Recording: The broadcast is now starting. All attendees are in listen-only mode.

Melissa Lapsa: Good afternoon, everyone. This is Melissa Lapsa from Oak Ridge National Laboratory, and we're really excited today to be bringing you Tech Solution Team Webinar on Building Envelope Commissioning and Retro Commissioning. And we have a lot of material here to get through today, so I'll go ahead and get started. So next slide, please.

So what is the Building Envelope Tech Team? A lot of you on the line are familiar or members of the tech team, so I won't go into a lot of detail. But just as a high level, what we're trying to do is provide information and resources to help advance energy efficient building envelope tech solutions, and that's through the form of technology verification studies, specification documents, case studies and fact sheets, calculators, and analytical tools.

We wanna hear from all of you to help us prioritize what we are providing so that energy efficient envelope solutions can be more available in the marketplace. So the members of our tech team are myself, Dr. Simon Pallin, Dr. Mahabir Bhandari, and Caroline Hazard. Next slide, please. And what we're doing is engaging and supporting our members in efforts to accelerate adoption of energy efficient building envelope technologies. We're building awareness with guidance information, connecting verification studies and other technical assistance as needed. Next slide, please.

We're very excited that we just launched our tech team in November, and so we've had two tech team meetings. And we also presented two successful sessions at the Better Building summit last month in D.C. And so our current list of members are listed here. We also will provide this PowerPoint file and a link to the recording to all of you participating today, and this has the link to these organizations for more information. And the members include building owners, managers, property managers, and construction industry and installers. Next slide, please.

In addition to our Better Building Alliance Tech Solution team members, we have friends. And these organizations include researchers, academics, trade associations, energy service providers, manufacturers, and subject matter experts, and this list is growing as well. So I'd encourage you if you're not already on our list and would like to get involved with our envelop tech solution team, to just drop me an e-mail – which I'll provide at the end of

the webinar – and we will get you added right away. Next slide, please.

So the agenda for our webinar today – and we're gonna have two great speakers, and then we're gonna open it up for some great Q&A – but Dr. Simon Pallin is first gonna talk about why building enclosure commissioning. And as I mentioned, he's on our tech team. He is at Oak Ridge National Lab. He has worked in the buildings industry since 2006, and he spent several years conducting research in Europe.

He joined our building envelope systems research team in 2103 at ORNL, and he serves as a risk assessment moisture simulation expert and works with both existing simulation tools and creates new tools to estimate the hygrothermal heat and moisture performance of building elements, such as walls and roofs. And following Simon, Dr. Paul Totten is going to speak, and he is gonna speak on going deeper, building enclosure commissioning and retro commissioning. Paul is a vice president at WSP and leads the building enclosures division.

He has over 20 years of experience in the field of structural engineering, building enclosure, technology and commissioning, and building science. He has concentrated his expertise on the evaluation of – an analysis of heat, air, and moisture transfer, and the cumulative effect of these elements on building components and building operation. He is past co-chair of the Washington, D.C. AIA NIBS Building Enclosure Council, a member of NIBS, ASHRAE, and U.S. Green Building Council, and was a committee member of the NIBS Guideline 3 – Exterior Enclosure Technical Requirements for the Commissioning Process.

Following these two presentations, as I mentioned we're gonna have the Q&A. We're gonna talk about next steps on this topic, and then we will wrap up and adjourn. So with that, I will turn the next slide over to Dr. Pallin.

Dr. Simon Pallin: Yes, thank you, Melissa. Okay, yeah, I'm gonna give you short introduction to Paul. I'm just briefly gonna talk about why commissioning? Why should we do it? About the importance of looking at the building as having a holistic view and an holistic building envelope assessment, why that is important. And we should talk about insulation quality, making sure that it's being – buildings are built as designed. And when relating to cost, and investment, and return of investment, we obviously want to make sure that we get what we paid for.

Looking at optimized ND performance is another aspect, benefit of doing commissioning. Maybe they're interested in having some building certification, such as LEED, and commissioning is important. Or user comfort is one of the reasons why conducting commissioning. Next slide, please. Okay, so building envelope is complicated. Most of us know that. And there are different control layers in the building envelope, and they have served one, or two, or several purposes.

We have like a water resistive barrier that's supposed to get protection for precipitation, rain, and such, and we have an air barrier that should help to reduce – if not minimize – minimizing the air leakage through our buildings. Obviously, we need a control layer that has the thermal resistance properties, insulation that is. We might need a vapor barrier. We might need something for light, for noise. And as part of this, is also structural performance, of course. Next slide, please.

The thing is that we can look at that whole building as pieces of puzzles that needs to be put together. We might have very good components individually that works great, but we need to make sure that these components works great together as well. That's why it's so important to have this holistic view when doing a building envelope assessment or commissioning. Next slide, please.

