Melissa Lapsa: – our building envelope Tech Team meeting, and I wanted to just put out a note that if you haven't entered your audio pin number, if you could go ahead and do that; that way at the end of the presentation we can unmute you if you have a question, 'cause we do want this to be a very interactive session this afternoon. So again, thank you so much for joining our building Envelope Teach Team meeting.

Next slide, please. I'm Melissa Lapsa, and I'm from Oak Ridge National Laboratory, and I am the Tech Team lead for building envelopes, and here's our agenda this afternoon. I'm going to give you a quick overview of our Tech Solution Team; what is it, and how are we working with our members, how can you get involved. And then we're very pleased to have Doctor Alexander Zhivov from the U.S. Army Corps of Engineers, and he's gonna give you a brief overview of a retrofit case study. And then finally, Dr. Diana Hun from Oak Ridge National Laboratory is going to give a brief overview on a new project that her team is working on looking at airtightness for new commercial buildings.

Next slide, please. So what is our building envelope Tech Solution Team? And again, if you have questions along the way and wanna enter them into the chatbox, feel free and then we can answer those at the end of the presentation. We're also gonna be running some very brief poll questions, so we wanna get your feedback along the way. So our Tech Solution Team is part of the Better Buildings Alliance under the Department of Energy, and this is really geared towards – as all of you I'm sure are aware – building owners and managers, and we're looking at five different sectors, and market solution teams are available in those five sectors to provide specific information for building owners and managers for those five sectors, and then the Tech Solution Teams – we're the seventh of them – are really meant to be a one-stop shop for information on energy-saving technology solutions so that building owners, managers – in our case, we're also very much engaged with the Architecture Engineering Organizations who also need this information on building envelopes and energy-saving and cost efficient solutions.

So, we have just recently started our Tech Solution Team and would encourage all of you, if you haven't joined already, to contact me if you'd like to become a official member of our Tech Solution Team.

Next slide, please. So our team is basically one of the Better Building Tech Solution Teams, and we're here to provide specific

information on building envelopes. So we're gonna provide information on demonstration projects, specification documents, case studies and fact sheets, calculators and analytic tools. These are the members of our team; Dr. Simon Pallin, Dr. Mahabir Bhandari, and Caroline Hazard, and Caroline will be running our poll questions for us today. Next slide, please. Caroline, go ahead.

Caroline Hazard: Okay, great. Thanks, Melissa. Virginia, if you wanna go ahead and put this poll question up, that would be great. It would be helpful if the participants could please select what type of organization best describes the work you do. You may have seen one of these before. We've changed it up a little bit to try and capture our audience a little bit better, the characteristics. So we have building owner/manager, architect/engineer, manufacturer, perhaps and energy service provider, or research/academia. And if your group is not represented here, go ahead and type that into your questions window box and we'll capture that. So let me see how far we're getting along on this. We're at about 60 percent. Let's give it another second or so to get folks to chime in. I do see that a lot of the names on the registration are some of our members, so that's encouraging. We're pleased to see that. So make sure you put in your audio pin so when we're able to get to the chat discussion section, we can hear from you.

Let's go ahead and close that out, Virginia, and show the folks the results. As we expected, with this Tech Team, we're anticipating working a lot more with other types of organizations, including the design community. So we are well represented here by the architects and engineers at 38 percent, but we're also excited to have a lot of building owner/managers represented and a handful of the other categories. So that's really wonderful. Welcome, and we look forward to working with you. Why don't we go ahead to the next slide?

Melissa Lapsa: Great. Thanks, Caroline, and some of you may wonder, you know, "Why are envelopes so important to buildings?" on the energy side, and it's because they use almost six quads of energy, and the envelope is the primary determinant of the amount of energy required to heat, cool, and ventilate a building, and this chart down at the bottom – I'm sure all of you are familiar, but you can see the breakout of that 5.81 quads to the right, and you can see how that breaks down by envelope components.

Next slide, please. So this lists the key barriers through research that we've done and talking with stakeholders as well to why new energy-saving envelope technologies are not more readily

deployed in the marketplace; cost, of course, supply issues, installation issues, the decision culture, resistance to new products, et cetera, and information gap. So these are the barriers that we're trying to address and provide resources for our members.

