. One of the things that the chiller industry has done, they have actually two paths of compliance. We call it path A and path B.

In the 2013 standard, we expanded the path B. There was an effective date of 1/1/2015, which is now in the past. Because they're not federally-controlled products, these will go into effect when the state adopts them. Like, for example, I mentioned earlier, Title 24, they had adopted these levels so they will go into effect on 1/1/2015, and a few other states are starting to adopt these.

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And in parcel with that, too, AHRI has revised their standard. They changed the rating conditions a little bit. And here's one that you all should do, are gonna be doing the SI work. A lot of what the industry is doing now is going to hard metric ratings, so a lot of times the SI ratings are not a numerical transfer of the IP ratings. They actually are adjusted for difference in rating conditions, and that's the case with chillers. So one of the things we did in this standard under the IPLV, which is the kind of controlling metric for chillers these days. It's an integrated part load value.

So if it's based on IP ratings, it says IPLV.IP. If it's based on SI rating, it says IPLV.SI, so that you know which one it is. In addition, we've updated the K_{adj} adjust. I don't know if any of you do any of those corrections for centrifugals. That spreadsheet will be part of the user's manual. By next week, it'll be posted on the AHRI website if you want to download it. And we set it such that it covers from 2010, 2013, and 2016 standards. Let's go to the next slide.

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So on the next slide, I just show the chiller. And, you know, we don't – we tend to hate tables, but we often make mistakes on them. So we've got an Errata that we have to do on the chiller table. It had an effective date of before 1/1/2015 and after 1/1/2015. We eliminated the date, but we forgot to eliminate the columns, so that first path A and first path B that I've drawn the X through, ignore those. Those are really prior to 1/1/2015.

And then the two to the right are what's really effective 1/1/2015. And you can see the various levels. You can see the full load of metrics, the IPLV metrics, and the designation for IP. Let's go to the next slide. So Table 6.8-1-7, that's heat rejection equipment. One minor change to this table for propelled and axial fan, closed-circuit cooling towers used a lot on water-sourced heat pumps, and things like that. We've increased the efficiency level from a 14.0 gpm/hp to 16.1.

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So you can kind of see that in the table. Next slide. On VRF equipment; VRF equipment has adopted a lot of the requirements that are similar to rooftops. So they have an EER level and an IEER level. They also have SEER levels for less than 65,000. And you can see what happens on a lot of our tables now that – like we have a 12.9 IEER before 1/1/2017 that it jumps up to 14.6 beyond 1/1/2017. So you'll see those. And in some of the VRF tables, there's a couple of changes like that. I didn't put the whole table on. I just wanted to show you what some of these values are, and where the industry is going on those.

Go to the next slide. So computer room units, that industry is changing rapidly, as we all know. And one of the things that's common in that industry now is to raise the temperature in the computer rooms. So what that industry has done is they've come up with three classes of products; a class one, a class two, and a class three.

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And you can see the rating conditions: 75-degree, 85-degree, and 95-degree. So for each of those now classes, we've added minimum COP levels, and you can see those down in the table. That's just a partial picture of that table. And you can take a look at that. And if you wanted to understand more about the actual rating conditions, you can look AHRI 1360, which you can download from the AHRI website. Let's go to the next slide.

So a new table. Table 14. Indoor pool dehumidifiers. Brand new table. No requirements in the past. AHRI has developed a new standard called 920 that allows us to rate these products now. And they have a new metric that's quite new to a lot of us. It's what they call a moisture removal efficiency, MRE, and you can see there is the ratio of the moisture removed expressed in kilograms-per-hour to the total power input. So it's basically a degree of how efficient the unit is at removing moisture. And you can see the various levels down there at the bottom.

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Right now, they're all at 3.5 MRE. As the industry gets a certification program under its belt, these numbers will probably be revised in future version of 90.1. Next slide. So a brand-new table, and, you know, a lot of you are quite familiar with DOAS

equipment, which is being specified on all their buildings, and in some states has actually been made mandatory. The interesting thing, there was no efficiency requirements on it. So one of the things that the AHRI committee has done is they've developed a rating standard, and then they developed some metrics for efficiency.

And, again, you'll see this moisture removal, but they did a very interesting thing. They did an integrated seasonal moisture removal. So it's very much like an IEER, an IPLV, so it kind of represents the efficiency of that product of an annualized basis for a given standard building. And you can see the various efficiency levels down there at the bottom, and where they are on that.

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Now, there is actually two tables for this. There is one that includes energy recovery, and one without energy recovery. So it's kind of a hybrid system, something that we're starting to look at more and more. And you'll see Table 15 is without, and Table 16 is with the energy recovery. Let's go to the next slide. So one of the things, there's a lot of work that the committee has been doing controls. So one of the things they went after is hotel/motel guestrooms. They put some more prescriptive requirements on guestroom HVAC set point control, as well as guestroom ventilation control.

And you can see some of their criteria down there. I won't go all through all the details, but it's basically to raise your cooling set point, lower heating set point, and then shut off your ventilation. This means a lot of hotels will now have to have variable ventilation control, and dedicated outdoor systems that are capable of variable control. A lot of it based on controlling it from central control centers, and hotel locks and securities are rapidly changing.

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So a lot of that is very capable now, but you can still do the captive keycard as an alternative. And there are some exceptions to this. Take a look at that. Get familiar with it. But that's now one of the new requirements for hotel, motel guestrooms. Next slide. Another thing that we're trying to do, a lot of things that – you know, controls and smart buildings, and diagnostics are growing rapidly, you know, as the smart grid evolves. So one of the things we're trying to do is put in place, you know, monitoring where it's applicable.

So we went after large chilled water plant monitoring. Put some requirements in there for what you have to do, which chilled-water plant monitoring, which is becoming quite common, you'll notice there's a slight difference between water-cooled and air-cooled. And I was trying to keep them competitive so one wouldn't get penalized more than the other. But that's another area you want to get familiar with, and look at the metrics, and what has to be recorded, and where we go with some of that. And then in the future, that will help us with other things that we want to do in standard.

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Next slide. So one of the things this miscellaneous control options, you know, one of the things that we used to have a statement, a lot of controls had to be capable of, but then they didn't say they had to be configured to. So you'll see a lot of changes in the standard where we set – and not only have to be capable of, but it has to be configured for that requirement. You'll see that in there. So new requirements on chilled water and hot water temperature reset. You can see that in Section 6.5.4.4. And, you know, with a lot of systems with DDC control, you can now do that. Let's go to the next slide.