So I'm just giving you an example here, where we have an existing building. You have the brick façade, and we might have interest in keeping the brick. I'm looking at okay, what options do we got to improve the thermal resistance of the wall? Then okay, maybe we need to do something from the inside. Typically, then a commissioning agent would think that okay, what could be the –

[Break in audio]

Dr. Simon Pallin: – or part of that wall. One concern could be that okay, if I put insulation on the inside in a cold climate, that means that the façade material might be colder by doing this. And so it would be of interest maybe – and certainly for brick then – to see will the number of freeze/thaw cycles increase by such a retrofit measure? And next slide, please. And what then can be done is that okay, create a simulation model. For this example here, it's in Chicago. We picked a climate. Next slide, please.

Then one can study and look at the temperature at the brick and see okay, did something happen with this? The blue is just representing the temperature variation of the brick before the retrofit, and it's touching the freezing point a couple of times. But when we look at the red curve, which is after the retrofit, we see that it's frequently going up and don across that freezing point. Meaning that now, oh, we increased the number of freezing cycles by – with more than 100 now. Then the question would be okay, is this brick able to handle this, or do we need to look at the different retrofit approach? Next slide, please.

And we wanna make sure that we have a good installation quality. We want it to be built as it's designed to be built. Next slide. So as an example, just showing you the importance of this – and maybe some of you have seen this slide before – but this is really important. We had a study where we looked at the air tightness of 12 identical buildings, and we measured the air tightness of these buildings. If we look at the air tightness, what might influence the air tightness in the building could be the construction design.

It could be the flow air of the volume, number of penetration, types of penetration and installation, what he material properties are, and workmanship. But what's interesting with this is that we looked at 12 identical buildings. So can I have another click, please? These will be eliminated – all of them – except for workmanship so that the installation quality is what is left. Then we can look at the result and understand importance of installation quality. Next slide, please.

Here we present the tested air tightness from this study, where we see great variation. ACH 75 means the number of times the air inside the building is exchanged with the outdoor air at a pressure gradient of 75 Pascal. It's just a relative indicator, but it helps to compare between buildings – one building with and so on. We see that we have almost down to 4, and it stretches up to 10, so it's more than a factor of 2 in performance. And this is only because of variation in installation quality. Next slide.

And quickly as well, I mean money, of course. When we have our energy bill, we have our energy charges, and we also have to pay for demand charge. And next slide, please. And here's just an example where there are two customers. They both use the same amount of energy, but they have a totally different cost just because customer A has a much higher demand than customer B. This would sort of exemplify the importance of, again, installation

quality, but also the importance of – showing the importance of the retrofit and the return of the investment. Next slide.

With that brief introduction, I'm gonna present next speaker for today. So Paul, thanks for presenting to us today.

Dr. Paul Totten: No problem. So we can go to the next slide. So we're gonna cover the building enclosure commissioning process as it's currently defined under *[inaudible due to muffled speech]* four and talk a little bit about older buildings and retro commissioning of buildings, how we can repeat that process over and over again on our building infrastructure. Next slide.

Just a brief outline of the presentation. I'm gonna discuss the processes as defined, leading from Guideline Zero all the way through to the ASDM standard we're currently using across the industry. Talk a little bit about how that applies and gets broken down differently for retro commissioning, and give a few project examples. As noted earlier, we'll take questions at the end. Next slide. So we have a wide range of buildings that we can commission, everything from significant museums to stadiums to schools.

Some of these are existing infrastructure that we're tying into. So the school example up on the right-hand corner is an existing brick masonry building with some historic aspects, which was receiving a new arm to the building, including solar chimneys for passive ventilation. Next slide. We can also look at other types of tie-ins to much more historically significant buildings, and even everything from upgrading HVAC within these spaces to what that impact may be on the enclosure systems.

We could have programs broken down to something as simple as plaster repair and define a commissioning program simply for the plaster repair program. Or retrofitting and installing new windows into an existing façade, and how we deal with the flashings of the membranes for that flashing system. Next slide. So what is commissioning? I think there's a couple terms that you will see throughout the slides, and one of them is listed here. I'm gonna list both of them now.

We have to focus on the owner's project requirements. What is an owner expecting out of the projects that they're planning to build, and construct, or renovate, or revitalize if it's an existing building? And what is the basis of design? What does the design team field they need to do to accomplish the owner's project requirements?

And so we will see over and over again in the context of commissioning is the OPR – the owner's project requirements – in the basis the design. The process overall is quality focused.

I would describe a good commissioning authority as a conscience of the project. They're there to verify that not only is design intent being met, but to point out issues that may result in an issue for the owner long term – widespread condensation risk, water infiltration risk. Next slide. We have a couple different processes that on throughout the industry, starting with the commissioning process as defined by ASHRAE in Guideline Zero that was built upon for enclosure commissioning that was part of the and follow-up effort by NIBS for Guideline 3. Next slide.

