

Rose: Welcome, everyone. I'm Rose Marie Bartlett with the Pacific Northwest National Laboratory, and I'd like to welcome you to today's event, Performance-Based Compliance Documentation for ASHRAE 90.1 Section 11 and Appendix G. Our speakers, today, are Maria Karpman and Christina LaPerle of Karpman Consulting. Welcome to our speakers, and welcome to all of you. Maria, take it away.

Maria Karpman: So, good morning, everyone, or good day, depending on where you are. So, here is our agenda for today; it's a two-hour training. We are gonna start with a review of the general reporting requirements of 90.1, then I'm gonna pass it on to Christina, and she will talk about general layout of the compliance form. And then, she'll go over the key input areas, she'll demonstrate instructions, dashboard, tabs where contact information and general information about the project is entered, such as project location, building type, and so forth, a tab where you enter different energy types used in the project. And then, she'll go over some of the key data input tabs where it would _____ information about lighting systems, envelope, and air-side HVAC.

And then, towards the end, we'll demonstrate how simulation results are captured in the compliance form, and how compliance calculations are performed, and also will talk about a submittal checklist that helps both _____ _____ to make sure that all necessary documentation is submitted. So, as Rose has mentioned throughout this training, please, type your questions into the chat, and then, at the end, we reserve 20 minutes to answer your questions.

So, the training format includes PowerPoint presentations, so again, as Rose mentioned, the slides are available _____ _____ at DOE website. We will also have, throughout the training, demonstrations on how to fill out the compliance form. So, for each building system, for each type of input, we'll discuss what kind of information is available for you on the design documents, what are the related reporting requirements of 90.1 Section 11 Appendix G, and then there will be demonstrations showing how to capture this information in the compliance form. So, compliance form covers both Section 11 and Appendix G, but we'll only have two hours, today, to talk about it, so, we will focus on 90.1 Appendix G documentation. But really, documentation for Section 11 is very similar to that.

So, this diagram is taken from Standard 90.1; it's shown the top of Section 4 of the standard, and it shows, at a glance, different

requirements that projects have to meet in order to document compliance with 90.1, and different compliance options available within 90.1. Some of you may be familiar with COMcheck. So, COMcheck is a tool that is developed and maintained with funding from Department of Energy. So, COMcheck is used to document compliance with prescriptive requirements of 90.1. So, up until now, there was no standardized reporting format to document _____ reporting requirements of Section 11 and Appendix G. So, different jurisdictions _____ programs that adopted this modeling protocol had to put together their own forms.

So, now, this form that we'll be talking about today was developed, again, from DOE and PNNL, so, the form meets requirements of Section 11 and Appendix G. And this form is the focus of today's training.

So, just a quick reminder of the general concept of performance-based compliance with 90.1. Two models have to be developed. The first model is the model of the proposed design that, generally speaking, reflects building systems and components that are specified. The second model is model of a virtual building, and the performance of this virtual building serves as a point of reference for evaluating performance of the proposed design. So, the relative energy consumption of these two models determine whether the project complies with code, or these models can also be used to determine the margin of improvement beyond code. So, the rules of how these two models are developed differ between Section 11 Appendix G, but this is the general concept that applies to both, that there are two models _____ develop.

so, these models are developed using the same simulation tool, the same weather file, and the same utility rates. And there are multiple simulation programs that can be used to develop these two models, and the simulation tool requirements are included within Section 11 and Appendix G. So, any software that meets these requirements can be used for modeling.

So, a quick overview of the compliance form that we will be talking about, today. So, it supports 90.1 2016 and 2019 editions of Section 11 and Appendix G. So, Christina will show you there is a list box within the form where you see the edition of the standard, and whether it's Section 11 or Appendix G path. The form is posted at DOE Building Energy Codes Program website. DOE intends to fund maintenance and development _____ fund maintenance of the compliance form, if there are any bugs that are reported, and also, to add new features. And DOE also intends to

fund customized versions of the compliance form, similar to how it funds development of state-specific versions of COMcheck, for example, when states modify 90.1 requirements based on state-specific amendments.

So, the compliance form is in Excel format; it helps establish the necessary modeling inputs. It has many built-in code lookups and calculators, so, for example, it helps determine what the baseline _____ construction or baseline lighting should be for the given proposed design. So, it simplifies _____ work in terms of having to go back to 90.1 requirements, to figure out what should be modeled. We worked with vendors of popular simulation tools, to allow importing simulation results from standard output reports generated by these tools into the compliance form. So, currently, DesignBuilder, EnergyPlus, eQuest, Trane TRACE, and OpenStudio are supported. And then, the compliance form also automates compliance calculations, because especially with the new Appendix G, establishing compliance based on simulation results is no longer as straightforward as just comparing energy cost of the baseline proposed design.

There is certain calculation that should be followed, that is sometimes misinterpreted, so, compliance form automates that. And there are a number of improvements that are already planned for the compliance form, so, there will be new versions posted, periodically, on DOE website. Some of the planned enhancements include adding quality control check step that will facilitate _____ and flag simulation inputs and outputs, within the compliance form, that appear to be inconsistent with 90.1 requirements. There are also plans to expand data import and data export capabilities of the compliance form. So, as I mentioned, for now, just importing of the simulation results from certain modeling programs is supported.

And then, another planned enhancement is addition of reports, including compliance reports that may be printed on drawings, and also, reports that will facilitate site inspections. For example, when a site inspection goes to the site, they don't necessarily want to see or interested in the parameters of the baseline model, at this point, only that configuration of the proposed design matters, and that's what needs to be inspected.

So, there are often questions and even debates concerning level of detail that must be captured in the compliance form. So, this is prescribed in standard 90.1, so it's not up to us to decide what level of details is required. So, I copied, here on the slide, the relevant

sections of Appendix G and Section 11 that describe reporting requirements, and the takeaway is that these requirements are very extensive. And here are the key highlights of what needs to be reported following this section of 90.1. So, first of all, all the features that differ between the baseline proposed design must be identified, aspects of the proposed design that improve over prescriptive requirements, or less prescriptive than prescriptive requirements.

And I highlighted prescriptive requirements in red, here, because with Appendix G, prescriptive requirements are not part of the baseline model, so they're not really affect the simulation. So, even though they are typically not captured in the simulation tool, not affect simulation results, still, the _____ between the proposed design and prescriptive requirements need to be reported. Another very important reporting requirement is demonstrating that proposed design meets _____ requirements of 90.1, so, again, this is not something that effects simulation, but it has to be demonstrated to code official. In addition, compliance forms should include energy consumption by end use for the proposed design and the baseline, and end uses include heating, cooling, lighting, service water heating, fans, pumps, so, key systems and components that consume energy in the building.

So then, also, energy cost has to be reported for the proposed design relative to the baseline. And last but not least, submittal must include backup calculations, demonstrating how the modeling inputs were generated based on design documents.

So, the current documentation process involves design team putting together project documentation, including drawing specifications, _____ modeler performing supporting calculations based on this documentation, to come up with simulation to inputs. Then, the modeler, again, enters the information per simulation tool, and, lastly, fills out the compliance and documentation. So, this is the current process. So, the improvement that the new compliance form brings to the table is that it incorporates both the supporting calculations and reporting _____ _____. So, modeler fills out the compliance form with information from design documents, to calculate inputs that would be used for the model, then enters this information in the modeling tool, and then, once simulations are completed, the simulation results for modeling tool can be reported back into the compliance form.

So, design documents includes drawings, specifications, and _____ this information requires significant processing, you know, before

it can be entered into the compliance form. You know, for example, for lighting, design documents include lighting plans that show different fixtures specified for each space, and also, lighting schedules that describe wattage of each fixture. So, this information has to be converted into lighting power density for input into simulation tool. So, compliance form helps calculate simulation inputs for the proposed design model, such as my example with calculating lighting power density based on fixture counts and fixture wattage. It populates simulation inputs for the baseline model, such as lighting power density that should be modeled for each space or HVACs in the baseline.

