Hayley McLeod: Okay, good afternoon everybody. Thank you for joining us. Welcome to the 2021 Better Buildings Summer Webinar Series. In this series we are proofing the best practices of Better Buildings Challenge and alliance partners and other organizations working to improve energy efficiency and buildings.

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So I'm Hayley McLeod, I'll be your moderator today. I am a technical professional at Oakridge National Lab, just outside of Knoxville, Tennessee. I am the non-technical lead for the Building Envelope Campaign, which is what we are all here to talk about today. I've been the building science industry for about seven years.

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We are excited to announce that today we will be using an interactive platform called "Slido" for Q&A. If you've been on one of these before you're probably familiar with Slido. But if you could please go to www.slido.com on your mobile device or by opening a new window in your browser, today's event code is #DOE. If you would like to ask our, myself or any of our presenters questions throughout the presentation please feel free to submit them anytime throughout. We'll be answering them offline after the webinar is complete, because all of our presenters are not live with us today. So please be sure to include the presenter or the presentation that you're question is about so that we can get those to the right folks at the end of the presentation. After the fact our team will e-mail you with a link where you can tie in the written responses to those questions on the Better Buildings Solution Center.

You can also select the "thumbs-up" icon for questions that you like, which will result in the most popular questions moving to the top of the queue and a greater chance of those getting answered if we get you know a ton of questions and can't do them all we'll obviously prioritize those that lots of people wanted to hear about.

Again, just to repeat I really request that you try to put the name of the presenter or presentation in your questions to make sure that we can get them to the right place.

If you have any technical issues or have any questions about this Q&A process please reach out to the webinar organizers through the Go To Webinar Chat box, not in Slido, but in Go To Webinar.

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So I wanted to start this presentation off today by just giving a huge shout-out to our organizers. The American Institute of Architects, the International Facility Management Association, and the International Institute of Building and Enclosure Consultants, or as you probably know them as "AIA," "IFMA," and "IIBEC." They've given us lots and lots of crucial behind-the-scenes feedback and guidance this year and we would not have had a successful year without them.

I would also like to take a moment hear and give a special thanks to IFMA who has donated these really awesome plaques that you'll hopefully see in the lobby of all of the buildings that we're recognizing in today's webinar, so again, a big shout-out and thank you to IFMA for these.

Back to slides and the next slide please.

Okay so I want to know just a little bit about who I'm talking to today. I'm always curious about you know who in the industry is attending these. So you should be able to see a poll up in Slido currently. So I will give you guys a few to answer. Lots of building owners and managers, that's great, lots of government folks. Oh this is great. There aren't a ton of "others" coming up to the top. Sometimes I, I miss a whole sector, but it doesn’t look like I've done that today. So this is great. It looks like we're still getting a few answers, but we will close this off here in a second to keep it going. Oh yep there's other, I knew it would pop up.

Yeah, lots of, lots of government folks and, and building owners and managers. I hope you're either participants from this year or are going to be participants next year.

So we can probably go ahead and, and close this whole if it's leveled out a bit and, and move one.

Okay, so I'm assuming that if you found your way to our webinar today, you're probably at least somewhat aware of what the Building Envelope Campaign is all about, so I'm only going to include a couple of really high-level slides about the Building Envelope Campaign in case any of you have, have come across our webinar and haven't, haven't heard from us yet.

So the Building Envelope campaign is a current Better Buildings Technology Campaign. There are a couple others that are running

concurrently or in development and there certainly have been several in the past, but so we, we are in series. So if you think you've heard of the Better Buildings Technology Campaign you probably have and we're kind of in that series.

This one in particular was designed to help create more energy efficient buildings by improving envelope performance in the building stock in the US and in order to do this the campaign has introduced a new metric for building envelope performance called the "BEP value." We have also released a tool on our website to help you determine that value for your building.

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So the, the three main goals of the campaign has been to motivate action and increase awareness about high-performing building envelopes, so that's what we have been using in conjunction with our great supporters and participants and organizers all year. That second bullet point there is recognized leaders in this field and that is what today is all about is recognizing those folks that have, you know have achieved really high-performing building envelopes in, in all building types. Then that last item is demonstrate and document the energy and cost savings that comes from these high-performing envelope systems. So that's kind of what our website is all about, what today's webinar is all about and more on some website updates coming later.