And that is now turned into an ASKM standard. So similar to the MEP side, which is ANSI joined at ANSI ASHRAE standard in the upcoming years. We now ASKM standard that defines the process for commissioning. It talks a little bit about qualifications. You do need a group of people commissioning your enclosure who understand roofing, waterproofing, air barrier, wall systems, insulation systems, and the building physics of those systems.

It's based on Guideline 3 as a backdrop and includes two levels of commissioning – basic and enhanced. These same two levels have fed into LEED version four and other commissioning standards and guides that we're seeing roll out across the country from different entities of something that's a much lighter, maybe cost for an owner. Just to have a single design review to make sure that the basis of design aligns with their owner project requirements, and that it's something that's well enhanced.

Additional design reviews, *[inaudible due to muffled speech]* construction observation, observation of performance testing at mock up – maybe in a laboratory or in the field – and some follow-up measurement and verification. So it gives you these two scales of program. Next slide. So where is the value? If you wanna just click on that a few times, we have a little animation on this slide. It probably does three. That should be good.

So as the project becomes more complex, there is actually more value in doing commissioning. And the reason for that is on the most basic of buildings, there's quite a bit of cost that has to go into a commissioning program. It's still has some value for that owner, and maybe on a brick mason restoration job there's some still some value in doing it. The program might need to be defined to be more cost effective while still providing that value.

_____ _____ _____ complexity, and the complexity could be as simple as we're doing a new glass curve wall we're tying in to portions in the existing stone masonry building. That interface actually has a lot of complexity to keep the new from condensing, to separate zones of pressurization between HVAC. And there is a good spot – additional oversight of your project to help reduce the risk overall of that project, and to provide better value for the owner at the end, that they have some confidence that our systems are gonna perform together.

They're gonna work better, and we're gonna have some reduced risk of water infiltration, heat loss and gain, air infiltration and exfiltration across those interface conditions. Next slide. It can be broken up into these steps, so we have a pre-design phase. This may be starting with an owner project requirement _____ and then working through an OPR BOD review. We have our design phase, schematic design, design development, and construction documents that are the various phases of the design team creating the drawings and specifications to the project.

We then move into a construction phase where we'll see some minerals and _____ drawings, the intent for the contractor to build the project. And then we move into kind of a *[inaudible due to muffled speech]* phase. Troubleshooting over that first one or two years to address issues that may arise. Next slide. This can then be broken up into the portions of the actual commissioning process, so we have these steps _____ _____ on the previous slide. And so in the pre-design as I previously noted, this is where our OPR and BOD will be reviewed and compared.

And the commissioning agent and authorities' role is point out discrepancies. The owner wants a 12-story building; designer's designing a 16-story building. Those two things don't match. We change our mind on the size of the building. Is the square footage the same? This is the new route. We need to have those documents aligned. Our design reviews that typically two stages for commissioning. Design development, we need enough details and information on the set to really define what the design team wants to do for the roof, the walls, the air barriers, the flashings.

And usually it's schematic design. That stuff is very, very much light. It may have a general system defined, but not really the specifics. And then construction documents. Before we go to construction, validating that all the changes that were looked for in DD have been incorporated. We have our construction phase. We

have our closeout. And many of our enclosure commissioning projects we find that the closeout doesn't always have post-occupancy work. That's becoming a more and more common thing to start seeing that.

But usually an owner would like a closeout document, something that summarizes all the work that's done from the beginning of the job to the end, and we tend to provide that in electronic format, a summary of all the document. Next slide. So what does this process look like? It could be something as simple as infrared thermography. So if I'm doing an existing building, one step that may – in many cases this has to happen before we dig too deep into the process is to do an upfront condition assessment of the infrastructure of that building.

What does the roof look like? What do the walls look like? What is the existing thermal performance of the systems, and one we might evaluate that is thermography. On the picture right below that is performance testing of some historic windows on a project that we did here in the Washington, D.C. market. Through the existing *[inaudible due to muffled speech]* building components leak _____ _____ need to be repaired. Then we'll drag all the way through doing construction observation, design concepts, in some cases observing of those design details. Next slide.

Under the chance to lead version four, we have actually the basic and enhanced described pretty intrinsically. In the prerequisite, there's a couple things owners, and architects, and those working with LEED need to understand. The commissioning authority now needs to be retained no later than design development, no later than DD. If they are retained after DD, they no longer meet the prerequisite. The enclosure commissioning agent usually would be retained at the same time, and they do need to two things under the prerequisite for enclosures.