Another very important energy saver that has been in 90.1. We've been gradually decreasing the size where it's required, and the climate zones where it's required. And pretty much economizers are now required in anything over 54,000 in climate zone two and above. It's not required in climate zero and climate zone one.

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But one of the issues that the industry has had, and it was based on some very good work done by Title 24, that a lot of the economizers, when we check them in the field, we're not operating as much as 75 percent. So Title 24 did a lot of work in putting in diagnostics and fault detection. And what we've now done is added that to 90.1. It's actually in 90.1, the IEEC Standard, and Title 24. So it's pretty much an all-efficiency standard. You can see what's in there, you know, some diagnostics that frequently is available. Economizers are enabled. Compressors are enabled. And you can see those there.

And then some fault detection, like air temperature fault detection, not economizing what it should be economizing, and so on. You can see that down the list. But, you know, you can kind of see it's a

little hard to see that picture up in the right-hand corner is San Francisco. And, you know, an economizer in San Francisco can pretty much satisfy most of the cooling, especially when you do integrated economizers, which is that little blue wedge that you see there.

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Let's go to the next slide. Another important thing that we updated in the mechanical section is about return and relief fan. Once you start using an economizer, you're bringing a lot of excess air into the building, a lot more than ventilation. If you don't properly relieve that air, the building becomes pressurized. You get doors whistling, doors blowing open. So we put some requirements in there on a return and relief fan, that it has to be variable speed or at least four stages of capacity, what the energy savings are that you get when you reduce the speed of those fans.

And you can kind of see that, whether it'll be a propeller fan or a centrifugal fan. Those are now new requirements for relief fan control. Next slide. The other thing we did, this was an important thing that we did on the 2013 standard. You know, fan power is a huge energy draw on buildings, as much as 40 percent, a lot more than people think because the fan runs all the time for ventilation. So one of the things we capitalized on is, you know, varying the speed of fan. That's now quite easy to do.

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So we put a requirement in 2013 that basically said you have to have a minimum of two speeds of fan control that modulate down to 66 percent for a DX system; 66 percent so you don't freeze coils, and then 50 percent for chilled water coils. But those, you know, the fan laws. You know, power goes down to the cube of the speed, so the savings are significant, as much as 30 percent on some units. So when we implemented this, it was one of those date-specific ones you can see down there at the table. It went in as early as the 2013 Standard, and then a second phase on 1/1/2014, and then the final phase at 2016.

So those all are now in the past. So now you have to have two speed fans on all products that meet the criteria of greater than 65,000 for DX, and greater than ¼ hp for chilled-water, which is an important energy saver. Just to remind you, one thing that's important to consider when you do that is that it also requires two

minimum positions on an economizer because two speeds are also used in economizer mode, and required.

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We did some other changes on parallel-fan powered VAV terminals, basically control the fans, control of the dampers, and you can see those criteria there. Get familiar with those if you're doing VAV systems, and you can kind of see what the requirements are on there. Let's go to the next slide. We also did some additional requirements. You can see a lot of work on variable flow because inverters and variable speed are becoming very common. We used to have requirements on variable flow in there. We've now changed it.

Instead of being based on a ten-horse power motor, it's now based on, you know, more than three valves. And then we have a table that's climate zone-specific. And a lot of good work was actually done by PNNL to evaluate these, and come up with these metrics. So it just kind of tells you where you have to hydronic variable flow control. Next slide. Chilled-water coil selection. This is an interesting one that we did a lot of work looking at more of the system aspects. You're not just looking at the chiller, but looking at the chiller, plus the pump.

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You know, if you go to a 15-degree delta T on a chiller, you lose a little bit in performance, but you gain significantly in pumping power. So there's now a requirement that all chilled-water coils will have to be selected for at least a 15-degree delta T with a minimum of 57-degree leaving water temperature. And that there are some exceptions down there that you can see. So that's a new one that you may want to get familiar with, and kind of understand the requirements as you get into it. Let's go to the next slide.

Just on exhaust air energy recovery, you know, we've had that for quite a while on the standard. We keep expanding that because it's a great energy saver. We did a little bit of redefinition of the metrics in the recovery ratio. We changed that a little bit. I won't read through it in detail. You can read that as you guys get the slides. So there's a new definition for enthalpy and sensitive energy recovery ration. The metric is still 50 percent. We changed some of the exceptions a little bit to make it more applicable.

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And then we did a lot of clarification on the – there used to be an exemption that if you didn't get 75 percent of the return air back, you're exempt from energy recovery. So we've had a lot of clarification on preventing some of the obvious exemptions that people were getting from that to make it a little bit more restrictive. Go to the next slide. Slide 45. Just a quick update on the tables. We haven't changed the tables. Just to recall those that are not that familiar with it. We have two tables. One for less than fully occupied, and then a fully occupied 24/7 building in the lower table.

What we did is we changed a few of the really small values. We used to have a lot of those that were greater than zero, like in climate zone seven and eight. And we found out that there really wasn't a product available, so we did a little bit more work and put some limits on those, and you can see those highlighted in the green there. Next slide. We did some work on transfer air. You know, I'm not gonna get into a lot of details. You'll have to study. This is one. This is the one that will put some good examples in the user's manual, which we're working on now.

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Hope to have done middle of next year. But you can see, it kind of defines where you've got a lot of exhaust air in a kitchen, or a place like that, how you treat that air, and so you don't do excessive cooling and excessive heating on there. And you can see the requirements in there on 6.5.7.1, and then some of the exceptions you can see there. Next slide. So let's dive into Chapter 7. We'll go through this pretty quickly. This is basically our heating section, service water heating section. Again, the flow chart was updated. You can see the Appendix G added there. No other real changes to that, so it shows you the compliance path.

Go to Slide 49. One of the things we did in there, we added some additional requirements for circulated hot water systems that the first eight feet of branch piping needs to be insulated. That's to prevent a lot of needless wasted loss in heat. So we did some studies on that. And then Table 7.8 is the primary table for efficiency for water heating.

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A lot of those requirements are federally-controlled requirements. So what we did is we pulled those out of the standard, and then we put in an Informative Appendix that you'll see in the back, kind of a new procedure we're doing in the standard. And you can see the products that are covered by that listed below. Slide 50. Let's just jump to other equipment. Other equipment is primary motors. Again, we updated the flow chart, again, showing Appendix G as an optional compliance path.