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So I wanted to give you know a high-level summary recap of year one. So 16 buildings were submitted, of those 14 were eligible. You're going to hear from 13 of those project teams today and then I'm going to tell you a little bit about the 14th. Those buildings represent almost 1.5 million square feet of conditioned floor area and 9 million kBTU and about $500k annual savings based on envelope technologies alone.

Personally as the lead for this campaign what I find most exciting about these numbers is that this is a really diverse collection of buildings that we are able to award in our first year. So we have new construction buildings, we have retrofit buildings, and we have multiple sectors represented here, so healthcare, education, commercial, industrial, which I think really goes to show that there are you know high-performance envelope solutions available to, to all sectors and all building types.

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So that was a bit of a year one summary and that's what today is about, talking about the successes from year one, but we are still going and we are looking ahead into year two, so I wanted to give you a little bit more detail about that.

We are looking to continue to grow. We want to recruit more participants and more supporters in the coming year and, and have a greater industry impact through that level of improvements.

I'd also be interested reaching some additional sectors this year. We don't have any hospitality projects this year. Obviously hospitality was an industry that took a huge hit from COVID, that's hopefully bouncing back a bit.

You'll also notice as this webinar continues that there was definitely a bias towards new construction projects, as opposed to retrofit projects and so I'd love to reach out and hear more, hear from more retrofit projects in, in year two.

We've also already updated our assessment tool on our website so that it includes a CO2 reduction estimator and we are also developing a "Successes" page on the website. So that's a mockup of it on the right. It won't look exactly like that, but in the coming weeks we are going to be able to post some basic information about all 14 of these buildings. So downloadable one-page factsheets, as well as the short clips that you're going to hear today. So if you, if you're interested in something you hear today you know I encourage you to go back and rewatch the whole the webinar if you want, but there will be the individual snippets available on our website as well.

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The last note that I wanted to make moving into year two is that in this year because we were a brand new campaign and because you know COVID did slow down the construction industry, we got a lot of projects that submitted that were either very late in construction or were post-construction when they heard about the campaign and when they analyzed their building with our tool. Hopefully this year moving into, into year two we've gotten into some heads of some folks that were a little earlier in those project phases and ideally folks will be able to use the, the campaign and the resources on our website and our assessment tool to help inform design and construction decisions and, and so that's

something that we're really looking forward to in year two as well is to get some folks that, that not only design great buildings you know with very little help from us, but who actually like really you know used our help to, to make design decisions, that's, that's what we're looking for.

So next up we are going to hear like I said from those 13 project teams. We're going to hear from our new construction buildings first, so those are those Novel 20 and 40 Awards. Then we're going to hear from our retrofit buildings, that's Retro 30 and 50 Awards and then I will wrap it up again at the end. So please enjoy hearing from all of our great project teams and thank you so much, we couldn't have done it without you.

Industrial Center Building Addition:

Hello, I'm Andrew Federowicz, an architect and project manager with FESS Engineering at Fermi National Accelerator Laboratory. I'm here to present an overview of the Industrial Center Building addition, a recipient of the Building Envelope Campaigns Novel 20 Award.

ICB-A is located approximately 35 miles outside of Chicago on the Fermi Lab campus. It is situated within the Industrial Building Complex of Fermi Lab core campus. ICB-A is a 25,000 square foot state-of-the art facility constructed to build SRF cryomodules and superconducting magnets for accelerators at Fermi Labs and partnering institutions.

In response to Fermi Labs campus master plan vision to consolidate and modernize new facilities ICB-A is an expansion of the applied physics and superconducting technology division's footprint.

The main level of the facility includes a 45-foot tall high-bay assembly area, with a 40-ton overhead crane used for maneuvering large components. Adjacent to the high-bay program is a connecting corridor between facilities that includes the building's main entrance, equipment rooms, and a quantum computing lab. Overlooking the high-bay space and above the entry corridor are two mezzanine spaces constructed for future office build-outs.

Key decisions made early on in the initial planning and conceptual design phases established that the new ICB-A facility would be an addition to the ICB and IB3 facilities. This approach allowed the design team to develop a strategy to unite the surrounding assembly areas and staff under one roof, while eliminating over

7,000 square foot of the building's envelope exposed to exterior climate.