We have to review the OPR and compare it to the basis of design, a BOD. We have to do a single design review of construction documents. Next slide. Under enhanced commissioning, there is a few more requirements put in. But a general breakout of that, an additional design review is done earlier. So if you're gonna do an enhanced platform, you're doing a second design review of what happens to the DD, design development phase, before the CD review that would happen under the prerequisite.

You'd have construction phase services, and this is when there's some flexibility in how an owner defines their commissioning

program. We've seen the most basic programs, just review and repair documents, their submittals for restoration, and then doing the on-site performance testing, observation, and site visits. That is the construction phase document. We see more extensive on some of our museum projects. We're going to a laboratory and watching full-scale mockups. We're reviewing all of the shop drawings, all the structural calculations for the façade components.

We're doing an extensive number of construction site visits. We're reviewing all the field testing for the enclosure systems. So this is where an owner could really pick and choose where they spend some of their dollars. And our closeout is typically final document. _____ looked under the ASCAM standard in LEED, provide documentation to the owner of the process from the OPR/BOD review through the final site visits.

And hopefully at that point all the open items that were issues on the project have now been resolved, though it also lists any remaining items that the design or construction team need to resolve before turnover of that building. Next slide. Within this e have a series of responsibilities. So the commissioning enclosing commissioner, they would be part of commissioning team led by an overall commissioning authority that may include an MEP commissioning agent, a _____ commissioning agent, _____ safety commissioning agent amongst others.

Their contract, however – these jobs get thought of differently. We've contractually been _____ _____ based on the owner's requirements of the construction manager or general contractor on some projects. The design team on some projects *[inaudible due to muffled speech]* construction phase by the owner. So again, there's this careful balance of what an owner's requiring contractually. And they may assign the commissioning agent more commissioning authority to a certain party as well _____ project requirements.

We then have to interface with all the other professionals on the contracting side and on the design side throughout the process. It allows us to not only comment, we have to work with the team to resolve issues that may come up within our purview of commissioning. Next slide. If we break this down to actually looking at the process, we may have some project requirements that are defined by an owner. "I wanna reduce my energy consumption. I have no tolerance for water leaks."

And so when I look through the base of design, how is the design to resolve that? Have they gone to code-compliant insulation levels? R 25 for a lot the _____ the United States. What type of waterproofing are they using on the roof and maybe the plazas? What type of flashings are they using? So we're looking for those really defined parameters in the base of design or some general understanding of the intent of the design team to make sure that those align with the project requirements an owner may have. Next slide.

To look at all the elements that lead into an owner's _____ project requirements, it's everything from the initial vision of the project to how they may wanna operate and maintain that facility. *[Inaudible due to muffled speech]* existing facility. It may mean something that's going through upgrading or improvement, and then the maintenance cycles that are being defined for that. There may be system performance requirements they *[inaudible due to muffled speech]* or blast, and those are built into the owner project requirements. Next slide.

And so we also might see things on system integration, the level of redundancy they want in their details. Some owners are very defined that they want two levels of redundancy in every roof to wall connection, every curtain wall, or _____ tie-in to the wall. And sometimes we'll see that in hospital projects, where leakage at those locations has got no tolerance for risk of mold growth and contamination. They may have training requirements for their own facility staff. We've seen this with roofing sometimes, where a campus may want one roofing type throughout all their buildings, because their staff is familiar with that roofing typed.

And anything that's new with the system, they get their staff trained on as part of the closeout of the project. Next slide. As we get into the design reviews, we are comparing our drawing reviews back to the owner project requirements of the basis of design. When I'm doing a consulting or design project on behalf of an architect, these comments might look a little bit different. I might say, "Here are your options for flashing. You should use this flashing as a consultant."

As a commissioning authority, we may get some of the same context, but the comment may read instead, "The flashing detail that's provided does not provide long-term durability and is at risk for water infiltration. Here are four options we've seen used with great success on past projects for improving this condition." So although the designer's getting the same end information, it's the

way it's delivered, aligning with the OPR that is very critical for a commissioning agent.

We'll go through those design reviews. I know that only DD and CD were listed earlier. Our firm tends to find that if we do initial review of schematic design, we may find something that needs to be switched out earlier. So for example, we may have a design team that's chosen a roofing system that due to some unforeseen condition – contaminants in the air or something near that site – may not perform as well. So we catch that at schematic design before they fully detail that system. There may be less design effort that's needed later on to go back and change that out.

We'll typically wanna compare systems so that if there are options that a designer should be considering, they understand the pros and cons of each. And then talk about material compatibility and the HVAC system – the heating and ventilation and air conditioning system's interaction with the enclosure. A lot of times we find that these reviews come in, and we don't see that the team has really had a chance to communicate. We've seen this as the consultant, where we get a set of comments back, and it's clear that they haven't looked at the HVAC layout.