Next slide, please. We did have a series of webinars some of you may have participated last year in trying to get down into the details of what resources would be more helpful in overcoming those barriers, and so on the right, we really could pull out by participant what was most interest, and just looking at building owners and managers, demonstration projects and performance specifications were the key pieces of information that – resources that they were interested in to help overcome those barriers in making decisions to try to incorporate new envelope energy-saving technologies. And so for FY '17, we are focused on demonstration projects to validate windows and air barrier technologies and we'll provide those results on our website, which I'll talk about in a minute, and we are doing, as Dr. Diana Hun will describe, the air barrier market analysis.

Next slide. So what our goals with the Envelope Tech Team is to engage and support our members, to accelerate adoption of building envelope technologies. We wanna build awareness with guidance and information. W wanna conduct technology demonstrations to really show and validate the performance of those energy-saving, cost-effective envelope solutions, and we wanna offer technical assistance for envelope projects. We have created a website and the URL is there and that's what the homepage looks like. If you would go onto the Better Buildings website and go under solutions – I mentioned there's seven technology solution teams – you'll see our building envelope. Ours is a little bit different from the other ones in that we kind of have three different websites in one because we have an area for walls, roof, and windows. So you can find information on all those three areas on our website, and it will be continuing to grow as we get more information. We want it to be a one-stop shop for envelope information.

Next slide, please. And I would mention that we are gonna have some technology demonstration opportunities, so if you're interested, there's the criteria; a building envelope retrofit construction or planned façade retrofit projects, 30,000 square feet or greater. Let us know and you might be able to participate with us. That would be fantastic. So we're looking for participants in our demonstration opportunities.

Next slide, please. So this lists our current members. We're super excited to have ten members already since we just started, and we have also some supporting organizations listed at the bottom, and I would invite all of you if you're not already on this list to e-mail me and join our Tech Solution Team. And so with that, I will turn it over to Dr. Zhivov for the Army Corps of Engineers. I'm sorry, Caroline, please run your next poll. Sorry.

Caroline Hazard: *[Laughs]* We're gonna do a poll here. That's okay. So this is a little different. We're gonna do this poll as an open poll, so this means that if you guys could chat into your window box what type of enclosure system topics or challenges you'd like to work with us on. So as Melissa described, we're really looking to engage some members and, you know, working on solutions that are helpful to you in trying to move forward with investments in enclosure systems. So the kinds of things – just to give you some ideas – maybe there's something that's technology specific, perhaps windows or perhaps it's something market barrier specific, you know, related to cost issues or installation issues, perhaps it's related to the building enclosure commissioning or testing procedures, or something else. So go ahead and type that in. I see we've got some folks lighting up the screen here behind the scenes so we can see. Thank you for that.

The kinds of things folks are saying are install best practices; that's great. Maybe if you can share what kind of technology you mean there. Window flashing, ventilated façades, commissioning, super insulated roofs, insulation behind the spandrel, commissioning again. Maybe you can talk a little bit about kind of commissioning, if you need specifically enclosure system commissioning. Somebody wrote in "We're interested in window retrofit technologies and demonstration projects. That's great, so maybe you can participate in our demonstration. Construction, air ceiling. So this is awesome. So keep that coming. We'll work with you to see how we can advance some of these ideas moving forward, perhaps at follow-on discussions at our next meeting or in a e-mail format. So we really appreciate that feedback. I'll also throw in here, if you have any questions about what the team is about or what we're trying to do, go ahead and type those in and we'll get to that during our question and answer period at the end of the session. So with that, why don't we go ahead and advance it to Dr. Zhivov.

Dr. A. Zhivov: Good afternoon. I just want to let you know that I was able to get on your system, so actually if you can give me driving abilities so I can change my slides myself?

Caroline Hazard: Sure. So Virginia, if you can go ahead and do that.

Dr. A. Zhivov: So, okay, show my screen. Do you see it?

Caroline Hazard: Yes.

Dr. A. Zhivov: Okay, excellent. Well, good afternoon. My name is Alexander Zhivov, and I'm within the US Army Engineer Organization Development Center. I'm working in the area of building and community energy efficiency and energy master planning, and one of my current projects is the International Energy Agency Annex 61 on Business and Technical Concepts for Deep Energy Retrofits of Public Buildings, and one of five products from the project is the technical guide on deep energy retrofits. So yesterday I send it to publisher, so it will be available. What our team did in this project is that we analyzed multiple case studies with the deep energy retrofit, so where you are using site energy used by more than 50 percent. And we found that actually we can easily achieve 50 percent energy use reduction in most quadratic zones in the buildings with the low internal loads by using a handful of technologies. As you can see on the slide, a bunch of those technologies are related to the building envelope, some of them are lighting, and then HVAC systems.