Let's go on to Slide 52. Electric motors. A lot of electric motors have been under DOE rule, and they were updated in the CFR 431. We've taken all those just to help you guys find these numbers. We duplicate them in the standard. We have one small error in the standard, which I've noted there, that used to be the Table 1 to 200hp. We've now extended it to 500hp, so there will be a slight Errata coming out to correct that.

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And then the tables have expanded a lot to cover a lot of motors that weren't covered in the past, as well as further definition of what these motors are. And you can see some of those criteria there. And, you know, as you get a chance, you can get familiar with those. But if you go to Slide 53, you can see the new efficiency requirements in there. So these are brand new tables with mostly the efficiency levels going up. The same thing on the next slide on Slide 54. Class C & IEC H motors.

And then we also – DOE addressed small motors, which previously, in the past, wasn't addressed, and you can see the efficiency level for these motors in there. The last thing we did, and one of the things we've been addressing is trying to see what we could do with elevators. Elevators can be somewhere in the order of three to five percent in the energy used in buildings. So one of the things we want to do, there is a lot of work underway in some of the ISO standards on elevator efficiency.

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We're not gonna specify a minimum efficiency, but we are asking that in design documents, you now document the ISO class of one to six, or class A through G. And, you know, you can get familiar with this ISO standard. We put the reference down there, and you can Google that and find that standard and take a look at it. And

later on, we'll come back with some minimum efficiency requirement probably in 2019. So with that, I'll stop, and turn it over to Eric, and he'll now dive into lighting and power performance.

Eric Richman: Thanks, Dick. Next slide. I'd like to start right in looking at the review, and mostly highlighting the changes. Lighting Power Density Limits, which everyone is familiar with. These were revised for the 2016 version. They are always looked at for each change to the 90.1 Standard. This year, there was some additional work looking at the newer LED technology, which actually has been looked at the last couple of cycles. But in the previous cycle, the committee felt they weren't quite mature enough for this cycle to definitely work.

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And so you will see that for the space-by-space LPDs, that most all of them were reduced from the previous 2013 levels. If you take an average of all the reductions, it's about 26 percent, but of course that's an average of a whole bunch of different space types, about 100 of them. A few of the space types did go up, and this does happen periodically, mostly because of design criteria and current practice, IS light levels does go up or down. We tend to follow those. But that's usually the exception, not the rule. A majority of them went down.

Building area LPDS, which are based on those space type LPDs, virtually all were reduced as much as 34 percent for one of the higher ones. The overall reduction was only 12 percent from the 2013 allowances. Now, you might ask, well, building area reduced only by 12 percent. The space-by-space by 26, but the reality is that the building numbers are a mix of space types, and so they weren't necessarily following what the average is for individual spaces.

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So a couple of slides here on some background on the LPD values that always seems to be a question. Where do these come from? And since the early nineties, these have been developed using a system of models. They aren't just a number that's ratcheted down for some random reason. There's actually a model development process for it. They are developed within the 90.1 Lighting subcommittee with illuminating engineering society support.

They're generated from a series of space models. There are about a hundred, a little over a hundred of those models, most of which become – are used directly to develop the hundred or so space types in the standard itself. And these models have several inputs. They start with illuminating engineering society recommendations for light levels. They incorporate light loss factors. They incorporate current design practice, and lots of other inputs to these models. And these inputs are all reviewed each time we go through a cycle.

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The whole building LPDs are developed essentially directly from space types. What happens is there's a large dataset of very detailed room-by-room, space-by-space data for existing commercial buildings. The space-by-space LPD numbers are applied to that dataset, and made up with a weighted average for a building, and that becomes the LPD. So that's where those come from. Next slide. A little bit of information on LED, which is the current buzzword, has been for several years.

As we know, the energy codes do limit the installed lighting power for interior and exterior. But the energy codes do not specify or require certain technologies. In other words, codes don't typically – like they won't say, "You must use a certain technology to meet the requirements." That's not commonly done. However, as I've noted, the new 2016 90.1 standard does include LED efficacy as part of the mix in determining what the LPDs will be.

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And of course, LED has improved greatly in the last few years. Its efficacy is up there with great energy saving capability. The costs have come down, and the product maturity, which is very important, has gotten to the point where there's a lot of product out there so that it's easy to apply it to different applications. So for these reasons, LED were put into the mix for 2016. And just one other further note, there were a few cases where the LED production maybe weren't quite mature enough for all application in a space type. Maybe some, but not all.

So for the next version of standard, you will likely see a lot more LED in the mix, and the lighting power densities could reduce further because of that. So another part of lighting power density requirements are some allowances that have been put in the standard, again, since the nineties. One is for retail display. You're

allowed a base level for retail space. This doesn't allow you any lighting for display. But if you do have displays, you get some allowances.

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These have also been reduced, again, based on LED technology on an average of 25 percent. The categories, retail area one, two, three, and four are still the same. They're descriptions for standard throws, but the allowance you're given is less. And of course, these are use or lose it allowances. You can only use them for display lighting. The decorative allowance was also reduced by 25 percent.

If we go the exterior lighting prior density limits, those were also reduced. LED products are very amenable to exterior applications. They work well there. It's one of the first places the LED market went for. And so the reduction is an average of 30 percent across the board for all exterior applications because they're just good applications for LED products, and that made sense for their standard, which has a lot of energy savings.

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Next slide. We go onto controls. They are a major part of the lighting requirements. And the controls are based on a space-by-space criterion. In other words, each space as its own requirements. And each space either had a requirement for a control type, or is winded by a control type. The important point I want to make is that these are control functions. There is no requirement for a certain specific control. It says that each space must have these functions. You're on your own to determine how to do those. There are a lot products that meet those criteria.

So the functions that are available, not all are required everywhere, but the functions that are available include local on/off control, manual on restriction, meaning that in some spaces, the occupant needs to turn the lights on. They can't be automatically on. They're partial automatic on/partial automatic off requirements in some spaces based on, in a lot of cases, safety requirements, where you don't want the lights to go off 100 percent.

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You have some automatic full off requirements in some spaces; bi-level control. Scheduled automatic off is sometimes an option. And of course they're daylighting controls, again, based on when you

have daylight capability. And all of these are described in the standard. If we look at how those are represented, the last two versions of the standard have a tabular format for spaces, and these include in the first requirements column, the lighting power density.