And so the comment might be, "You're not getting heat to the window system." If they looked at the HVAC layout, they would find there's diffusers for the heating system very close to almost every window on the project. So regardless of which role one's playing, they need to make sure that there's an understanding of those systems interacting, because they can drive a lot of risk. Next slide.

In the process of doing these design reviews, there has to be an intrinsic good understanding of the basic fundamentals building physics, and building science for walls and roofs, and below grade waterproofing, which direction heat transfer's gonna occur at different times of the year, where the various vapor float control layers are. We may have a lower _____ material *[inaudible due to muffled speech]* certain climates like Florida, Washington, D.C. where we have higher humidity.

We would do something different in, say, Kansas City, or Los Angeles, or Portland, where the climate conditions are different. We understand the airflow, and then how those impact our various systems – below grade waterproofing, our walls, our various types of cladding, our roofing and the interface between those assemblies. Next slide. And so something that might come out of

this on _____ an existing building is something critical for a window replacement program.

We've seen these on all sorts of buildings – on the commercial side, on the residential side, and looking at federal buildings. Window replacements are becoming more common. If the building's in pretty good shape, this is a pretty good target for energy improvement. With our current project we're working on with mass masonry walls everywhere, the walls have some efficiency.

But the window replacement from single-pane glass old steel windows to new windows has provided a 300 percent improvement of the window opening based on the overall percentage of the window influence on the rest of the building. One hundred percent improvement in the energy performance of that building versus where it was performing today. So we find this as low-hanging fruit *[inaudible due to muffled speech]* projects. And one thing that you may have to work through is flashing concepts.

So with this designer, we provided a series of options, where you can see in the top right photos, they end up having to fit around some existing portion of the structure that would've been challenging to modify with this nice soldered flashing with a kind of indented _____ condition. Next slide. On our drawing markups, what you may see is something that is used by a member of *[inaudible due to muffled speech]* commissioning agents in the industry is color coding of comments.

What you're seeing is a markup on the sheet. Everything's in blue. The blue identifies concerns with the waterproofing of the detail, and the tie-in below a door, which can be very challenging. We tend to follow red for thermal, green for _____ _____ considerations. For those of us who run the Oak Ridge National Lab _____ Institute _____ _____ program – hygrothermal analysis to look at heat and moisture movement through materials in one dimension – the green is a reminder to look at vapor permeates, because the software uses the green color in the grass to look at vapor drive. Next slide.

We may be looking at something as simple as the roof data, so we're finding more and more on retrofits and revitalizations, and especially on new construction. More thought is being put into how we safely tie workers off on the roof, the walls to do window washing, to access the building for re-caulking and repairs. And so

what we'll find is that these details tend to have a massive _____ potential. And sometimes they'll show condensation in certain climates *[inaudible due to muffled speech]*, and the facility staff may assume they have a roof leak.

And so we've had projects where somebody's ripped apart a perfectly good roof detail to find a condensation problem later. And so by insulating that, we find that you can box that in and make that airtight *[inaudible due to muffled speech]*. These are comments that are helpful for a designer to pick a couple options. We've given them two different ways of isolating it in this detail. Next slide. When we get to something more complex, like a _____ tie-in, it's really important to have an understanding of how the different materials interface.

Buildings move. We see a lot of movement sometimes *[inaudible due to muffled speech]* condition, where we don't have the constraint anymore of the wall. If it's gonna extend, it's gonna extend *[inaudible due to muffled speech]*. And so the way that membrane is layered at those interfaces is actually pretty critical to make sure that when the building moves, it doesn't move that membrane and pull it apart where it's gonna create a leak.

So although many of the designers we see in the industry will draw their intent of a continuous membrane, we'll usually comment or recommend they show the layering of those membranes because of the criticalness of movement as part of their doesn't intent. We find that almost every designer we've worked with either as a consultant or a commissioning agent has found this extremely helpful to think about. The other thing is we tend to insulate the _____ _____ _____ wall, but lo and behold we forget the back.

In certain climate zones, that's a massive thermal bridge where we can drive massive condensation problems with the top of the building *[inaudible due to muffled speech]*. And so just understanding the limitations of the space, how much insulation we need based on the climate zone, then offering viable suggestions as a commissioning agent is extremely helpful for the design and owner team to make a decision on the cost, the benefit versus the extra effort that might need to go into it. Next slide.

And then another thing that we find complex is sometimes we have an architectural intent. Maybe it's to meet an historic need. We have a lot of buildings where we're retrofitting roofing onto an existing façade panel. It might be concrete. It may be stone. It may old precast. Many of our '50s and '60s buildings now are at the

point where they could be designated historic, and so we're finding those modernist and brutalist structures are hitting that mark. Many of them have historic skylines where you're seeing the sky at the top of the building, so you can't really put a _____ all the way over for historic reasons.