Building envelope plays a significant role in energy use reduction, and if you want to have a discussion on economics, we can talk later or you can ask questions or contact me directly. But single measures payback. They have a prohibited for payback period. It's related to the building insulation, windows, and such, but when you bundle all these technologies, they become cost-effective, and one of the important parts of this task is the air barrier.

So let's go to the next slide and, as I promised, most of my presentation will be on the air tightness in new and retrofitted army barracks. And we started being interested in this topic not because of energy. A few years ago we had a lot of problems related to mold and mildew in our buildings, and we started looking at reasons for that. So we look at a number of buildings which had these mold problems, and they were energy inefficient, there was a lot of air coming through cracks in the building envelope between the windows and walls, and actually all this moisture and energy issues are coming head and head. So as you can see on this slide, some of the buildings have very extended envelopes surface and the courtyards which are not necessary. When you do major renovations, you create more penetrations in the building envelope

between floors than there was before and they become leakier, poor workmanship, a lot of cracks in doors, building need a lot of authorization efforts. And as you can see, there's a lot of examples, and I have thousands and thousands of these pictures where you have mold issues.

So we started this effort in 2006. We tested a few buildings, and there were about 0.57 up to 2 per square foot, so the way you measure air leakage is to the air flow from the square foot of the building envelope, that includes walls and slab and roof. So all this _____ box surface. At the measure – at 75 _____ _____ pressure between inside and outside. And then we did some analysis and we found that if you reduce air leakage from the baseline of 1.0 CFM per square foot to 0.4, you're already gaining quite a bit of energy saving. You can see here how difference of 0.25 and 0.15. So we decided that actually 0.25 looks very attractive. It's very easy to achieve where you don't need to do a lot of effort and will pick up that number, and for the high performance we decided that 0.15 is achievable based on some statistics that I show a little bit later.

So what we did was we developed a requirement. So this requirement was 0.25 CFM per square foot, and this is our team that participated, and the meeting _____ _____ was endorsed by the _____ of the Army and the command of _____ and you see on this picture our team. So we developed the requirement to air tightness. We developed the protocol, which went through two phases. So one was developed by the small group, and then another one, the newest version was developed in cooperation with the air barrier _____.

And then the third key to success is that you have a mandatory requirement to test every single project for the new construction or renovation. So the requirement for air tightness, the protocol how exactly you measure, and the requirement to measure every single project. And then you can _____ _____ _____ success. So here is some slides showing what we mean by the continuous air barrier just in schematics and the drawing for the plan and _____ section of the building. And so we required that this type of drawings and architectural details shall be shown on all the architectural drawings of the project. So here are those architectural details that I'm talking about, that you need to _____ require your constructers to have for new construction and major renovation project. But in many cases, you don't do major renovations. So you do minor renovations, and actually we learn from _____ _____, who passed away a few years ago in _____ _____, how to deal with the organization of buildings since _____ buildings with a minor

renovation. So we're talking about certain areas, and what kind of technique to use, and what kind of technologies _____ to be applied, and that's the way you can get to 2.3 or 0.25 CFM even with a minor renovation.

So this is a sample of requirements to airtightness in different countries. So as you can see in – our _____ 0.25 is most recent in many – in the European countries, but not as _____ as, for example, requirements for the _____ _____. But if you put requirement 0.25, you will get to this 0.15. People will strive to achieve this target, and therefore they will reach those in average 0.15, which is pretty close to the _____ requirement.

So this is requirement to the air barrier materials, specifications of the requirement to air barrier testing, and standards to be applied. And this is some sample from results. As you can see, we can achieve easily 0.05, 0.14 in some of our new constructions renovation projects. But it's a sample from 500-plus buildings that we already built and renovated since we put this requirement in place. And if you look at our previous projects, the average air barrier testing was 0.57. Actual requirements from _____ 189 is 0.4. Our requirements, 0.25, and in average, we achieve 0.18.