You then have a – you'll see an RCR column. This is room cavity ratio, which is – some of it's been in the standard for several cycles. If you have a strange room with really weird geometry, you can sometimes get an allowance for additional wattage because it's hard to light the space because of its weird geometry. The rest of those columns are all space – are all of the control options. And for each space, you'll see very quickly what's required, and what you may have to add in. So if it says REQ, that means you're required to have that specific control in that column.

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The next two columns, for example, you'll see the examples say add one. That means you have to pick one of those two columns, and implement that control. Not both of them, just one. And then you'll see there is more requirements. At the very end, it'll say add two. That means you have to pick one of those two columns, and add that requirement. And this goes on for several pages with each of the spaces types. If we look, next slide, looking at one of the – what I think is a significant change is to the controls was a revision to the full-on/partial auto on restriction.

The issue has been in open office spaces. There's always been a requirement for either manual on or partial auto on. And for most smaller spaces, this works well, but in the open office plan where it's been tough to save energy because of people going in and out at different times, there are now been developed a lot of advanced control systems that work very well and save a lot of energy, but they don't work well with a partial auto on or a manual on requirement.

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So an expectation was put in there with limits to make sure that it's granular enough to save enough energy in 600-squaare feet per control zone. But this now allows those systems to be put in, which will save a lot of energy in that area. So moving onto next slide, we look at exterior lighting control, and there were some revisions here. There used to be a 30 percent reduction requirement for periods where there is no occupancy, or after business hours.

This was based primary on older technology, lighting ballasts that couldn't do better than this for the most part, or some restrictions because of technology that was used. But now with – most with LED advances, dimming is more continuous, control is more continuous, so this has changed to like 50 percent across the board, again, to save more energy.

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A new requirement, next slide, that's been added is for parking lot control. Occupancy sensing and occupancy-based control has always saved energy, but it's been a problem in parking lots because of high poles, large areas where the sensor wouldn't work. But the sensors have improved a lot, and so for the majority of parking lots, those with 24 feet or less poles. And if they have enough wattage to make it cost-effective, which is kind of termed to be 79 watts, you now must reduce your power by at least 50 percent when there is no occupancy detected in the area.

And it has a 15-minute delay limit on it, again, just to save energy. And, again, there's a requirement that most control only 1,500 watts per zone, again, to preserve that granularity. So that's a new requirement. Another new requirement is for dwelling lighting control. Historically, lighting in the dwelling unit has been exempt. And by dwelling unit, I mean the place where you live, your apartment, your condo, et cetera. That does not include common spaces in a high-rise building, such as hallways, lobbies, laundry room, exercise room, et cetera.

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The requirement, again just for dwelling units, is that 75 percent of those must have a high efficacy, either on the lamp basis, 55 lumens per watt, or on a fixture basis, 45. It's only 75 percent, and realizing there may be a few cases where this doesn't make any sense to have that kind of requirement. And there are some exceptions. If you have control of those lights, you don't have to have this efficacy.

Now, what that effectively means is that older incandescent won't comply with that. And even some lower efficacy CFLs won't comply with that. And to be clear, even some low efficacy LEDs won't company with that because there are some low efficacy LEDs out there. So it'll basically force you to put in 75 percent of them to be good efficacy CFL or LEDs. And this applies, of course, to only 90.1, which is four stories and above grade.

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It's only the dwelling unit, so all the other common spaces; hallways, lobby, et cetera, must comply with the requirements that we were just talking about in the rest of the spaces. So, next, we'll talk a little bit about alterations. There was some revisions here as well. Basically to add more control requirements, historically, when you did a revision, if you just changed the fixtures out, you just had to meet the LPD requirements, and only basic controls.

Now, there's more of a requirement that you have to also comply with the basic occupancy and scheduled partial off, bi-level switching type requirements. What's not included in that list, you'll see, is daylighting. That's a little more problematic. So those are not required when you're doing this type of retrofit. Exterior retrofits also must comply with similar shutoff requirements, where it's required for that space or application. Next slide. There are some additional requirements in alterations. There used to be a threshold. It was at ten percent. That's been relaxed a little bit to 20 percent.

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Realizing that if you're gonna require all of these controls, if you're only changing a few of those lights, it becomes problematic. But there's a huge tradeoff here. With those control requirements, you're gonna save a huge amount of energy, and so reducing these thresholds to 20 percent made a lot of sense. There's also an exemption here in that if you're only doing lamp plus ballast retrofits, in other words just gutting the fixture, and putting new lamps and ballasts, or replacing one-for-one fixtures without any other changes, you only need to comply with the LPD limits because you're not gonna necessarily mess with the control schemes.

Power requirements. Let's talk about those a little bit. Section 8 in the standard. A couple of really significant ones are dry transformer efficiency changes, which are done periodically. Those are always looked at. And these is also a change to the voltage drop efficiency requirement. Previously, this was done separately for feeder circuits and branch circuits, and there is a lot of concern about that over many years.

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So it's been combined into one requirement, just to five percent design load for a combined set of feeder and branch circuits. It makes things a little simpler. I'd also like to cover, the last slide here, just to review one of the more significant Chapter 8 requirements on receptacle control. Fifty percent of receptacles, standard 15 and 20 amp receptacles in these spaces only, and there's the list, must have occupancy-based control. It also applies to 25 percent of any branch circuits that are put in the building just for modular furniture.

It requires automatic control use, either scheduled, occupancy sensor, et cetera. And there are exceptions to this. This is a requirement that's there to try and get some efficiency or some shut off applied to receptacles. One key point there at that bottom is that plug-in type devices do not comply with this requirement.

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We've got lots of questions about that, but they do not comply. That covers it for lighting and electrical. I'd like to turn it over now to Mike Rosenberg to talk about Appendix G.

Mike Rosenberg: Okay. Thank you, Eric. Today, I'm gonna be talking about new things in Appendix G for 2016 in 90.1 First, from the backend, on a compliance and standard 90.1 through 2013 included two paths to compliance. Prescriptive compliance, which requires things like R values of insulation, lighting power density, EDR of air-conditioning equipment, et cetera. And then the performance method; the energy cost budget method in Chapter 11 of the standard. Using that methodology, we simulate a building of a proposed building design, and compared that baseline building design.

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And if the proposed building design has a lower energy cost than the baseline building design, the project complies. You do that using simulation tools like DOE2, Energy Plus, EQuest, Train Trace, et cetera. In addition to the energy cost budget performance path, there's a second performance path in Stannard 90.1. That's the Appendix G, the performance rating method. It's very similar to the energy cost budget, but it's more flexible. It also uses simulation to demonstrate that it's a proposed building design. It uses less energy than a baseline building design.