And then, it also auto-populates prescriptive requirements that apply to the proposed design, which is one of the reporting requirements of 90.1 Appendix G. So, model then transfers information from the compliance form into simulation tool, and performs the simulation, and when simulation is completed, the simulation results are imported back into the compliance form that also performs compliance calculations to determine whether project passes or fails code.

So, this slide shows how compliance form is organized, so, each grey box within compliance form rectangle corresponds to individual tab in the compliance form. So, modeler and design team would fill out the information on individual tabs, sequentially, so again, for greatest efficiency, the compliance form should be filled out before modeling is done, because it helps generate modeling inputs. Then, the information is entered into building energy modeling tool, and some of their simulation results are then brought back into the compliance form. For example, based on 90.1 Appendix G rules, the baseline HVAC system efficiency depends on its capacity, and capacity is established by running baseline model. So, that's why there is this arrow going from building simulation to the baseline or budget HVAC box, or when simulation is performed and capacity of each baseline system is determined, it would be entered into the appropriate tab of the compliance form.

But you can see that, mostly, the import from building energy modeling tool is limited to simulation results. So, which are brought into compliance form by copying just standard simulation reports coming out of the tool into the dedicated tab within the compliance form. And Christina will demonstrate to you how that's done. So, in the training, today, we are gonna go over just several of the tabs, and even the tabs that we'll go through will just cover some of the functionality within these tabs. So, we're gonna go

over contact information, general project information, energy sources, and then, envelope, lighting, HVAC tab, and compliance calculations group of tabs.

And with that, I am gonna pass it on to Christina.

Christina LaPerle: Thank you, Maria, for that overview. Can you hear me?

Maria Karpman: Yeah, yeah, and we can see your screen.

Christina LaPerle: Perfect, great. Hello, everyone. Thanks for joining us, today. We're just gonna dive right in and get started with the general features and the layout of the compliance form. *[Audio cuts out]* blue tabs, which are informative tabs, and they don't require input from the design documents or from model output reports. They're also tabs that, they don't do any *[audio cuts out]* calculations of model inputs. The beige-colored tabs, those are tabs for modeler and/or design theme inputs, and they generate baseline and proposed model inputs. Then we have our bright-green tabs, and those are for importing model output reports, and for doing some automated compliance calculations. And lastly, we have tabs with checklists. As of right now, the compliance form has a submittal checklist tab, to make sure that you are meeting all of the reporting requirements of 90.1, and we'll go over that tab in more detail, later on in the training.

Okay, so, the default setting for the compliance form is to not show the formula bar or the headings. So, the headings are, like, the A, B, C, D, E and the 1, 2, 3 that you usually see on the screen. And then, you usually see that white band here, and that's the formula bar. So, the default is not to show that, but for some of you, that may drive you crazy, so, I just wanted to show you an easy way of changing that. So you just have to click on the view tab, and then check Formula Bar and Headings, and then you'll be able to see them as you see here.

Okay, next, throughout the compliance form, there are help buttons, and the user can click on these to get further guidance with regard to filling out the compliance form. But some of these help buttons also provide information from 90.1 with regard to requirements. So, this is, here, circled, is this blue question mark, and it's a button that you can press on, and then a dial-up box will pop up with the help text. And when you click on the text, the scrollbar will become available, and you can scroll through the text. You can also copy, you can also select the text and then copy it. So if there's a link to a website or something like that, you can

easily copy and then paste it into your browser.

Okay, so, each tab has the same setup. So, at the top, there is a Return to Dashboard button, and you'll see what the dashboard is, on the next slide. But that allows you to _____ instantaneously click this and return to the dashboard tab. There is also an Adjust Column Width and Row Heights button, and this allows the user to adjust the column width and row heights on each tab. Every monitor is different, and text that we can see sometimes won't fit with other people's settings. So, this allows you to adjust the rows and columns _____ so that you can see all the text you've typed in or the default text. The compliance _____ is password-protected, and this button allows you to adjust the rows and columns while still maintaining the protective state of the particular worksheet.

Each tab also has a table of contents, which shows you all of the tables and sections on that tab, and allows you to easily jump to different tables and sections. And finally, under each section and table is a note field that you can include any applicable notes.

Okay, so this is that dashboard tab that I just mentioned, and the dashboard allows easy navigation to all of the different tabs in the compliance form. So, what you see here in blue are all the different tabs in the compliance form, and when you click on the hyperlinks, it takes you straight to those tabs. So, by clicking on the Return to Dashboard on the individual tabs, you can come to the dashboard instantaneously, and then move on to another tab. So, this means we don't have to scroll through a large amount of tabs _____ _____, so it makes it just easier to use. The next aspect of this dashboard tab is that it has this compliance summary where you can see the energy modeling outcome at a glance.

So, that is based on any modeling output data that has been entered into the compliance form. So, in this particular example, we have not yet entered data, so it's in progress. You can also see the compliance path, at a glance, so, this example is Appendix G and it's the submittal for an above code program. We also have these design professional sign-offs and modeler sign-offs, and basically, those are impacted by what's been filled out here. So, kind of new with the compliance form is that we're trying to bring the design team into the modeling process.

And in doing so, remember that the design team are assigned individual tabs, and it's their responsibility to ensure that the information entered on the tabs is in alignment with the design

document. So you can see, here, that Johnson Avery has been assigned to a number of different tabs, and then, the date is entered for when he has reviewed the tabs and signed off that they are consistent with the design documents. For the energy model, the modeler is signing off that the modeling inputs shown on the tab _____ what's actually been captured in the energy model.

All right, so now we're gonna move on to the compliance form demo, and we're going to start with the Instructions tab. So, the Instructions tab provides general information about the compliance form, and step-by-step instructions for how to use the compliance form. So, if you're in doubt, you can return to the instructions tab, and look at the step-by-step instructions. It also provides them productivity tips, including the one about being able to view the headings and the formula bar. And it has a color legend. There are a number of different colors used in the compliance form, and you can find out what they mean, from the instructions tab.

It also has abbreviations and acronyms that are used throughout the compliance form, and links to different reference documents that are used. So, for an example, we reference ASHRAE Appendix C schedules within the compliance form, so, if you don't have that, you can just come to the instructions tab and obtain the link for getting to that information.

Okay, so you can see that the Instructions tab is blue, 'cause it's an informative tab. The Dashboard tab is also blue, 'cause it's also informative. So, we've gone over all the aspects of the dashboard, but this is what it looks like when you're actually in the compliance form itself.

All right, so, next, we have our contact information [*glitch interferes with audio*], and this tab is where you would enter project information, project contact information, and the energy modeler qualifications.

The next tab is the general information tab, and before talking about this tab, I just wanna demonstrate the Return to the Dashboard feature. So, if I click on this hyperlink, I'm right back at the dashboard, then I can just pop to any other tab I want. But I'll go back to General Information and talk about this tab.

So, this tab is where basic information regarding the energy model and project is entered. So, details such as the climate zone, the simulation tool used, and the weather file name, et cetera, are entered here. So, Maria mentioned that we have a dropdown,

within the compliance form, for choosing whether it's an Appendix G or Section 11 project. So, that's on this tab, and you can see that you can choose 2016 Appendix G, or Section 11, and you can do the same for 2019 projects, as well. You can also choose whether you're filling it out for an above-code performance or a minimum-code compliance. There are different rules, depending on whether you're doing performance-based modeling for above-code performance or for minimum-code compliance.

For example, there's no credit for Energy Star appliances in multifamily buildings, if you're doing minimum-code compliance. So, that's just an example. And also have a dropdown with a list of popular simulation tools, and when you select your simulation tool, if it's a supported tool, the corresponding tab will become visible. And you can copy and paste output reports onto that tab. So, today, our example is eQuest. And then, we have a section for capturing the different building areas in the project, and a section for describing if there are any renovations or yet to be designed systems and compliance. Because 90.1 has specific rules how to treat these different components, when you're modeling them.