And this graph shows for different types the effect for having a consultant. So if you hold a hand of your constructor, and you are explaining what it means to design and to perform a air tight barrier, and you do it maybe twice or three times, then _____ _____ is already embedded and you already know that the next project they'll doing for you or for somebody else, they will know what is expected. So you see the difference between the consultant and no consultant.

Now, we tested two barracks, one before renovation, another after renovation, and here's the difference when 075 CFM per square foot and 0.1. There's a dramatic difference, almost better than a _____ _____ building. So since we started this process, ASHRAE has adopted our requirement, but as you can see, they give you three passes. First would be a requirement to air barrier materials, then you can option to test the assemblies of the walls, and only the third option is the whole building test. And of course, the path of least resistance is number one. Not many constructing companies want to do the air barrier testing of the whole building.

So in conclusion, the requirements result in sustainable buildings, and they improve soldiers' wellbeing, and it's not on the energy – also the ability of the building, and we achieve that for all our

projects; new construction and the renovation projects. As I mentioned, till now, we are requiring measurement after each project is completed. I was thinking about reducing that measure maybe two out of three, and then maybe each _____, but it's easier for our constructing officers to require it for all the buildings. Estimated first cost is about $0.50 per square foot or less, and the simple back depending upon the climate zone, between two and ten years.

Okay, and this is my contact information, so if you are interested in talking more about requirements, protocol, and other things, you are welcome to send me an e-mail. Now, I think _____ we can go to questions.

Caroline Hazard: Great.

Melissa Lapsa: Right. Thank you, Dr. Zhivov. Next slide, please.

Caroline Hazard: Yeah, while Virginia's pulling that up, we're gonna go, Melissa, to a poll question, and while that's coming up, I'll also remind her that if you can type in your questions into the window box, that would be great. We'll save time for questions at the end. We have one more presentation from Dr. Diana Hun coming up. But before that, one more poll question. This is one where you can vote. So go ahead – Thank you, Virginia, for putting that up. Would you be interested in working with the Tech Team on developing resources such as those listed below to address airtightness requirements? That's one of the deep _____ areas we're focusing on for this call today. Installation or product specification guidance, case study demonstration best practices, case studies demonstrating energy and non-energy benefits, training tools for decision makers and designers, and if you have other ideas, go ahead and type that in.

We'll give that a minute or so, see how you guys feel about that. This is great. We really appreciate your feedback on these things, and as we work on this, we'll be contacting you to get your feedback and involvement in developing any of these resources. And again, if you have questions for either Melissa or either Dr. Zhivov, go ahead and type those in and if we have time, we might even unmute your line and hear from you directly, or we might have to read your question, depending on the timing. So why don't we go ahead and close that out. We're at about 60 percent here and we'll show those results. You know, this is not surprising to me. We want to hear some case studies demonstrating both the energy and non-energy benefits. So that's really great to hear. That is something that we have been thinking about on our end with the

Oak Ridge Tea, so we'll look forward to working on that. We'll also investigate how we can maybe address those other options that folks have selected. So with that, why don't we go ahead and – Melissa, do you want to introduce Dr. Hun?

Melissa Lapsa: Yes, absolutely. So we're pleased to have Dr. Diana Hun from Oak Ridge National Lab presenting next. So Diana, you're next.

Dr. Diana Hun: Yes, good afternoon. My name is Diana Hun and _____ my information. I'm a researcher at Oak Ridge National Lab and in particular I work for the building envelope systems research group. Today, I am just going to give you a very brief overview of a study that we just started on the evaluation of airtightness requirements for new commercial buildings.

Next slide, please. So given that I just mentioned this project just started, we would really appreciate your feedback on the relevance of this work that we are proposing with regard to how relevant this information would be to building owners and managers as well as to the construction industry in general, and at the end, you can either e-mail us, or during the Q&A let us know what tasks we need to add or what tasks we could delete because the information is readily available.

Next slide, please. So as you probably already know, commercial buildings are responsible for about 19 percent of the energy that is consumed in the U.S., but one of the reasons that we are conducting this work is because about 6 percent of this energy is due to infiltration or exfiltration through the building envelope; or in other words, air leakage. Okay?