However, when you took 2016, and filtered it through the 2013 standard, it was not used for code compliance. Instead, it was only used for beyond code programs like USCDC's LEED, ASHRAE's Standard 189.1, the International Green Construction Code, Federal Energy Policy EPACT tax credits, and the Federal Energy Management Program used it as well.

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The energy cost budget uses what we like to call the dependent baseline. That means that the baseline matches the proposed building design to the greatest extent possible, with all the parameters back down to the prescriptive limits. So for example, the window area in the baseline design matches the proposed design up to the 40 percent limit. HVAC system type matches the proposed design with the prescriptive efficiencies.

HVAC systems size matches the proposed design. The orientation is set the same as the proposed design. The fan power matches the proposed design up to the prescriptive limits. Air tightness matches the proposed design, and use of thermal mass in the basslines does meet the same as the proposed building. So the impact of that is that ECB compliance path is not really prescribed in energy use. Instead, the energy use of your baseline building depends on the prescriptive options that you've chosen because it's dependent on your proposed design.

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So each combination that you choose can result in very different energy use. So, for example, if you had 100,000-square foot office building with 40 percent windows, and those windows were all aluminum frame. And you had packaged rooftop equipment, and all the components of that building met the prescriptive requirements, that would meet the energy cost budget requirements, and it would comply.

If you had a similar building, but with let's say only 25 percent windows, and those windows were wood frame, and you had a central plant with a water-cooled chiller, and all the components in that building just complied with the prescriptive path, it would also company with the energy cost budget. And the energy cost budget approach would not recognize the difference between these two building designs. It wouldn't recognize the fact that the second building design will use much less energy than the first building design.

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Appendix G is a little bit different, and it has a more independent baseline. So instead of setting all the parameters based only on the proposed building design, there is a standard practice in many instances. And that means that it allows credit for good design choices. So if you exceed standard design practice, even if that practice just meets the prescriptive requirement, your building performance reflects that. And here's some examples.

So the window area, instead of matching your proposed design, the bassline is set at standard practice based on each building ratio. For example, a large office building is – I think it's 40 percent window-to-wall ratio. A big box retail store is closer to 15 percent window-to-wall ratio. HVAC system type also set at standard practice based on building type and climate zone. For example, a very large office building over 150,000-square feet, I think, would use a water-cooled central plant, whereas a 50,000-square feet office building would use packaged rooftop equipment.

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HVAC system sizing, that's the standard practice as well in the baseline. I believe it's 20 percent oversizing for heating, and ten percent oversizing for cooling. Orientation, that's set in neutral. So what you're doing is you rotate the baseline four times, and you take the average energy use to get the baseline. Fan power, that's also set at standard practice. There's a certain number of horsepower for CFM of supply air. Air tightness set at standard practice. Use of thermal mass, same thing, set at standard practice.

That means if we look at those two buildings that we looked at before under the ECB approach, the Appendix G approach would recognize that the second building is using less energy than the first because these parameters are all fixed with the amount of window, the type of HVAC system, the type of window. So it recognizes that this design will use less energy than the first design.

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So we've got the energy cost budget method, and we've got Appendix G, the Standard 90.1. Each addition of the standard has both of those performance methods. And there are different programs and codes that reference version of those methods back all the way to 2004. I'm showing here, currently, we've got 16

states that reference the 2007 energy cost budget for compliance. There are 15 states that represent the 2010 energy cost budget, six state that represent the 2013 energy cost budget.

LEED 2009 references the 2007 energy cost budget. The current federal tax incentive program, that was recently renewed, references the 2007 energy Appendix G. LEED V.4 references the 2010 Appendix G. The Federal Energy Management program, federal buildings, reference 2013 Appendix G.

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The International Green Construction program references 2013 Appendix G. And Standard 189.1 references 2014 Appendix G. New York State code compliance recently approved 2013 Appendix G, plus the Appendix G supplement that was released halfway between the 2013 and 2016 version of Appendix G. So as you can see, that's a pretty confusing landscape.

It's possible if you have a building that you need to show compliance, need a performance path, and was going for the LEED incentive and a tax credit, you could potentially have to create three different baselines in their energy simulation. That is very expensive; confusing, takes a lot of time. And all those rules have such subtle differences, that it's very difficult for somebody to understand. It's difficult for people to quality control it.

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It just makes things very, very complicated. In addition, because that market is so diluted, people that made software, that developed software, can implement things like these bassline energy – the baseline energy model, don't really have as much of an incentive to do it because it's just not financial attractive. Did they make a software program that follows the rules of Appendix G 2007 with LEED using it, or did they make one that follows the rule of Appendix G 2013 with the supplement because New York State is using it.

So there is just not a lot of tools out there, and I think that's just one of the bigger reasons. Another issue is what I call the moving baseline. So we discussed that each time a new version of the standard comes out, a new version of Appendix G, and ECB come out, with each version of this standard, the prescriptive requirements get more stringent. As the performance path

traditionally have followed the prescriptive requirements, each new version of the performance path gets more stringent as well.

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So, for example, this shows LEED V.2.2 reference the version of Appendix G that had a bassline equivalent to 2004. LEED V.2009 has a baseline that referenced the 2007 Appendix G, so the energy use it a little bit different there. And the current LEED V.4, represents the 2010 Appendix G, and energy use lower. And so what that means is if you've got buildings that were constructed in different years, it is very hard to determine how their performance compares to each other.

So what's better, 40 percent below 90.1 2004, or 30 percent below 2007? It's not a very easy question to answer. So that's the landscape through 2013. So just let me summarize. There's two paths for compliance in 90.1, the prescriptive path of the energy cost budget.

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There's an additional performance path called Appendix G, the performance rating method used for beyond cod programs. The energy cost budget is dependent on the proposed design, which limits credits available. And Appendix G is more independent from the proposed design, and that allows increased credit for good design practices. Both of these performance paths change with new prescriptive requirements.

That is also in limited software, difficult, difficulties in learning and performing quality control on the models, and it becomes a very expensive process if you've gotta do more than one baseline building model. So things have changed in 90.1 in this regard, starting with 2016. The biggest change, the most important changes came through with Addendum BM. First of all, instead of having just the prescriptive and energy costs budget at the compliance path, Appendix G has now been approved as a compliance path.