And then finally, in the basic overview section, we have our Energy Sources tab, and this is where all of the purchased energy sources, all of the relevant applicable-to-the-project energy sources are entered. And we have dropdowns for choosing the energy type and the units. The person inputting the data also chooses the utility rate type, and there's a number of options to choose from. And there'll be some – throughout the compliance form, there are some flags; we've let you know that, because you've selected a particular item, that you need to submit documentation. So, in this example, because I've selected fixed rate per unit of consumption, I need to include some supporting documentation in my submittal, for modeling those rates.

And we have that submittal checklist tab that I mentioned, and that is dynamic, and when you select a particular option that triggers a need for documentation, that will unhide on that checklist, so you can make sure that you submit all of the proper documentation. We also have other metrics in this table, and these are applicable only for jurisdictions that use alternative metrics for determining compliance, and they're optional. So, source-to-site ratio and greenhouse gas emission factors are optional inputs on this tab. So, when you select your energy types and your utility rate types, other tabs will show themselves as applicable, to fill out the details of the particular rate function that you're modeling.

All right, so that concludes the basic structure section of the presentation.

Next, we are going to move on to lighting, and we're going to touch on, briefly, the types, the tabs highlighted on the screen now. _____ as we cover these sections that involve modeler input and automated calculation of baseline and proposed model input, it's structured where we're gonna talk about the available information on the design drawings and in the specs We're gonna talk about the required simulation tool inputs, the applicable reporting requirements, and then we're gonna go through an example of how to fill out the compliance form.

So, with lighting, we have the, as Maria talked about, earlier, actually, we have our lighting plans, our lighting schedules, and our lighting specifications, as part of the design documents. And you can't just take that information and put it into the BEM tool. It needs to be processed so that it can be input into the model. So, as you can see here, in the model, you'll need to put in wattages per square foot, or total wattages for each HVAC zone. And for the proposed design, you'll need to model schedule adjustments. So, this is just to illustrate that there are intermediary calculations that need to be performed, in order to transfer from here into the building energy modeling tool.

And with lighting, the design documents provide schedules, so, fixture schedules, with wattages for each of those fixtures, that are typically based on the specified bulb and ballast. The design documents also have lighting plans, which show you the fixtures and stuff about controls, in each space. And then, if they're not on the design drawings, the specs can and often do clarify the actual lighting control sequences, okay? So, that information is in the design document. However, the BEM tool [*glitch interferes with audio*] to calculate lighting wattages and schedule adjustment credits, and the proposed design model for each HVAC zone. So that's one difference: the design documents, its by space, but in the BEM tool, you're typically inputting the information by HVAC zone.

Also, in the BEM tool, it's a requirement of 90.1 that you enter the wattage based on the fixture's maximum rated wattage. And this is often not on the design drawings, so it's something that, as the modeler, you need to check. And the baseline design model, you also need to determine the lighting wattages and schedules for each HVAC zone, which is going to be comprised, typically, of multiple spaces, and often multiple space types. So you need to calculate

that based on the tables and instructions in 90.1.

Okay, what are the applicable *[glitch interferes with audio]* reporting requirements for lighting? So, Maria went over, earlier, the key documentation requirements in 90.1, and we've got requirements A, C, and E up on the screen. And they just basically boil down to, you need to show differences, key energy efficiency differences, between the baseline and proposed. You need to identify aspects of the proposed design that are less stringent or that are more efficient than prescriptive provisions of 90.1. And so, for lighting, this corresponds to needing to show both the proposed baseline and prescriptive lighting allowances. So, proposed lighting power, baseline lighting power, and the prescriptive lighting power allowance.

So, these need to be readily available for a reviewer to compare, in order to meet the requirements for A, C, and E. And note, text in blue is not an actual simulation input, so, the compliance form is there to help auto-populate these values, to make the review process and the QC process easier.

Next are backup calculations, and material to support data inputs. So, in the context of lighting, you're going to need to show a reviewer for the proposed design the fixture counts, wattages, and HVAC zone, and how the lighting power densities were calculated. And how the schedule credits were calculated based on the controls specified in the design documents. And for the baseline, you need to show how the modeled lighting power densities were determined based on the areas and space types within each HVAC zone. And lastly, the other applicable reporting requirements, well, they're all applicable, but the other one that we wanna talk about today, for lighting, is the reporting requirement that you need to show that you're meeting all of the mandatory requirements of 90.1. And in the case of lighting, you need to show that you are meeting the lighting control requirements, the standard, and these are entered into the compliance form, which documents, for the reviewer and authority having jurisdiction, that you're meeting those mandatory lighting requirements.

All right, here's our lighting example. Okay. So, prior to entering lighting information into the compliance form, the building geometry and thermal zoning needs to be created in the BEM tool, to let you know the modeled HVAC zone name associated with each space in the drawings. So that's the first step with lighting is you wanna know the HVAC zone associated with each space in the drawings. So, here's an example, I'm showing you an excerpt from

a set of design drawings, that's those two spaces, so we have project storage 101G, and we have metal shop 101F. So we've got two spaces, and then this boundary here in red represents the boundary of an HVAC zone. So we've got two spaces, two space types, one HVAC zone.

And here in this graphic, you can see this HVAC zone in the model, and its corresponding name. So, we need to figure out the lighting power density and controls for each of these spaces, and then calculate the lighting power density for this entire zone. And we need to do that for the baseline and the proposed.

Okay, so, I'm gonna show you how that's done, when we get to the compliance form, but I just wanna zoom in and focus on one of the spaces. I'd like to focus on establishing the lighting count for project storage and the controls, and then we'll see how it's been entered in the compliance form. Okay, so, here we have our project storage space, and as you can see, there are six B1 fixtures. So, we get that from the lighting plans, but then we need to figure out, okay, what is a B1 fixture? We look at the lighting schedules, and that gives us the make and model number, and it gives us a preliminary wattage.

We then, often, we run a check based on the model number that is actually the maximum fixture wattage, and that it includes all components contributing to power consumption. So, we looked up this particular fixture, and we were able to confirm that the input wattage is actually 43.2 watts, so that is the wattage that we will model in the proposed design. So far, lighting counts, we have 6 B1 fixtures, they're each 43.2 watts, and our space is 471 square feet.

Okay, so next we have to figure out what kind of lighting controls we have in this space. So, we can see, from the drawings, that there is this symbol here that has a VC with an S, and that it's attached to these OCs – so, we see we have that, and then we look at the symbols to figure out what these mean. And so, we can see that the VCS is a vacancy sensor control switching, and that there are two occupancy sensors attached to it. Well, that still doesn't really tell me exactly the sequence, so, I went to the project specs, and that tells me that the vacancy sensor is such that the lights are randomly turned on, and that sensors turn the lights off when the room is unoccupied, with a time delay. So, basically, the lights in this space are all manually turned on, and then once they're manually turned on, the occupancy sensors sense occupancy in the space. Once there's been an absence of occupancy for a specified amount

of time, it automatically turns all of the lights off.

Okay, so, we know what controls we have in our space, but now we need to define what controls we have based on how controls are captured and defined in 90.1. So, in the compliance form, you enter the controls associated with each space, based on the way they're classified in 90.1. So, what you can see here on the screen are _____ control requirements for this particular space, which is a storage room between 50 and 1,000 square feet, okay? So, we can see that local controls are required. We can see that, either restricted to manual on or restricted to partial automatic on, either one of these is required. So, that's what the ADD1 means, it means you've gotta have either one of these, okay?

The next daylighting sidelighting daylighting controls and toplighting daylighting controls are required. Now, these are not applicable because this is an interior space, and there's no top or sidelighting. And then, we can see that automatic full off is required, okay. So the question is, which of these controls do we have in our space? Well, we definitely have local controls, because we have our local switch that controls all of those fixtures. We know that we have restricted to manual on, 'cause we read in our specs that that's how that vacancy sensor works: an occupant enters the space and manually turns on all the light.