Next slide, please. So obviously then our goal is to try to decrease this energy penalty. So the goal of the study that we just started is to try to help building owners and managers and the construction industry better understand key aspects that are related to envelope airtightness, and more specifically we want to gather information about the current airtightness requirements, the methods that are currently being used to demonstrate compliance with these requirements, we wanna to also gather feedback from the stakeholders that are affected or could be affected by these requirements, and also we would summarize what are the measurements that are currently available, and our last task would have to do and try to predict what's coming up for new commercial building construction. I'm gonna describe in a little more detail each of the bullets that I just mentioned. As you can see on the right side of the slide, if you want you can type yes or your e-mail

address in the chat box to let us know if you're interested in collaborating in this study with ORNL.

Next slide, please. So with regard to the current airtightness requirements, we are gonna summarize what is currently being used as a requisite both from the building code and also from standards. Also we're gonna look at the local governments that tend to be a little bit more progressive in order to then summarize how they differentiate themselves from, let's say, what the IECC or ASHRAE are asking for. In addition to that, we're gonna look at what governmental institutions, such as GSA and the Army Corps as Dr. Zhivov just presented, are requiring and how that compares to what the codes are asking.

Next slide, please. So on the methods to demonstrate compliance, currently most codes refer to ASTM E779 as what consultants should follow. However, as Dr. Zhivov mentioned, the Army Corps recently put a test protocol out. So we're gonna compare how the ASTM standard compares to what the Army Corps has proposed. Also the Air Barrier Association of America, or ABAA, has currently submitted a protocol to ASTM, so we should be seeing that in the near future. Also we want to see how ASTM E779 compares to what the Canadian code is requiring. And again, all of this information will surface to better know or predict what may be _____ _____ of new construction in the near future.

Next slide, please. As I mentioned, we also want to gather feedback from stakeholders, and these stakeholders include the consultants that conduct these air leakage tests, and we want know from them _____ information that in general managers and designers would care to know. Okay, what is their availability? Are there certification programs that they need to comply with in order to be conducting this test? Also we want to gather more information about how the costs of their tests are determined and how long does it take to conduct this test, and if there are any ways in which either one of these could be decreased. Okay, so also we want to find out, okay, what type of documents they provide to the designers and the code officials, and what kind of feedback they have received from customers who have agreed to have these tests be conducted in their building.

Also we are gonna gather information from the customers. That's, again, the owners and the designers, and we want to know, okay, what kind of information they need in order to make more educated decisions about how to improve their _____ of their _____. *[Break in audio: 0:34:08]*. Also we want to know what do

they see as the benefits and drawbacks from requiring an air leakage test in their buildings and if there – and in the end, okay, so we want to compile all of this information to put together some best practices.

Next slide, please. As I mentioned, we are also going to summarize the data that is available on the air leakage rates of commercial buildings; more specifically regard to the building type, the size of the building, the number of stories of these buildings, and where these buildings tend to be located. Okay?

Next slide, please. We will also gather information on what is being predicted for new construction, again with regard to the building type, size, and where these are gonna be located, so that we can combine this information with what I just previously described, let's say with regard to the availability of air leakage test consultants, and also the measured data with regard to air leakage rates, and also with regard to the proposed changes to codes that were tried to be implemented in the 2018 IECC, but they were not successful. And by combing all of this information, we may then be able to determine the market that could benefit the most from improvements in airtightness. Okay?

Next slide, please. So again, we just started this project and we will appreciate your feedback with regard of, okay, what we could change or to improve it now that, again, we're early in the project.

Next slide. And with that, I'll be glad to answer questions when the time comes.

Caroline Hazard: Great.

Melissa Lapsa: Thank you, Diana. That was excellent. Next slide, please.

Caroline Hazard: Well Melissa, if we're ready – Oh, Melissa, I was gonna try and take questions before we went to your last _____.

Melissa Lapsa: Sure. Okay.

Caroline Hazard: Is that okay?

Melissa Lapsa: Absolutely.

Caroline Hazard: Sorry for the switcharoo there. So we were gonna try and unmute someone. I think that was Joan. Joan, are you there? *[Background conversation]* Okay, so Joan maybe is away from her phone, but

let's go to the next question. Why don't we go ahead and mute that line there, Virginia, and I'll remind folks, if you wanna type in any questions for Dr. Zhivov or Dr. Hun or Melissa – okay, so we're muting those lines. Sorry about that. So Joan's question is for Dr. Zhivov. Does the Army Corps do testing for indoor air quality given the very tight building or do they adjust ventilation rates to insure fresh air?