In addition to minimizing the building's exterior envelope ICB-A was designed to be compliant with the guiding principles for high-performance sustainable buildings. To achieve compliance an energy model was developed during the design phase to ensure a 30 percent improvement over the ASHRAE 90.1 standard. All together the building's _____ systems utilized an insulated precast panel for durability along the assembly areas, a double-glazed insulated unit for daylighting and insulated metal panels to reduce thermal bridging and improve air tightness of the primary façade. Vertical connections between the insulated metal panels were backed with a vertical insulated spline. This spline was sealed at each reveal to maintain continuous insulation.

For the horizontal connections the panel, the panels utilized a double-gasket shiplap filling to maximize thermal efficiency and create a double barrier against air and water penetration.

On behalf of the ICB-A project team thank you again for letting us participate in year one of the Building Envelope Campaign and for recognizing the Industrial Center Building Addition with the Novel 20 Award.

Lubber Run Community Center:

In December 2016 VMDO was selected to begin work on the replacement of the 1950's era Lubber Run Community Center in Arlington, Virginia. In addition to a new community center building the project includes new outdoor recreation spaces and amenities, as well as underground parking on a four-and-a-half acre site. The center is located in Lubber Run Park, a precious natural resource in urban Arlington County. Connection to nature and preservation of open space were essential to designing the new building and as a result parking and some programs are located underground to allow for increased outdoor amenities at ground level.

The 50,000 square foot facility features multipurpose rooms for recreation programs for all ages, a fitness center, locker rooms, a gymnasium, a preschool program, community meeting rooms, a kitchen, reception, and office space for countywide parks and recreation staff. Outdoor recreation spaces include a playground, volleyball and basketball courts, covered gathering spaces, and improvements to site circulation and streetscapes needed to facilitate access to the facility by all modes of transportation.

The project seeks to blur the distinction between outdoors and indoors and promote the health and wellness of building occupants. Care was taken to maximize views to the outdoors from within to provide dynamic daylighting to all the occupied spaces and encourage occupants to feel connected to the park landscape around them.

The building envelope that acts as the threshold between indoors and outdoors is significant in both its high performance and economy efficiency.

Because burying the parking was an expensive undertaking compared to a less desirable and less sustainable surface lot, measures were taken to reduce the cost of the rest of the project. This included right-sizing building program for the projected need, providing flexibility, simplifying building geometries, and using structural materials as finish materials, including using Thermomass walls in place of stone plating.

Given the extent of concrete on the site steps were taken to mitigate its environmental impact. The Thermomass system, which embeds insulation within a mass wall to improve performance reduces the amount of Portland cement required and allows the use of the structure as the final interior and exterior finishes. Concrete used on the project employs CO2 injection which sequesters CO2, reduces the embodied energy of the concrete, and improves strength. Once this was established a mass timber structure was employed, which further reduces the project's embodied energy.

The project's material palette was deliberately chosen for low-maintenance qualities, as natural finished of concrete, wood, and copper patina over time and improve with age. The approach also resulted in some surprises, such as the cost savings associated with site milling trees, which turned out to be less expensive than purchasing conventional hardwoods. There was also the added benefit of reusing the site's trees that were significant to local community residents. Site-harvested cedar, walnut, and oak were milled onsite and converted into furniture and paneling.

Areas where you see vertical-seamed copper siding have a fluid applied air-barrier system that adhere directly to the exterior face of the sheeting. Horizontal girts were installed to support the panels and before insulation was incorporated or copper attached, an air infiltration test was performed to confirm the performance of the system. Some small gaps in the barrier were detected, especially at the anchor points for the girts, which allowed us to

return to the overall conditions and ensure the envelope was as tight as we could get it.

Lubber Run recently won an AIA DC award for architecture where the jury commended the project dynamism and section, thoughtful use of materials, welcoming atmosphere, and net-zero initiatives. As a LEED for Communities Platinum winner our Arlington County is a sustainability trailblazer combing forward thinking environmental goals into its energy use standards, while also balancing issues around livability, diversity, and increasing development.

Many of the approaches pioneered at Lubber Run, including the Thermomass system have informed new projects currently on the boards. The lesson learned is clear, attentive design of the building envelope contributes to healthier buildings that last longer and perform better.

Plant Sciences Building:

Hello, my name is Andrew Cherry and I'm a project architect at Flad Architects. I'm here today to present NC State University's new Plant Sciences Building, a Novel 20 awardee in the inaugural year of the Building Envelope Campaign and the latest edition to the University's Centennial Campus.