This partial automatic on becomes N/A, because we've met one of these two requirements. The daylighting is N/A, as discussed. And then, we've met the automatic full off, because we read, in our specs, that after a set amount of time, all of the lighting in this space is turned off automatically.

Right, so let's go to the compliance form, and talk about how this information is entered into the compliance form [*glitch interferes with audio*]. So, we started a lighting space types _____, and we start with Table 2. So just let me backup a little bit. So, for lighting, we've got, for interior lighting, we have three tabs: we have the Lighting Space Types tab, we have Interior Lighting Counts, and we have Interior Lighting Model Inputs. So, as we go through each of them, you'll see the features and how each of them work together. So, whenever we're filling out lighting, we start with the Lighting Space Types tab.

And Table 2 is where you define all of the different space types in the project. And the reason for this table is to eliminate excessively long list boxes when you're entering the fixtures associated with each space in the building. Because, I'm sure some of you are

aware, there are a lot of different spaces types in 90.1, and scrolling through long list boxes hurts the efficiency of filling out the form. So, we've predesigned our space types. In our example, here, we're just getting started, so we only have two space types: we've got the storage room and the workshop. I've prefilled this out. Then we've got our Table 3.

So, Table 3 is where you copy and paste the HVAC zone _____ from the simulation tool into the compliance form. And this makes it such that you can easily assign each space to an HVAC zone in your model, and – it helps prevent typos is one thing, so that we can – so that the compliance form can calculate the lighting power densities for each HVAC zone. So, I've prepopulated this based on the geometry I created in my model. You can also enter these by hand; you don't have to copy-and-paste, although it's probably easier to copy-and-paste. So, after I've filled these out completely – and normally, you'd fill out all of your space types, but you don't have to; you can go back and forth – I go to the Interior Lighting Counts tab.

So, the general tab layout is such that the fixtures are defined close to the top of the tab, here. So, as you can see, I've predefined the fixtures that were in that workshop space that we did not zone into, but I've filled out the compliance form for that space, previously. But I've defined, also, my B1 fixture that we saw was in our storage space. So, I've captured that here. Then, in this section, you enter the number of fixtures for each space in the design drawings. And then, controls are entered over here, but we'll get to that *[glitch interferes with audio]*.

There are a number of productivity features to help navigate this tab. The first one is that you can freeze panes by pressing control-shift-M, so this freezes the top row and it freezes at the space type, so that you can just go across and still see them and scroll down and still see the headings. So that definitely helps with productivity on this tab. You can also mark rows, so if you double-click on a row, you can mark it in this orangey color, and that's useful because, often, you maybe have a question about a particular space and you wanna revisit it later, so it's nice that you can mark rows that are incomplete and you wanna revisit. And just double-click again to turn that off.

We also have this filter feature, so right now I have it turned on – I'm gonna turn off the freeze panes *[glitch interferes with audio]* – so that you press this button to turn on and off. Right now, I have it turned on, and basically, you see these arrows here? This allows

you to sort the rows and columns, based on different column headings. So, you could filter them so that you only show workshops, or you could filter it by area, these different column aspects you can filter it by. I'm gonna turn the filter off, so you just press it and now it's off. Okay, so, with our example, I've prefilled it out, and so you can see I have the space names here, and then I've selected the name of the HVAC zone that we saw on that slide.

And they both have the same HVAC zone name, 'cause both spaces are part of the same HVAC zone. You'll see, throughout the compliance form, you need to indicate where in the plans or specs that you got this information, and this is there that will help you, if you're a modeler or a member of the design team, keep track of where you got particular information. And it's also there for review, to be able to check against the design drawings. You select your space type, you enter your area, and then you capture the number of fixtures associated with each space. And you can assign multiple fixture types to each space. So, based on our example – let me freeze panes – based on our example, our storage room space has 61 fixtures, so we've captured it there.

So, as you can see, moving across, if there's a particular area of a space where the lighting's not yet specified, you would enter that here. This column just _____ some special rules of 90.1, regarding retail. And as you can see here, the proposed design, baseline, and prescriptive LPDs are populated based on the entries. And over here, I enter my controls. So basically, I just enter whether or not a particular control is specified in the design. So, in the case of our storage room, their lighting was all N/A, all of the wattage was controlled, so *[glitch interferes with audio]* the total wattage of the space, manual on was a yes, remember, our controls were manual on, pressure automatic on was a no, and so forth. So you just select yes or no, as applicable, and the compliance form will automatically populate the credit to be applied to the proposed design schedules, based on Appendix G.

And you can see to the right, as well, the mandatory requirements auto-populate for reference. And another feature is that, these cells will show in red, to let you know which items are required, and as you say yes, the red disappears.

Okay, so that's our Lighting Counts tab, and lastly is our Interior Lighting Model Inputs tab, which basically quantifies the lighting power density and lighting wattages, both by space type in Table 1, and also by HVAC zone. So you can see, here, we've had _____ _____, so far, one _____ _____ with HVAC zone, so

we have our lighting _____ and lighting power densities calculated for the proposed baseline. And then, the prescriptive also populates for reference, for that HVAC zone, so we can directly input that into the model. I also wanna show you that there's some functionality in which, if the proposed lighting power density is higher than the prescriptive requirement [*glitch interferes with audio*] in red, to indicate that it is less stringent than the prescriptive requirements of the standard. And the _____ highlights in green if it's better than the prescriptive requirement of the standard.

All right, so that concludes our lighting compliance form demonstration. Back to the PowerPoint.

All right, so, to conclude lighting, I just wanna discuss some common lighting mistakes. The first is, sometimes as a shortcut, modelers will use the dominant space type associated with a model HVAC zone, rather than using all of the areas of the different space types to determine the baseline lighting power density. And this is automated in the compliance form, so that should eliminate this issue, or reduce it. The next is a failure to model proposed design controls, especially daylighting. [*Glitch interferes with audio*] we're reviewers, and often modelers, so we'll receive submissions where daylighting controls aren't filled out, or are partially filled out, and sometimes this can be due to a lack of information in the design documents.

So, at least now in the compliance form it's very clear what information is needed, so that a request can be made to the design team, to get the information needed to really determine whether you're meeting the mandatory requirements. The next is a lack of accounting for areas where lighting is unspecified, or where the design intent is for hardwired lighting to be supplemented with receptacle lighting. So, that last part, and example would be, like, in a hotel, maybe the bathroom has hardwired fixtures, and, you know, the corridor when you enter the room, but the design intent is for there to be table lamps. So that's receptacle lighting. And so, this needs to be accounted for.

And so, the compliance form automates this, as I showed you, briefly, there's that column for entering areas where lighting isn't specified. And lastly, not modeling the maximum fixture wattage, and also, failing to include all of the components of the lighting fixture. So, like, you need to include the lamps, the ballasts, drivers, transformers, all of those need to be captured. So, a prime example, actually, with fixtures is, often, a fixture may be rated at

60 watts, maybe 'cause it's a fixture that, you know, an older fixture model where, you know, people are reusing the 60-watt incandescent lamps, frequently. And so, the fixture is rated at 60 watts, but the design is for, you know, 8-watt LEDs. Well, you'd have to model the 60-watt fixture, not the 8-watt LED, so that's a common mistake.

All right, so that concludes lighting. Next, we'll move onto _____ envelope section of the training, and we'll briefly touch on the three tabs you see highlighted on the screen. And primarily, you'll see these tabs once we get to the actual example.