Dr. A. Zhivov: Well, we do not, and there is no need to test buildings for indoor quality if you make them airtight. You would just design good ventilation. If you want to open windows when needed, you open windows, but you have a control where _____ _____ the ventilation rates by mechanical systems. So you have a mechanical system with heat recovery, and actually one area on the table in the second slide is the dedicate outdoor system. So you overdesign the ventilation.

Caroline Hazard: Great. Thank you for that.

Dr. Diana Hun: Can I answer that, Caroline?

Caroline Hazard: Sure, go ahead. Thank you.

Dr. Diana Hun: So in general, also designers follow ASHRAE 62.2, which provides the – specifies the ventilation rate requirements so that you can have adequate indoor quality.

Caroline Hazard: Great. Thanks for that. We also have another question for Dr. Zhivov. Have the leak rate reductions been made without thick building issues? So I read that poorly, but let me read it again. Have the leak rate reductions been made without thick fix building issues?

Dr. A. Zhivov: Again, you are not ventilating buildings through cracks. You have control of that. If you want to have a natural ventilation, you open part of the windows so you don't have all these issues with the thick building syndrome if you tighten the buildings. So your residential buildings, probably in most cases, are designed so that they ventilate using cracks in the buildings. But most of our commercial buildings should be designed to have a mechanical system with outdoor air.

Caroline Hazard: Yeah, so our questioner wanted to know has it improved the IEQ of the building; how has it helped that aspect?

Dr. A. Zhivov: Well, if you have a dedicate outdoor system, then you have guaranteed supply of the fresh air from outside.

Caroline Hazard: Okay, great. So I'm not seeing a lot of questions on here. I did want to mention to you, Diana, that we have at least four or five folks that are interested in working with you on the study. That's great. Do send your e-mail either to Diana or to Melissa. Either way, we'll make sure you get involved in that. So –

Dr. Diana Hun: Yeah, and _____ _____ *[crosstalk]* Caroline, if they are interested in working on demonstration projects, I am leading a couple of those that are with regard to the retrofit of building envelopes. So just let me know too.

Caroline Hazard: Right. Great. So why don't we go to the last slide here, and Melissa you can take it away, and if folks have more questions, feel free to type those into your chat window. We did have some issues with the unmuting, so apologies for that. We'll have to do the reading off of you typing it in if you have questions. Thank you.

Melissa Lapsa: Right, thanks Caroline, and I wanted to just take a minute to thank all of our speakers, Dr. Hun, Dr. Zhivov, Caroline, and Virginia for helping us put this _____ _____ Tech Team meeting together today. I wanna thank all of our participants. It's just been fantastic to see the response to this Tech Solution Team. We would invite all of you to join us at the Better Buildings Summit in May in D.C. If you haven't already registered, please think about that, and we are gonna have two sessions on envelope technologies at the Better Buildings Summit. One is gonna be on Tuesday afternoon of that week, so the afternoon of the 15th, called "Hidden in Plain Sight" where we're gonna be presenting Tech Team resources including information on air barriers, and then on Wednesday morning we're gonna have a session called "Stranger Things" and we're gonna be presenting some new technologies on emerging window and wall systems. So please, we invite you to participate. We're also gonna participate in the "Ask-an-Expert Sessions" at the Better Building Summit. So we're looking forward to it. It'll be a great event.

In summary, the Get Involved! section is really our ask of all of you; please join the team if you're interested in keeping engaged with us, send us your feedback on our webpages that we've put out on the Better Building Alliance website – as I mentioned, there's three different areas and we wanna get your feedback. Are there things missing or things we should be adding, or what is your feedback? What is useful to you that's on that website? We talked about Diana's study; provide input if you wanna get engaged with

that or keep informed on the results. We'd like to hear from you on demonstration projects. Would you like to get engaged, or what would you like to hear from us? When we get done, make sure that you stay engaged on the whole process. We're happy to hear from everyone.

My e-mail address is down on the left, and we really appreciate all of you joining today. With that, we will end the webinar, and we did record this so we will post this out on our website, and we'll send a follow-up e-mail with the links to everyone who participated today. Thank you very much.

[End Transcription at 0:43:38]