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This the language from Section 4 that authorizes Appendix G to be used for the compliance path. You know, it tells you that can comply with either the prescriptive requirements. That's A, Section 11, energy cost budget, or c) Appendix G, performance rating

method. In order to comply with Appendix G, there is a new metric developed called a performance cost index, and it's specific to building type and climate zone.

And the formula for calculating that performance cost index is the proposed building performance, which is actually the purposed building energy cost, divided by the baseline building performance, or the baseline building energy cost. So that means that a performance cost index of one is equivalent to the baseline building performance, and a performance cost index of zero equals a zero-net energy building.

In order to show compliance, the performance cost index has to be less than the performance cost index target. And that target is developed specific for building type, climate zone, and the proportion of regulated to unregulated loads in your building.

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So here's the formula. The performance cost already equals the baseline building unregulated energy cost, plus the baseline, plus the building performance target times the baseline building regulated energy cost, divided by the baseline building performance. These two terms, the baseline unregulated energy cost, and the baseline building regulating cost, deal with the normalization for the proportion of regulated to unregulated loads.

The climate type, and the climate zone and building type is addressed by this table called the building performance factor. There is a different building performance factor for each building type and climate zone. And using that building performance factor in the equation that we looked at, at the last slide will give you a different performance cost index target for each building.

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Your second change with Appendix G in 2016 is that the baseline is now fixed. It's set at approximately the stringency of 2004, or the 2004 version standard of 90.1 The intent is that stringency of that baseline will not change with each new version of the code. Instead, the performance cost index change becomes more stringent. So each additional, each subsequent code, will reduce the performance cost index target and beyond code programs, and choose a performance cost index target for the current code to the extent that they feel comfortable with.

And, you know, as you can see as it progresses from the baseline, here we are 2010, 2016, down eventually, hopefully, to net zero performance cost target of zero. So the intent, the hope here is instead of the confusing landscape we looked at before, all of these programs, any building energy code, any beyond code program, any tax credit program…

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…can use the same performance path method, and just simply create their own performance cost index targets. So that means the same software could be used for all these programs, the same models can be used for all these programs. And that makes things simpler and cheaper. It's likely to be more accurate because people will become more familiar with the rules. People that review these models will understand the rules better because there will only be one set of rules that they have to deal with. So I think there's a lot of advantages here.

So I've mentioned already that Appendix G 2016 is a performance path in Standard 90.1-2016. It's also a performance path for compliance with the New York State energy code recently adopted. And, also, it's been added as a pilot credit for LEED V.4. This is the language from the LEED pilot credit. This is for the energy and atmospheric prerequisite. It tells you though the whole-building simulation that you need to demonstrate a reduction of five percent for new construction, or three percent for major renovations in the performance cost index…

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…below the performance cost index calculate through Section 4.2.1 or Standard 90.1 using Appendix G, but replacing the baseline – or the building performance factors in 90.1 with these building performance factors that are specific for me. So you can see one thing that's a little bit different from what LEED did and what 90.1 did, in in the Standard 90.1, as you remember, we created building performance factors by building type and climate zone.

LEED looked at the data, and decided that they only needed to create it by building type, so there is only a single building performance factor for each building type, not one specific for each climate zone. Okay, just the summary of changes in BM for 2016. Appendix G has now a third option for compliance.

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We've increased flexibility. It's intended to save time and money dedicated to energy modeling because the single model can be used for multiple purposes. Hopefully, it will encourage the creation of automated tools that simulate the baseline building, as there is a greater market need for those, and it provides credit for good design practice that was previously not recognized for code compliance. So that's it for Addendum BM, but that was not the only change in Appendix G for 2016.

Addendum K directs the modeler to use the default assemblies in Appendix A of 90.1 for building opaque envelope construction. So, for example, in climate zone five, you're asked to, in your baseline, simulate a steel frame wall with the U-factor of .55 for the baseline.

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You can go to Appendix A, and see here's the U-factor 0.55. It's a steel-framed wall, 2x4 deep steel studs, 16 inches on center. It's nominal four inch, but they're actually three and a half inches with R-10 rigid insulation, and R-13 batt insulation between the studs to match your construction, and it gives you the U-factor of .55 that the standard is asking for. Addendum Z.

This provides some detail on how the simulation of auxiliary heat in heat pumps should be modeled, and how that works in conjunction with the compressor in heat pumps. So it just really clarifies that not only does the strip heat need to be locked out, or the auxiliary needs to be locked out when the temperature is above 40 degrees…

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…also the air source heat pump has to continue to operate in conjunction with the rip heat even below 40 degrees, just until it's no longer able to keep up. But you don't shut the heat pump off at 40 degrees, and switch only to electric resistance heat. Addendum AA provides direction regarding when to model a heating-only system in Appendix G. In 2010, and previous to 2010, all spaces in building models had to be simulated as both heated and cooled. Beginning with 2010, we introduced the heating-only system, and this addendum clarifies when that heating-only system can be used. So it's when you have heating-only in your proposed building design, and it is for the type of spaces that typically are only

heated, such as storage rooms, stairwells, vestibules, electrical and mechanical rooms, restrooms that don't exhaust or transfer air from cooled zones.

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Those are the spaces that can be modeled with heating-only systems. And then Addendum AD clarifies when preheat coils should be used. So it specifies that preheat coils are used in systems five through eight. Those are the systems that are multizone reheat systems, VAV reheat systems. So there's a preheat coil, and that preheat coil needs to be simulated to a fixed set point of 20 degrees less than the design room temperature set point, heating set point. So it just really gives some quick – it adds some clarification, and fixes some loopholes that were in this section previously.

Addendum EK says baseline efficiency requirements for commercial refrigeration system. So there's a couple of new tables in here. The commercial refrigeration system. It gives you type of refrigeration systems, and it also gives you the energy use in kilowatt hours per day that each of these systems can use. So by having this for a baseline, it allows you to get credit for putting a better refrigeration system in your proposed building.

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Previous to this addendum, that was not available. In the similar vein, Addendum DW sets baseline efficiency requirements for elevators. So it gives you a formula for calculating the brake horsepower of the elevator motor based on the weight of the car, the rated load, et cetera. It tells you what sort of an elevator you have: hydraulic or traction depending on the height of the building. And it gives you efficiencies for mechanical and motor efficiencies for the motors as well.

So as with the refrigeration baseline, this allows credit for putting in an elevator that is beyond standard practice. And that's it for the major changes for Appendix G. I guess, now, I'm gonna turn it over, back over to Pam, and she's gonna go through some questions. So thank you very much.