But first, we're gonna start just by discussing the information, the relevant information in the design forms for building envelope, and the BEM tool inputs. So, in the design drawings, we have our construction assembly schedules, so the layer-by-layer assembly schedules, we've got elevations _____ build areas, window placements, areas of different wall types. And then we have our window and door schedules. The BEM tool, you need to model the thermal properties of the different constructions; you also need to model the window and door thermal properties. And you need to capture all those modeled area and door and window locations. So, there definitely needs to be some organization and some processing of this information, in the design documents.

Specifically, you need to take the opaque assembly, the window and door schedules, and their thermal properties. So you need to, like, for an example, you see, "Okay, we have R19 insulation in this particular wall assembly, and we have these different layers – " So you need to take that information and calculate the thermal properties that go into the model, and account for _____ effects, using Appendix A. So, that requires some processing, to go from those schedules with all the layers to the actual model thermal properties, accounting for the effects of framing. Okay, you also need to think the window and door properties sometimes go in the drawings, so sometimes there's new values and – so if you gain coefficient _____, you need to obtain the NFRC ratings, to ensure that those thermal properties in the design drawings include the window frame.

So that takes some organization, in order to do that. So, in the design forms, you have elevation showing the window and door and different types of wall locations and areas, and you need to capture that in the actual proposed design model. And in order to figure out the appropriate model inputs, you need to not only capture those areas but understand the different opaque assembly

and fenestrations areas, by orientation, building area type, and then also, the space-conditioning category. 'Cause those are important in determining the prescriptive requirements and the baseline model inputs. So, for the baseline, you need to take that information from the proposed design and from the design documents, and you need to determine the opaque assembly and fenestration thermal properties to model, per the rules of 90.1.

Same with the window-to-wall ratio to model in the baseline. For Appendix G, it's often not the same as the proposed design, and that needs to be determined using the rules of 90.1.

So, in terms of documentation, we've gone over the meaning of A, C, and E, here, I think twice, so I'll skip that. But in order to meet the reported requirements of 90.1, and show how the baseline and proposed compare, and to show where you are meeting or not meeting prescriptive requirements, the reviewer and the modeler needs to see the opaque assembly and fenestration thermal properties, including U/C/F/solar heat gain coefficients/visual transmittents, all those thermal properties we need to see, or reviewers need to see, for the proposed design and the baseline design. You have a compare, in order to meet these reporting requirements that you see on the left. The prescriptive requirements also need to be shown, for comparison purposes, as well.

In terms of backup calculations, it needs to be shown how the U/C/F values were determined using Appendix A. And also, how were the window-to-wall ratio scenarios determined, how were they calculated. And that's true for both the baseline and proposed levels. And, so, meeting the requirement of the mandatory provisions is not yet supported by the compliance form.

All right, so here is our envelope example. So we've got an exterior wall and a roof assembly, from a set of design drawings, and so, we take a look at this and we pull the relevant information. So, in the case of the exterior wall assembly, we note that we have – here, we can see that we've got the vapor retarder, and then, we've got additional layers. And then, we've got an insulation layer, and we have R19 cavity insulation, and we can see these design drawings are nice and detailed, and then it tells us it's 16 inches on center. And there are six-inch metal studs, so that's great. And then we've got another layer of gypsum sheeting, and then we've got a weather-resistant barrier, and then we've got two inches of mineral fiberboard insulation, so that's that continuous insulation, and this tells us that it's rated at R8.5. And then we've got our outside

stucco.

So, basically, we've got R19 cavity insulation, and R8.5 continuous exterior. So, insulation, 6-inch metal studs, 16 inches on center. So we get that from the design drawings, and I'll show you what we do with it, in a couple minutes, after we discuss the roof assembly. So, for the roof, we've got our roof membrane, then we've got R39 of continuous insulation [*glitch interferes with audio*]. Then we've got our air/vapor barrier, and then metal decking. We also have our reflections and emittance values. So, just summarize the important information, here, we've got R19 continuous insulation; this is entirely above deck, as we can see, here, with a reflectance of 0.55 and an emittance of 0.75.

So, the point of me showing you this is, we're gonna discuss how this is entered in the compliance form, and how the compliance form helps us determine thermal properties. And how the compliance form meets the reporting requirements that we discussed.

So, then we've got our envelope elevations, which help us determine the fenestration areas and opaque areas for the different wall types, by orientation. And if you have different building area types and different space-conditioning categories, you'll also need to break down the different wall areas in terms of those variables, as well. In our example, we just have a building that it's just [*glitch interferes with audio*] building area type throughout, so we don't need to break it into that detail, but we do need to capture the wall areas for each assembly type, by orientation. And same for the different types of windows. So, this set of drawings provided that information right on the drawings, and so, we extract that to put it in the compliance form, in order to calculate some of our model inputs, and to meet reporting requirements.

And just note, it really depends on modeler preference, and also, the level of detail in the design drawings. Sometimes it's easier to just take this information out of the simulation tool, but that depends on a particular scenario.

All right, so let's look at the envelope tabs in the compliance form – wrong direction – all right. So, we're gonna discuss the proposed envelope assemblies tab, envelope areas, and infiltration. So, we start with the proposed envelope assemblies, and on this tab, you could find all types of constructions in the proposed design. So, Table 1, here, is for entering information about opaque assemblies and _____, okay? So now we have Table 2, and as you can see at

the top, there's only two tables _____. And then, Table 2, we enter our fenestration.

So, in our example, here, I've pre-populated it with the different constructions in the proposed design. But in our up-close example, *[glitch interferes with audio]* PowerPoint, we discussed *[glitch interferes with audio]* the roof construction, and then the only – this is a pretty simple building – the only exterior wall construction. So we've got our roof, which, as we saw, was insulation entirely above deck, and these classifications, here, so, you define your surface type, your construction type, these are all based on Appendix A, okay? And they're dropdown. So they're all dropdown. So I go across and I enter this information, I get to Colum J *[glitch interferes with audio]*, I get to the cavity insulation column, and there was no cavity insulation for the roof.

However, if you recall, we had our R19, and let's take a look, we had our R39 insulation *[glitch interferes with audio]* 39 here, for the continuous insulation. And the Appendix A U-value auto-populates for us. And Appendix A _____ are a very common source of review comment from conducting reviews, so this is designed to eliminate some of those comments, and streamline the process for modelers and members of the design team. So, sometimes you have materials that are different from what was used in the Appendix A tables, to determine the thermal properties of the construction. So, here, you would describe the materials, in addition to what was used in the Appendix A tables, and you would enter your, actually, modeled UCRF factor. So, the Appendix A table is a helper for you.

If your constructing is the same as the constructions used for determining the thermal properties in the Appendix A tables, then it would be the same. If yours differs, you describe that here and let'em show your actual modeled value. Then there are some rules in the standard for treating uninsulated assemblies, and modeling similar assemblies, so you answer some questions that are dropdowns, here. And if you answer yes, it'll prompt you, through these other columns, to describe the uninsulated assemblies, to describe the similar assemblies. And as always, there's a column for entering the plan of specification reference for the information that you've entered in the compliance form.

And for exterior above-grade wall in process – and I just wanna show you, there is a _____ of the compliance form, if I delete this, you see how that turns red? Well, for crucial inputs – you know, all of the peach cells are important, but for input where it's, like, "This

is not gonna work if you don't input something," it'll, for the most part, turn red. So that's why that turns red, and then I enter my value *[glitch interferes with audio]*. So, I've got my steel-framed wall, 16-inch on center, 6-inch depths, we had our cavity insulation, our 8.5 continuous – it's the same as for the roof, it auto-populated the Appendix A value, okay?

So, that demonstration, we didn't look at this in detail, in the PowerPoint, but you would enter the – you would describe your fenestration in the design documents, these are all dropdowns also based on Appendix A options. You would include the thermal properties of each type of window, or each type of fenestration; your plan and spec reference. You'd also, you need to indicate how the fenestration U-factors were determined, because you need to include _____ framing, and typically, that's through NFRC testing. So, you indicate that here, and then, again, depending on how *[glitch interferes with audio]*, you have a prompt to submit the certification or label. For example, if you're saying that you use NFRC testing for the manufactured fenestration assembly, as your way to determine U-value, well, then, you need to submit backup documentation. And again, this row will unhide in the submittal checklist, to make sure you don't forget.