And so the detailing of something seems as simple as two stages of sealant becomes very critical in these projects. And so we tend to work through in our commissioning effort of thinking about how the water drains between those two joints and gets out of the building. Next slide. The same is true of terrace conditions. We're looking at all these interfaces between now what is essentially almost two coping conditions – a _____ condition, a terrace, an area that is being used for access.

In this case there's no railing shown, so this might just be a perimeter detail that's tied to something beyond with access. And we have a second coping ahead of the curtain wall, so these transitions require some of the same redundancy in more than one location. But we're also talking about *[inaudible due to muffled speech]* wall barriers, roofing system details, more wall barriers, and back to roofing. And sometimes we occasionally end up with two different roofing system. So helping the design team to see the nuances of how those go together are very critical.

And the way the comments are put together to help them understand what would meet an owner's project requirements can be very helpful. Next slide. The other thing that we wanna look is how the HVAC system interacts with our building enclosure. This is an atrium on a project that we're currently working on. It's a museum space. And our diffusers are kind of near the end of the top, right at the blue arrow. They're _____ because they can't aesthetically be any closer, pretty far from the glass.

So we had a discussion with the team about how the air was gonna move to the glass, the effective convection, and the convection heat exchange of the occupants moving through the space. We were able to resolve ways of heating parts of the structure, potentially drive more heat into the glazing and use that as a passive radiator to drive better convection in the space, which allowed us to look at downsizing the air handler for this atrium. Next slide.

And then we found another project where we looked at issues driven by system furniture on a retro commissioning project, where they were missing insulation in a couple zones of the building.

What is happening is in the summer, solar radiation would immediately transfer to heat. The complaints would be, our feet are always hot. Our legs feel extremely warm, but our upper body's cold because of the air conditioning. And so this thermal bridging issue couple with how the system furniture was laid out, and how air moved around the system furniture – so if we look at the diffuser, we had the air coming towards the glass.

Then that's following the pathway _____ _____ the system furniture, people's desks, and the partitions. The bottom of that, just for leveling purposes and sometimes to run infrastructure for IT. We tend to have a gap that acts almost like the same diffuser in the ceiling. In the winter this problem was worse because of the thermal bridging. All that heat was being lost to the outside, and so the air would cool almost to outdoor condition. So what people were experiencing above their desk was heat, and below their desk was the cold conditions of outside.

So we went through a retrofit insulation *[inaudible due to muffled speech]* condition and improved the system furniture coordination to eliminate the issue. The HVAC in this space had already been optimized, so now it's performing the way it's expected. Next slide. We'll wanna verify the submittals, shop drawings *[inaudible due to muffled speech]* and how that stuff aligns with the installation for schedule. Next slide. And then we wanna go through mockups, and if we go to the next slide, it's probably a little bit easier to describe _____ looking at a visual.

So if we go to a test lab, they're gonna build a full scale mockup of part of your building. They're gonna run wind pressures using usually an airplane propeller, create hurricane-type loading. It's a very useful way of determining what details may or may not be working in the shop drawings before they actually build your building. And so in commissioning this as a common thing that we're asked to do on more significant buildings. Next slide. And some of that testing can then be taken to the field.

So what you're seeing on the right is that same type of lab testing, but using an interior chamber with a small leaf blower fan to essentially create a pressure-like wind across _____ _____ system. It's hard to tell, but we have a spray rack on the outside. We're doing that in the field. So similar to the lab testing, the same types of tests can be performed in the field. We are seeing on the left-hand side is this giant metal suction cup on a roof. This is the test run by FM Global to look at wind uplift *[inaudible due to muffled speech]* bonding.

It uses a deflectometer and this large suction cup material to essentially pull up the roof membrane under some load to determine is it gonna be at risk for tear off based on how much it deflects. Next slide. We also wanna look at air leakage. If you're doing an Army Core building, they have a pretty stringent air _____ testing that they like to run. _____ _____ this whole building air barrier testing, which you fill the building with smoke. You essentially are running blower _____. You're looking for –

[Break in audio]

Dr. Paul Totten: – visually the leaks. And then the second phase of that test is you can get a quantifiable amount of leakage. And sometimes in localized conditions on existing buildings, we may be asked to go an look at what's going on with the enclosure. We seem to have a lot of air leakage or complaints of draftiness. And so we can go down and use that same type of testing very localized with a small handheld device that creates smoke to determine if those interfaces are actually leaking air. Next slide.

Another construction observation *[inaudible due to muffled speech]* these projects being able to walk through safely while being tied off. _____ materials as they go in. Next slide. This sometimes involves working with the tray, so we can see on the right hand side it's one of our masonry projects. One of the details we like to use and comment on for our designers and our contractors is the small tab – you see these little squares around every brick tie? They're air sealing, and they're caulking only on three sides.