[1:15:00]

Pam Cole: Thank you, Mike, and thank you to all our speakers today for such a very informative webinar. A couple of resources on the next

slide. Thank you to the Department of Energy, Energy Codes program, and a couple of refresher items that's out on their website. There is compliance software. Com-Check software shows compliance to commercial buildings. We do have technical support where you can submit question on the National Energy Codes, and support for software tools.

There are code notes available, specific code notes on specific code requirement provision for commercial and residential on the energy code. We have several publications, energy cost analysis that have been done for the states and so forth, so if you haven't spent any time out on the energy codes website, please do so. There's a lot of good information out there. there's also resource guides for architects, engineers, policymakers, and so forth.

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And then we do have a whole range of training materials. We have full slide decks that are available for trainers and just for information purposes that you can take, use, customize for your own being that are on the national codes. So they are on the versions of 90.1 and IECC for both commercial and residential, so that might be a good resource for you as well. And let's go to the next slide, and we'll talk a little bit about how you can get your certificate after I mention one more time to you, if you have training topic ideas, we want to hear from you.

Please give us your feedback. You can also provide feedback on the link that I'm going to provide on the next page here in a minute. But we want your ideas. This topic came about. This was a very interesting topic, and really good timing to provide this information on 90.1-2016, as this is the next standard that's coming out.

[1:17:00]

With that said, there's different avenues that you can submit your topic ideas. You can do it through the webinar reminder that you received. You can do it through our help desk, or you can send it to me directly. A couple of you e-mailed me already. And then I think let's open this up for some questions. We've received a lot of god questions today. And I am gonna start with Dick. And Dick, if you could go through some of the questions that you've received. You have a lot of good ones. And I'm gonna let you start with some of yours that you've received, and go ahead, Dick. I'll let you start.

Dick Lord: Yeah, sure. Yeah, one of the question that came in was about the user's manual, and where can they find it. We're in the process of developing that user's manual, and we hope to have it completed by the summer meeting. It's an aggressive goal. And one of our things we're trying to do, as Drake mentioned, you know, we not only reformatted the standard; we're trying to reformat the user's manual, and make it a lot more user friendly. So we're trying to put a lot more examples in there, and a lot of these questions are good questions that we'll factor into the user's manual.

[1:18:00]

So stay tuned for that, and we'll let you know when that comes out. I think it'll be a very useful tool. The other thing just to let you know in terms of other reference documents, there is also a red line version of ASHRAE 90.1 that compares it against the 2013 standard. You can get that from the ASHRAE site. So that's one question. Another question was that – one question I get a lot about the efficiency tables is whether they match the federal requirements.

It's a complicated question because some of the efficiency requirements are what we call federally-preempt, but some are not. But for example, chillers are not under federal control, but rooftops are. We go to great pains to make sure these tables do align, and generally, they do align. The only thing I'll warn you on is date-specific implementation dates, and that's kind of what I covered under the rooftop table is in 90.1, they go into effect a little earlier than they do under federal requirement.

[1:19:00]

But in general, we did a lot of this standard to make sure they harmonize, and we actually referenced the federal standard in some cases, where they have primary control over them. The next question was what is IEER? The IEER is actually kind of a new metric that we developed for rooftops. It came about in 2010. It's basically a weighted average of the performance of the mechanical pulling of the equipment, basically at 100 percent, 75, 50, and 25 percent load with a scheduled ambient.

It's kind of related to highway and city miles per gallon. It's a metric that allows you to compare units. We feel, and I think DOE feels the same. It's a better metric to really measure the efficiency of a rooftop because they seldom, if ever, run at full load, which is our primary metric is. And a lot of the HRI sections are now

starting to evolve to metrics like this, whether we call it IEER or IPLD, that's where we're going. We are planning some further improvements on this to look at more ventilation load, look at can we include economizers, can we include it in heating.

[1:20:00]

So those will be future things that we're looking at. So I'll stop there with those three questions.

Pam Cole: Thanks, Dick. Eric, under lighting, there was one question that came in, and it refers to on lighting controls. "Is lighting control commissioning required, or will it be in the future?"

Eric Richman: Thanks, Pam. Yes, good question. I didn't touch on that. There were a few minor changes to that for the 2016, but they were mostly clarification. We don't call it commissioning; we call it functional testing for various reasons. But there is a relatively large functional testing section for controls in the lighting section. And it basically looks at the common controls, occupancy sensors, daylight sensors, and specifies what has to be checked to verify that they are working correctly. And there are actually some step-by-step instructions in there.

[1:21:00]

So it's fairly detailed. And, yes, those in there with the recognition that that's a very, very important part of making sure that you get the energy savings for controls.

Pam Cole: Okay. Great. Mike, let's switch back over to you. There was quite a few questions on your topic. I'll start with the first one. "How do we know, or how do we show standard practice under Appendix G?"

Mike Rosenberg: So there's a standard practice that I refer to, it is in the actual ruleset of the manual. So the baseline building description is the standard practice that I'm referring to. So, for instance, the baseline building, we talked about this for a large office building over 150,000-square feet has a 40 percent window, and it has a VAV system with a water-cooled chiller and a boiler. So that's the standard practice.

[1:22:00]

It is set – it is described in Appendix G, itself. Now, there are some instances for underregulated loads, where – not for compliance with the code, but if you're going for beyond code programs, you are allowed to show that you're exceeding standard practice on what we call unregulated loads with the permission of the rating authority.

So, for instance, if you're doing a LEED project, and you've got some sort of a process in your building, and you've developed a better process that uses less energy, if you can demonstrate that to the rating authority, is the term we use, LEED if it's – USGBC if it's a LEED project, then you can get credit for that. But those credits for beyond – for unregulated loads are not available when using Appendix G for compliance.

[1:23:00]

Pam Cole: Okay. Great. Another question on Appendix G. "Appendix G seems to be somewhat redundant as compliance paths, as Appendix G being superior for effectiveness and application. Will the energy codes budget be phased out in future additions, or is it here to stay?"

Mike Rosenberg: Well, it's hard to really answer that because changes like that come about from proposals from committee members, and proposal from the public. I think that the SSPC 90.1, when we introduced Appendix G as a compliance path, we felt that in no way we were ready to eliminate the ECB compliance path. There were certain things that ECB works better for at this point, particularly existing building retrofits would have a hard time complying using the Appendix G path, and might necessitate using ECB.