Okay, so that is the Proposed Envelope Assemblies tab, so now we have the Building Areas tab, and at the top, here, in Table 1, is where you find your surfaces, your opaque surfaces, building area type, orientation, space-conditioning category, and whether the area is new, existing to remain, or existing to retrofit. *[Glitch interferes with audio]* entered this information, just for the sake of time, today, and that came – this information came from the – in this case, it came from the elevations from the design drawings, as you can see here. So I took this information and I entered it into the compliance form, and as you can see, the baseline and prescriptive thermal properties auto-populate. For model inputs, in the case of baseline, and to meet reporting requirements in the case of prescriptive.

And I just wanna briefly just touch on the colors, here. The peach cells require an input; the white cells auto-populate and are not editable; and these beige purple cells auto-populate, but they're editable. Okay? So, same principle for Table 2, except, you enter the fenestration areas in the proposed design, by those categories that we discussed. So I took these from the building elevations design drawings, and entered them here. And again, the baseline and prescriptive thermal properties auto-populate. So then, on this tab, you would press "Calculate Window to Wall Ratios," and this

would calculate, when you press this, which I already did, the window-to-wall ratios and the different areas that need to be modeled in terms of fenestration auto-calculate for the baseline and proposed design.

And as I discussed before, Appendix G has specific requirements about baseline for modeling the window-to-wall ratio. So, this example that we're looking at right now is a school, and according to Appendix G, it's to be modeled with a 22 percent window-to-wall ratio. And based on the entries in Tables 1 and 2 above, these have been auto-calculated for you, so that you can model the correct baseline and proposed fenestration areas. Table 5 is designed so that reviewers and modelers can _____ their work, and look at output reports, and check that everything has been modeled as it should be. Table 6 is for capturing exterior and interior shading. So, you basically check what's applicable in the proposed design and the _____ should be modeled in the baseline auto-populates.

And then lastly, we have our baseline orientation and rotation section, and you select whether the baseline/budget building performance was generated by simulating a building with its actual orientation. And again, after rotating it by 90, 180, and 270 degrees, and then averaging the results. So you basically check whether you did that, or there are a few exceptions in the standard where you don't have to do that. So you would click the radio button to indicate that there's an applicable exception, and then this field would become available down here, where you would explain how that exception is applicable. *[Glitch interferes with audio]* understood in that baseline air leakage is prescribed at a pressure differential of 75 pascals, and it's normalized per unit _____ _____ pressure boundary.

But actually, most simulation tools require entering infiltration at normal pressure conditions. *[Glitch interferes with audio]* so this Appendix G value, at 75 pascals, needs to be converted to normal pressure conditions. And this calculation is automated, here, and a number of infiltration modeling methods are available for selection in this dropdown. So, you could select to model the leakage per gross floor area, per exterior wall area, and when you select different ones, it'll update your actual model input for you here, at normal pressure conditions.

Okay, so that concludes our demonstration for building envelope with the compliance form. So, basically, I just wanna touch on some common mistakes for envelope. A typical mistake is

modeling the center of glass U-value as opposed to the NFRC assembly U-value, which includes framing. So we see that a lot, and we try to help modelers avoid this, by prompting you to indicate the method used to determine the model's U-value. So that'll eliminate a lot of questions, 'cause this comes up a lot in reviews.

So, a failure to model or account for, in the model, uninsulated slab edges that penetrate the wall plane on each floor of the building. So, by having to enter each unique construction on that proposed Envelope Assembly Tab, hopefully, *[glitch interferes with audio]* eliminate that mistake, because you'll need to explicitly enter the unique assembly associated with that slab edge. Not using Appendix A to account for the effects of framing, when determining proposed design opaque assembly thermal properties. So, this is very, very common, so, the hope is that since we've automated, for most constructions, this process of determining the Appendix A value, that this issue and the number of review iterations will be reduced.

Another modeling, the same window-to-wall ratio in the baseline and proposed. So, as discussed, the baseline needs to be determined based on the rules of Appendix G, or Appendix G models, and this is automated in the compliance form. And lastly, I already discussed this, but modeling infiltrations entering the value from Appendix G, which is at 75 pascals _____ simulation tool, when the simulation tool requires that input at different conditions. *[Glitch interferes with audio]* that process, we're hoping, again, that we'll reduce the number of review iterations.

All right, so, next we have HVAC, and we're going to touch on the two tabs shown there. Okay, so, with HVAC, we have our design documents once again, we have mechanical equipment schedules, riser diagrams, we have HVAC plans, which include piping, ductwork – and so, there's a lot of information in design documents, with regard to HVAC. And there's also a lot of inputs that need to be made. You need to determine the appropriate system type based on your design documents, your HVAC zoning, then you need to determine what types for controls to model for HVAC systems. Then the efficiencies and all the other parameters, like fan power, pumping power, all those items need to be determined from the design documents, so that they can be input into the building of energy modeling tool.

So, to be more specific, you know, we get the HVAC capacities, efficiencies, different components, or other CO2 sensors for _____

control ventilation. What are the control sequences? How do the units operate? And we get make and model numbers from the equipment schedules, so we can determine zoning from _____ and piping plans. We can also determine heating and cooling capacities, by HVAC zone, from *[glitch interferes with audio]* plans, as well. And then, all of that information needs to be organized, and then, input into the model. So, for the proposed design, you need to zone your building, and then you need to figure out, for each zone, what equipment serves that zone, what's the capacity, what efficiency should I model.

And for efficiency, you often need to remove fan power, so there's an _____ calculation. Often, you'll need to do a fan power calculation, to convert the information on the design documents to kw per CFM, depends on how you're modeling it, but that's, typically, a calculation that needs to be performed. And then, all of the control sequences, to input the controls and the control parameters. Baseline design in HVAC designing is the same as proposed, but you need to determine the efficiency, fan power, pumping power, all the control sequence, that needs to be figured out from Appendix G. And these items are automated in the compliance form, to help with organizing and figuring out those model inputs.

In terms of reporting requirements for HVAC, you need to show the differences between the baseline and proposed for equipment types, the capacities, the efficiencies, the control sequences, lots of different items. You need to show whether you meet or exceed the prescriptive control requirements, for an example, does your design have economizers? Things like that.

In terms of backup calculations, the proposed is on, depending on how you're modeling it, but typically, you need to show how was fan power determined, how was pumping power determined. From the baseline, you need to show, from Appendix G, how was the fan power determined for this particular project, how was the pumping power determined, the efficiency, the controls, all of these items, you need to provide backup calculations. And this is all needed in the compliance form. And in terms of _____ compliance with the mandatory provisions, the mandatory controls and the requiring minimum efficiencies, efficiencies will auto-populate.

So, this is our HVAC example; this is an excerpt from some design drawings. And I've highlighted the important inputs, here, in yellow. So these are two rooftop units, they each serve an office; these are interior offices, and they, actually, based on the rules of

Appendix G, in the model, they are able to be combined into one thermal block, one thermal zone. So, we've got our supply CFM [*glitch interferes with audio*] outside air CFM, we've got our motor, supply fan motor break horse powers. We've got our heating capacity – we can see this is a gas furnace unit, so we've got our heating capacity, cooling, we've got our cooling capacity, here. We can see that it's a DX unit, from this information here, there's a condenser, a fan, they've got _____ temperature.

We also have our manufacturer and model, here, too, so if there was any doubt, you can always look that up. We've got our cooling part load and full load efficiencies, here. And then we have our filter type, which can be important if you are claiming allowances – well, not – yeah, if you're claiming allowances for [*glitch interferes with audio*]. And the notes always have some good information, as well. We can see these are variable air volume, they have DFTs, we see the supply temperature controls. And then we can see that they have enthalpy-controlled economizers with – and we can also see the high-limit setpoint. So, this is all the important information that we'll need to enter into the compliance form.