Tie locations and _____ framing are very susceptible to air infiltration and some water risk. And over time, that can corrode the little bit of protection you have on a metal framing stud and make that tie loose over time. So this is a quick easy way of doing that with redundancy. And sometimes the contractor's stuck with some very tight conditions to put things in.

And so as a commissioning agent, we are occasionally out in the field working with them to make sure that we have a good detail for that condition, and then going back to the design team and their consultant to discuss, "Here are some other things we're seeing in the field. What should we do? Do you have some ideas?" So as a team we can come together and find a better way of doing it. Next slide. And with that, I think we're ready for questions.

Melissa Lapsa: Great. Thanks, Paul. So Simon, do you wanna take it from here?

Dr. Simon Pallin: Yeah, I hope that some of you have some questions.

Caroline: This is Caroline. If folks want to raise their hand if they have a question, we'll unmute your line, or you can chat into your chat window if you have questions. I'm not seeing any questions just yet. My while we're waiting for some of those questions to come in, Simon, you could queue up some of the ideas that we're thinking about for the tech team to work on, some of the questions we're asking ourselves that the members might help us think about in terms of resources that could be helpful to them.

Dr. Simon Pallin: Right. Yeah, so let's click on next slide. We had a couple of topics here that is relevant for commissioning. I'd like to hear what you think in your experience. For one of them, we wanna talk about LEED certification. What is your experience here? Have you completed a project on the LEED certification? What was your experience on that?

Caroline: I think Joan from Arlington might be unmuted. Joan, are you there?

Joan: I'm here.

Caroline: Great, maybe you can speak up just a little bit. You're a little far away. But did you have some questions or thoughts to share?

Joan: Well, I wanted to thank Paul. We've met once before. He gave a great presentation in Arlington, and he is a phenomenal commissioning agent. So thank you for all that. One question I had – *[inaudible due to muffled speech]* but just overall – buildings are becoming more and more complicated.

The photos you were showing, and the designs you were showing, and the commissioning review that has to happen. Is there any movement to make buildings a little bit more simple so that some of these – all these penetrations, and different angles, and _____ connections, and all of that might become simpler in the future instead of more and more complex? Seems like that would help the commissioning process as well as the just general construction process.

Dr. Paul Totten: So I'll take that question. This is Paul. I don't see designers becoming more simple. _____ _____ that has really allowed designers to really stretch their imagination with architecture.

However, as either an enclosure consultant or enclosure commissioning agent, you can work to simplify the locations and the way that the detailing is done. So one of the buildings that you saw earlier is actually the International Spy Museum here in D.C., which will have a very complicated façade.

But our air barrier installer on that project has complimented us on how simple the details are for them to install. We essentially made a box for all their detailing for the air barrier systems and the waterproofing that the façade is proud of. And in doing that, we've gone back to the basics. And so it is really the role of the consultants and the designers to find those simplifications within their design and for our commissioning agent on the enclosure side to work with them to help them resolve those simplifications.

We dropped a lot of money in that project for the owner by doing that, and so it is a thought process. There's no hard and fast rule that your façade needs to be tied directly to all of your other performance layers. You can layer up a building differently, and so we have when we worked with designers – we're getting thinking about that. Where does the product actually need to go for _____ _____, maybe in a different plane where it's easier to detail. Then this other stuff can be out in front of it without compromising the overall building performance.

Joan: Another thing I noticed is in your – one of your slides, you said one of the other project requirements was that there was no tolerance for water leaks. Why wouldn't that just be an assumption in every project?

Dr. Paul Totten: By code it is. We like starting with the simple, so if I can get an owner to answer some simple questions, many times they – the owners we work with don't always have a defined set of requirements. If I'm working with a major museum or hospital group, they usually have a very, very stringent set of requirements for their designs. But not every owner does, and so we find that that's an easy one to get people to think about. The building should be watertight, and then we ask, "What else should it be? Well, it should be airtight. Then we need to think about ventilation."

Ends up being a good discussion point. The sad reality is those in my field, we also spend a lot of our time on leaky buildings. And roof leakage is still one of the number one lawsuits experienced on building construction. And so bolstering that, and by putting it in the project requirements as a reminder, and being able to take that

through the commissioning agent through the project, helps to minimize that risk greatly.

I've seen my past experience – looking at some projects and talking to some of the other people in our industry that sometimes when an owner hasn't come out and said that emphatically, it's amazing how often it doesn't get achieved. Yes, it should be blatant.

Joan: Yeah, it should be blatant. Perhaps – you just said that roof leaks are one of the most common problems, and we see that also here. But I'm wondering if that's something that one of the research labs is either looking at or should look at as ways to minimize those roof leaks. _____ there's a huge problem and costs a ton of money once one of those roofs does leak.