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So I can't tell you what will happen in the future. Maybe they'll meld together into one, some parts of each of them will come together. You know, maybe it will be two separate performances as for the long-term. I can't really tell you for sure.

Pam Cole: Okay. Great. Another question was – two more questions kind of came in on commissioning, and so maybe we touch a little bit more on commissioning. And one was on: "Is building envelope commissioning required now?" And maybe that's something for Dick to touch on, if you want to maybe try to take that. There's

actually two questions on commissioning. The other one is any plans in the future to include anti-certification requirements for commissioning. Do one of you want to touch on those two commissioning questions?

[1:25:00]

Drake Erbe: I can do that. This is Drake. We have an active workgroup commissioned by the SSPC on commissioning. And we're going to – we're talking a very hard look at all the requirements possible for commissioning, and will be addressing that hopefully in the 2019 standard.

Pam Cole: Okay. Another question. "How to handle unregulated loads in models?" And I think this refers to you, Mike, because this can have a huge impact on building performance. So, again, how to handle unregulated loads in the models.

[1:26:00]

Mike Rosenberg: When you say handle them, I'm assuming the question there is wanting to know how to quantify them. Typically, there are end use meters in energy modeling programs that allow you to get the energy use of different systems in your building, including subzones, including HVAC, fans, lighting. So that can typically – the unregulated loads can typically come from the metered end use. There is just a number of different ways to do it depending on what kind of simulation program you're using.

But if it's metered separately, that's the easiest way. That's the way I would I do it. But also getting annual loads for most simulation programs would be the way that I would do that. Now, the question is about how are they handled between the two models, the baseline of both building and simulation.

[1:27:00]

In general, they're held the same if they're unregulated, except as I discussed in the previous question, if you can demonstrate to the rating authority that you've gone beyond standard practice, then they give you permission to model them differently for beyond program credit.

Pam Cole: Okay. Great.

Mike Rosenberg: Hopefully, I covered the question. I'm not positive that was it, but I think so.

Pam Cole: It was a little generic. That's great. Another question; Michael, I'll let you answer this one. "Are there any future cost benefit analysis to 90.1-2016 compared to the prior standards for different building types? Is there anything gonna happen with cost benefit analysis?"

Mike Rosenberg: Yes, there is. So typically with each new addition of Standard 90.1, GNNL for DOE does a cost-effective misanalysis of the new version of the standard.

[1:28:00]

And we do a general cost-effectiveness, and then also issue state-specific reports. So right now, there's out there, if you go to the BECP website, you can find that cost effectiveness analysis for the 2013 standard, and you can find cost-effectiveness individual results for each state. Rose or someone else might have something to add to that, but…

Pam Cole: No, that's great.

Mike Rosenberg: …there is a lot of information on there. Okay.

Pam Cole: Another one. "You had mentioned envelope testing was an option, can you touch on that a little bit more?" When you mentioned the envelope testing was an option, do you remember that? If not..

Mike Rosenberg: I think that's Drake, right?

Pam Cole: Is it? Actually, no, but that's okay. I'm gonna go to the next question.

[1:29:00]

"Is there any software for use for the revised Appendix G right now, and if so, where would it be available? Could you please state where it's available, and if not, if you know of someone who might be developing such software to Appendix G?"

Male: Yeah, so I don't think there is any that is available right now. As I mentioned, there is not a lot that was available for older versions either. There are several efforts that I've heard of people putting efforts into software development. At PNNL, we've developed a ruleset manual, which is sort of like a specification that software

developers could use to implement the 2010 version of appendix G. And that's completed, and we're working on the 2016 version, so that effort is ongoing. There is some work on what's called an open studio measure to automate the Appendix G 2016 baseline, work going on there.

[1:30:00]

And I think there are some other software developers. I don't want to commit any of them to it, so I won't spread the rumors. But I have heard of other efforts in this area as well. So the feedback we've gotten from software developers is that they're very excited about it. It really makes things much more straightforward for them.

Pam Cole: Okay. Great. Eric, I have a question for you. "You mentioned an exception for daylight responsive controls and alternations in the 2016 standard. Are daylight responsive controls required in alterations in 90.1-2013 Standard?"

Eric Richman: No, in the previous version, 2013, the control requirements were even less. There was just like nighttime afterhours cutoff. For 2016, we've added more during the day kind of control requirements, but daylighting is still not required for alternations projects…

[1:31:00]

…unless, however, you're changing the control system. So if you're only changing the fixtures, you have to comply with the LPD, and some controls, but not daylighting. If you are gonna yank out all your controls and start over, if you're changing the controls, then you would have to upgrade to daylighting if your space has that capability. But in general, no, it's not required.

Pam Cole: Okay. Great. I'm gonna circle back to the commissioning just so we're clear because I was asked again if we could clarify. "Is envelope commissioning required now in the standard?"

Mike Rosenberg: No. The Section 5.9 is a brand-new section to increase, you know, the delivered performance by inspecting verifying that the requirements of Section 5 are met, but not for the full building, for all of the various pieces and parts.

[1:32:00]

Pam Cole: Great. Thank you. Can one of you touch on, expand upon, envelope testing versus the air barrier path?

Eric Richman: Yeah, it's a whole building air leakage test. This has been added. And now you have two paths, basically, a whole building air leakage test and the air barrier. Air barrier was already in the standard, and this has been added as a compliance option. If you don't perform the whole building test, then you're going to have to do the air barrier design and installation verification.

[1:33:00]

Pam Cole: Okay. Great. A generic question, and maybe this kind of goes back to somewhat of the user's manual. "Is there a plan to produce these new standards in a more user-friendly format, such as a smartphone app, or Excel worksheets, or et cetera?"

Mike Rosenberg: I think I better handle that one. *[Laughter]*. This standard is a very large standard. *[Laughter]*. And while you might be able to do pieces and parts of that, I don't think the entire standard, at this time, can be condensed into an app. However, there is a lot of thinking going into how we might do this electronically and interactively. And the only thing I can say that is stay tuned.

[1:34:00]

Pam Cole: Well, I think that we received a lot of good questions. Some are related to training and continuing education credits. And it looks like we're gonna be able to end this webinar a little early. We do appreciate that everyone has attended this webinar today. And I'd like to thank our speakers yet again. This was a great webinar, very informative. And at this time, I think, all attendees, we're done a little bit early, which is great. Thank you for participating today, and thank you from U.S. Department of Energy, Building and Energy Codes Program for bringing us such a great webinar. And all of you can now disconnect.

[End of audio]