So, let's dive right in to the compliance form for HVAC. All right, so at a high level, for HVAC, we have the Proposed HVAC tab, and then we have the baseline HVAC tab. If this was a Section 11 project, then, instead of baseline HVAC, you would have a budget HVAC tab. And the first thing I wanna point out is just, when you look at the baseline HVAC tab, there are many, many auto-populated values. And that's because the baseline tab automatically tells the modeler what the baseline model inputs are, based on lookup tables from Appendix G that are integrated into this tool. We can see a lot of white and a lot of this tan color.

And the reason the tan color – not tan color – beige color – beige-purple color – and the reason you see that is sometimes there are exceptions that apply, so, the user is allowed to override them. Okay, so that's a baseline tab, so there's many auto-populated, see, look at all the controls auto-populated.

All right, so let's look at the proposed tab, which is mostly – it's mostly going to be this peach color. And that's because you're entering your unique _____, so the client's form can't know what your unique design is. There, just quickly, is a productivity tip for this tab. Each of the tables, if they're wide, have a freeze panes button, so you can click that, and it will free the top row and the

system name, so that you can easily navigate the table. Click it again, and then it turns it off.

So, I've pre-entered the loose cap units, and as I said, they're modeled as one thermal block, based on _____ of Appendix G, enter my drawing plans and specifications reference for that unit. So, just from a high level, let me step back here. On PK HVAC tab, we've got a table of contents, and we've got tables for describing the air side HVAC system pipe capacity and efficiency. We've got tables that deal with some fan power and efficiency. We've got a table for capturing any pressure drop, fan power pressure drop adjustments, that's why I brought up that filter. We've got a table that captures controls, economizers, demand control ventilation, energy recovery.

We've got a table that captures the different aspects of loops, so, loops, hot water loops, condenser water loops, they're described in one table. A table to describe cooling plants and heat reflection equipment. And then, a table to describe heating plants. The information about these items are entered in their respective tables. So, we briefly touch on each table with our example, so, we've entered the rooftop units in Table 1. So, many of these are dropdowns, but, for example, Equipment Type, these units are central furnace, there's a dropdown for selecting the equipment type.

We entered the capacities in this section, and described some information about perimeter radiation _____. Same with cool, you have cooling, equipment type, dropdown. Then we enter the capacity, and we enter our efficiencies, including our modeled efficiency, which fan power had to be removed. And _____ minimum allowed efficiencies per the standard auto-populate here, and it might be difficult to see through the screenshare, but because our efficiencies are better or equivalent with the minimum allowed efficiencies in Section 6, they're highlighted in green, here. We also need to describe the performance curves used in our modeling, and we have a dropdown, here, for selecting that.

So, each table, we just enter the details of our proposed design. Under each table is a summary table, that summarizes the information entered in the table above. On the baseline _____ tab, these summary tables compare the proposed and baseline design, which makes QC and review a lot easier. So then, we've captured our fan power based on that break horse power that we discussed here, the fan flow controls, so then, you know, if we had other fans, we would capture them. In Table 2, we need to type our

applicable drawing or spec where this information's coming from, so we entered that here. And then, any relevant pressure drop adjustments, controls, we've captured those, here.

And no other tables were relevant, so, if a table isn't relevant, like, for an example, I showed you, at the top, there are heating plant and loop and cooling plant tables, but they're not applicable to this unit. This is DX and it's a furnace, so, we don't need to fill those out, so *[glitch interferes with audio]* themselves. And with the controls, so, whether it's required auto-populates, and you can override this, and then, indicate which exception is applicable, for transparency.

So, that's HVAC in a nutshell. And so, let's go back to our PowerPoint, now, and talk about some common mistakes.

So, some common HVAC mistakes is modeling the incorrect baseline system, due to the incorrect application of G3.1.1.1 a through h. And we have narrowed the selections a little bit, based on upstream inputs in the compliance form for the baseline type *[glitch interferes with audio]* help with this particular issue that comes up. So, we often see a failure to remove fan power from the baseline and proposed efficiencies, where it's applicable. The baseline automates this process, the model input auto-population automates this. Modeling the same controls on the baseline and the proposed, instead of following the rules of Appendix G, this is automated in the compliance form, to reduce this issue.

And then finally, modeling different outside CFM rates in the baseline and proposed model, when there are no exceptions. So there are limited exceptions where this is okay, but we see this a lot when none are applicable. And you need to indicate how you're, you know, you need to provide information about this in the compliance form, so you need to select whether there's a reason for modeling different ones. And this will help reduce this issue and error.

All right, so we wanna leave time for questions, so, we only have a few more slides left, but we're gonna cover the simulation outputs and compliance calculations section. And the relevant documentation here, as Maria discussed, is you need to provide a summary showing energy cost savings with respect to the proposed. _____ the compliance form, this is met, in that it shows the baseline and proposed design costs by _____ for many uses. Another requirement that Maria talked about is that you need to provide input and output reports that show a breakdown of energy

used by at least the following components. And Maria mentioned these: lights, there's water heating, space heating, space cooling, and – and these are all captured in the compliance form.

As Maria said, modelers can paste the standard reports into the compliance form, and these _____, the energy consumption will automatically be calculated. Also, part of _____ is showing the unmet load hours for the baseline and proposed models, and this is also automated for the tools discussed earlier in the compliance form. So, the supported tools are listed here, and as Maria said, we worked with the vendors to develop tabs where the standard reports can be copied and pasted. And once these reports are copied and pasted, then, on the compliance calculations tab, the compliance outcome is automatically calculated. And like Maria said, some of the calculations can be a little complex for Appendix G, so this process is automated, and the calculation also includes the caps, if applicable, for onsite renewables or exceptional calculations. And there are areas in the compliance form for entering that information, but that's outside the scope of today's training.

All right, so, I just wanna show you these tabs. So, for this example, it's a request example. So, I've prepopulated this tab; I just copied and pasted the output in the ponds file into this tab. You can see there are instructions telling me how to do this, at the top. So I just copied and pasted that, then I went to my Compliance Calcs tab, and I saw that the information I copied and pasted resulted in some auto-populated tables. _____ you have to press, depending on – when you first click on this tab, you need to press these buttons for them to auto-populate. I already did that. So, my _____ is populated.

And then, Table 2, which shows the energy consumption by end use, this also auto-populated. And you can make manual adjustments to this, so as you can see, it's that beige-ish purple color, so, auto-populated, but if you need to reclass something as unregulated or regulated or add end use, you can do that. And then, you can select different columns, on the Results from eQuest tab, to bring in the consumption associated with those columns. And all of these can be manually entered, if needed.

And then we have Table 3, with the summary of the costs, and it compares your model baseline and proposed design dollar-per-unit costs, to show if there's any variation. And again, these can be overridden, if needed, but these auto-populate based on the results from eQuest.

The other tables are just summary tables, and so, we get to a compliance calculation table, which is what I showed you in the PowerPoint presentation. And so, this shows us our compliance outcome for *[glitch interferes with audio]*. So, those are the results from BEM tool and compliance calculation tabs.

All right, so, lastly, we've got our submittal checklist. All right, so, we see this huge big long list again. So, these are all of the documentation requirements and Appendix G, and they're not here for you to read each one, but just to show that they are significant. And the submittal checklist was created to ensure that each one of these, the _____ and modeler is reminded about, and they can make sure that they include each one in the submission. So, let me show you what this looks like. So, this here is the submittal checklist. Note that this is just showing you as if someone had completed the compliance form.