Melissa Lapsa: Simon, you wanna take that one?

Caroline: Simon, is that – yeah, Simon?

Dr. Simon Pallin: Yeah. Can you please repeat that, Joan?

[Crosstalk]

Dr. Simon Pallin: About the roof leaks?

Joan: Yeah. Paul just mentioned that roof leaks are very common, very expensive, and _____ sorts of lawsuits. It seemed that if we could nip that in the bud, design them better initially, perhaps have different materials, something like that – that's a problem that might be addressed by some of the building experts at one of the research labs.

Dr. Simon Pallin: Right, yeah. But you're referring to water leaks now, right?

Joan: Water leaks mostly. I mean, I think that's what the roof problem is, right?

Dr. Simon Pallin: Right. We see many problems, not just from the water leaks, but from air leaks actually through roofs as well that's supposed to tied. The problem is complex. We know that. It's one roof that works in a cold climate will not necessarily work in a hot, humid climate. There's continuous research going on to – best of all we would have one solution that would work in any climate, but we definitely not there yet.

Melissa Lapsa: Simon, maybe you could speak to some of the tools that are in our roofing webpage section that could be helpful to folks in trying to think about addressing any problems, or finding problems, and then finding the products to solve those roofing problems.

Dr. Simon Pallin: I understand we're short of time. I'm just briefly saying that if you all visit our website, we have under Better Building Alliance, we have one category just for roofs. You can find some really useful information and resources there. Also tools, especially for – we have one newly launched air leakage calculator for roofs, which is very useful. So I would definitely recommend having a look at the website for that.

I wanna just quickly go through a couple of these points that we've – bullets that we wanted to discuss here. Can I have some clicks here so we can present the full lists, basically? One more. There you go, okay. So what we wanted to talk about – and what we think is relevant and of interest for building envelope commissioning, hopefully for the team as well – is when we talk about metrics in building envelope or the building envelope performance. I want us to discuss if they are useful.

Do we think that they represent the performance of building? Are they too many? Are they complicated? Are we missing metrics? We would appreciate some of your thoughts and experience there. Also, when it comes to buildings built as designed, what is your experience here? When it's not perfectly built, have there been – what's the reason for that? Is it lack of communication? If so, what actions do you think are needed? Like Joan said here, is the envelope system too complicated?

Are we looking for more bulletproof systems? Is it because – the reasons it's not being built as designed, is that because there's conflict between trades and things like that? We also wanted to maybe discuss the costs associated. Based on these bullets here, if you have any thoughts – and this is something where you can also send an e-mail to Melissa Lapsa afterwards. But if we have the time to discuss one or two, or if you can share some experience right now, that would be great. But if not, we also appreciate if you can share your experience with Melissa Lapsa and the team later.

Caroline: I'm not seeing any questions typed in or any hands raised. I know we're running close on time, so Simon, maybe you could share the other – the last bit of questions. Then Melissa, you can show the last slides that had your e-mail on it so people know how to get a hold of you.

Dr. Simon Pallin: Right, right, okay. Next slide. And if I can have a couple of clicks there, too. Right, okay. And other questions that are relevant now is, of course, for retrofit commissioning. What is the difference between commissioning for new construction and for retrofits? Are incentives different? What's the building owner's incentives for retrofit commissioning? What are the barriers? Are we missing certification programs?

And again, can new construction metrics apply to retrofits? Those are the questions that we think are important when discussing commissioning and retrofit commissioning. So with that, I think we can click over to our very last slide. So we have a double click. All right.

Melissa Lapsa: Thank you very much. And back to me, Melissa Lapsa, to close out this webinar. I really appreciate everyone's participation today, and of course Simon and Paul, for your excellent presentations. We would like to hear from all of you, so these tech team meetings are meant to be interactive. So we appreciate your participation. We'll send out the slide deck and a link to the recordings, so we'd like to hear from you. You can call me or e-mail me, and give us your comments on Simon's questions.

And also, as Simon mentioned, there's a link here to our website. Give us feedback. It's a lot of information broken down by windows, walls, and roofs. We're continuing to add resources to the website. These resources are there for the team, so if something's missing or you have questions about it, please let us know. We'll also be sending out information on what our next tech team meeting will be, what the subject will be based on the feedback that we've received on priority topics to cover.

So we do have – we encourage you to join the team. We do have some ongoing activities as well that once you're a member of the team, they're open for your engagement. We have an airtightness requirement study going on right now. We have technology verification studies going on right now, so we would encourage all of you – if you're not already engaged with our team – to join. Just send me an e-mail, and we'll follow up. With that, I will thank everyone once again and appreciate your participation. Have a great rest of the afternoon.

[End recording at 55:08]