This one is obviously in progress, but I just wanted to show you an example of a completed one. So, it lists the information that must be provided, and you can fill – the color scheme, here, is that the peach-colored cells are for the design team and modeler, and these blue cells are for the reviewer to make comments. And once the modeler or member of design team, you know, makes sure that they have included the item, they would turn this from no to yes. So, green is good, you're ready to submit your package to the rating authority. So, once the rating authority has reviewed it and they don't need any, you know, extra documentation or clarifications, they can mark it as resolved, and it greys out. And you can kind of see the white text.

All right, so, some of the items on here, weather file used, explanation of error messages, diagram showing thermal blocks, so, these are all included in the Appendix G requirements.

All right, back to the PowerPoint. Okay, so that concludes the training, the organized training part. So, now we would love to have any questions that may have come up.

Maria Karpman:

Thanks, Christina, thanks. And we have a good number of questions, so I can answer them one by one. So, the first question: "Slide Seven states that the import can come from a range of BEM tool, but ISV was not mentioned. Are you saying that the spreadsheet only allows input from the named tools?" So, the spreadsheet only allows importing information from the named tools, but modelers can also just type in results into the compliance

tab. And we have been working with the software vendors to incorporate data exchange, and I hope it will be able to support ISV. And then, another popular tool that does not yet support it is _____ organizers tool, so we hope that, in the next versions, these tools will be included.

Next question: "Will GBCI accept this compliance form in place of the mean energy performance calculator?" So, we have been talking with GBCI about that, and their current plan is to post the link – the current plan is to allow this compliance form as an alternative of documentation method, and post the link to this compliance form at LEED online website. So I mentioned to you, at the beginning, that, for some jurisdictions and _____ programs, the form can be customized. So, there may be some customization that will made to the compliance form, to tailor it to LEED-specific requirements. But again, the bottom line is that, yes, as it stands now, GBCI does plan to accept this as an alternative reporting format for mean energy performance.

Next question: "How does the modeling outcome show cost performance and usage?" So, this is all shown on the compliance compilations tab, and Christina demonstrated it to you, that the compliance form uses conversion factors, that modeler-specified conversation factors from site to source energy, from site energy to emissions. And display energy use of the baseline and proposed design in this alternative format.

So, next question: "What happens if you choose 'other' from the simulation software?" So, if you choose "other," then modelers can just manually enter simulation results into the compliance form, so you can use any tool that meets 90.1 requirements. To perform the analysis, you just need to manually type in numbers, and again, we will be happy to work with the vendors of other tools, to automate this data exchange between the tool and the compliance form.

Next question: "Can the baseline design parameters be changed, or are they set?" So, certain baseline parameters can be overwritten, and Christina demonstrated one such area where the economizer requirement applies, was selected by default is either yes or no. But then, modeler could overwrite it and cite exception that applies. So, in some cases, compliance form would allow you to do that; in other cases, the baseline value will be non-editable. You know, for example, baseline lighting power density would be non-editable. But in most cases, there is a column to the right of the table, which allows you to – allows modeler to include notes. And perhaps if you need to override some of the default baseline value,

that would be a good place to clarify why it was modeled differently compared to what's included in the compliance form.

So, the next question relates to the supported versions, to the versions of 90.1 that the compliance form supports. And the question is that most of the states are using 90.1 2013 or older, so, how do we handle that. So, the form supports 90.1 2016 and 2019, and Mike Rosenberg actually looked it up during the presentation, and I believe, Mike, and I don't see the exact numbers, but about – okay, got it. So, 11 states use 90.1 2016, and more considering adopting it. In other 16 states, either the process of adopting 2016 or considering it. So, probably the first one was 2019 – so again, good number of states are either already using 2016 or 2019, or considering it, so, *[glitch interferes with audio]* address *[glitch interferes with audio]* needs of the states. Mike, do you wanna add something?

Michael Rosenberg: *[Side conversation]*

Right, so, yeah, about 11 states are on 2016 or the equivalent IECC that allows compliance with 2016, right now. And an additional 16 states are in the process of adopting it, or their processes are considering adopting it. So, in the short-term, there'll be about half the states we anticipate will be on 90.1 2016, with 1 state adopting 2019, in several months.

Maria Karpman: Great, thanks. Thanks, Mike.

So, another question regarding lighting: "If the _____ is rated up to 60 watts, but you inspect and see an 80-watt lamp installed, would you take an 80-watt lamp since it was installed, or still use the maximum rated of the fixture?" So, 90.1 requires you to model the maximum rated for the fixture, but some adopters allow you to model what's installed. You know, for example, EP _____ _____ program that is based on 90.1 Appendix G allows to use the installed lighting wattage. So, I recommend checking the rules of the program for which you are doing the modeling, either state energy code or the _____ code program, and see if they have any rules that deviate from 90.1.

So, there were a number of questions about ASHRAE endorsement of this compliance form. And in general, ASHRAE doesn't endorse any software, it doesn't have any required compliance forms. So, compliance forms are included in 90.1 users' manual, but even these forms are there for just reference, so they are not mandatory. So, this form was developed with direct engagement of 90.1

committee, so, committee is aware of that, and we have 3 members of 90.1 ECB committee who were directly involved with developing of this compliance form.

All right, there are several questions related to 90.1 requirements, that are not specifically related to the compliance form, but _____ we have a little time, so I'll try to answer some of them. "If you use a high-performance infiltration barrier, can the energy savings be considered? Also, what is the basis of the spreadsheet derived infiltration rate?" So, the rate, infiltration rate, included in the spreadsheet is based on requirements in 90.1 Appendix G, and also Section 11, that prescribes the default infiltration rate that must be modeled for the baseline and proposed design. You can model lower infiltration rate for the proposed design, if a leakage is tested, so that you can model this tested rate for the proposed design. So, but just the fact that there is an infiltration barrier installed wouldn't allow you to claim this credit.

The next question: "Is there a place in the tool or accompanying documentation where common mistakes are listed, so the designer can quickly scan through them as a final checklist?" So, one of the updates that is being planned through the compliance form is additional quality control tab. And it will include number of checks to help organize the review process, and we will address these common mistakes within this quality control tab. There will also be a companion submittal review manual that will be a PDF document, and it will also elaborate on best review practices and common mistakes.

And we have good number of other questions, and I don't mind staying on longer. So, there's one question from code official, about his jurisdiction requiring COMcheck. He writes: "This tool appears to be valuable for consistent plan reviews, but our jurisdiction requires a COMcheck report, even if taking a performance compliance option." So, we hope that, perhaps, jurisdictions like this one will consider using the compliance form is the only reporting requirements, in other words, not asking modelers to also fill COMcheck. Because as I mentioned, and as Christina described, this compliance form is meant to fully meet reporting requirements of 90.1, for Section 11 Appendix G project. And we are planning to add reports that will facilitate site inspections right to this compliance form.

So, another question about LEED, minimum energy performance calculating, and whether this can be used. So again, I would – if you intend to use this compliance form for LEED project, I would

doublecheck with GBCI first, but as of now, they do plan to allow it.

"Where is the compliance form acquired?" So, there is a link to the compliance form on the DOE website. [*Crosstalk*]

Rose: And Richard actually added that link, Maria, in the chat, so attendees can look at the chat window, and the link is there, as well.

Maria Karpman: Okay, yeah, thank you. Thank you, Rose.

And then, I see some complimentary notes about the compliance form – thank you for that, and we are all very excited about having this tool available. And, you know, I'm sure once people start using it, there will be bugs and we will work to fix them and make productivity improvements, and hopefully to simplify life for both modelers and signatory viewers. But really hope that it will see a lot of use, because that's the best way to improve the tool, to have people use it and comment on it. And you can submit comments on the tool to _____ help desk, and I think there is a link for that right within the form. Or you are also welcome to just e-mail Mike, me, or Christina, if you have questions.

Rose: That's great, Maria. Thanks very much, and thanks to Christina, also, for a great presentation. And we'd like to thank everybody for participating in today's webinar, brought to you by the US Department of Energy's Building Energy Codes program. Thanks to all.

[End of Audio]