The building is an 184,000 square foot academic research building, comprised of wet and dry labs, faculty offices, industry partner suites, and a 10,000 square foot research greenhouse on the top level of the building. The building's program would typically indicate that it's a heavy energy user and this building is no exception, particularly with the environmental requirements of the greenhouse. To help offset these large loads the project team worked to reduce environmental loads on the HVAC system as much as possible. One of the primary targets was the building envelope.

The Plant Sciences Building is clad in a nix of aluminum curtain wall and opaque rainscreen systems, specifically terracotta and aluminum composite panels. Both rainscreen systems are back ventilated and supported by thermally broken rainscreen support systems. These support systems allow the project to maximize the thermal benefits of the insulation provided at opaque wall assemblies. The drain nature of the rainscreen discharges moisture that manages to defeat the rainscreen and enter the wall cavity, while the vapor permeable fluid applied air barrier allows additional drying of the wall cavity in North Carolina's mixed humid climate.

The exterior glass for the building strikes a balance between providing visual clarity and limiting solar heat gain. At public-facing areas of the building the insulated glazing units were coated with a low-e coating that meets North Carolina's energy codes prescriptive values for solar heat gain and U-value, but also allows a high degree of transparency. This clarity allows a visual connection between building occupants and the campus community, a key feature of NC State's campus character.

In other areas of the building, like open offices and laboratories, a different coating was selected that exceeds prescriptive requirements, but still provides building occupants views to the surround campus.

Glazed areas of the building utilize a traditional stick-built aluminum curtain wall system that incorporates a thermal break in the glazing pocket. When aligned with the insulation layer at adjacent opaque walls the combination of the thermal break and insulated glazing helps to reduce heat transfer between the interior and exterior of the building. Although other more thermally-resistive materials were considered for the curtain wall system traditional aluminum curtain wall was selected in part for its ability to be reinforced, allowing the outboard attachment of one of the building's defining features, its exterior solar shading devices.

While coatings can help reduce the amount of glare and solar gain attributed to glazed curtain walls the most effective means of reducing these gains is to not let sunlight get to the glass in the first place. To reduce the amount of solar radiation reaching the glass an array of aluminum airfoils was mounted to the outside of the curtain wall. This array was broken into a series of zones at each floor, a vision zone, a daylighting zone, and a spandrel zone. Using a genetic algorithm the angle of the shades in each zone was optimized for its function.

In the vision zone the airfoils were tilted downward to reject incident radiation, but provide occupants on the upper floors views of the surrounding campus.

In the daylight zone the airfoils were installed level, to reflect daylight deep into the building and help illuminate the spaces within.

In the spandrel zone the shades were redundant to insulated spandrel glazing and interior insulation, so shorter, lighter, rectangular profiles were provided.

This combination of glazing and insulation strategies allowed the Plant Sciences Building to right size its mechanical system, devoting the building's energy to the occupant's research, rather than making up for excessive energy transfer across the building envelope. Just as importantly, the project demonstrates what can be achieved using materials and systems that are readily available across the US when they're applied in a judicious and systemic manner.

On behalf of the project team I'd like to thank the Building Envelope Campaign for this recognition and thank you for your time and attention. Happy building.

Vermeer - New Plant 7: While our equipment is making a critical impact on the environment, our manufacturing processes are too in a good way. We strive to be good stewards of the resources we have and how we use them, from time to money and everything in between. For the last seven years we've been partnering with the Department of Energy to reduce our energy usage by 25 percent in 10 years. To help reach this goal we have made sustainable building practices a priority in our facilities at Vermeer, including Plant 7, our newest facility in Pella.

Following a tornado in July of 2018, we quickly made the decision to expand upon the 400,000 square feet of manufacturing space lost that day. The rebuilding process was quickly underway with diligent planning that pulled on our facilities, finance, operations, continuous improvement, and strategy teams.

This build had the following goals: demonstrate our 4P philosophy and help carry that culture long into the future; implement safety measures at every team member touchpoint; create a collaborative and respectful environment through consistent communications; inform and engage all team members; enable ultimate productivity that allows team members to be proud of their place of work; and outfit an agile workplace with high-quality resources to drive quality production.

The basis for our energy efficiencies in Plant 7 starts with the outer walls. Vermeer chose precast walls not only for their protection from severe weather, but also for the insulation. Each of the precast walls surrounding the new addition of Plant 7 contain four

inches of insulation. The roof has as rubber membrane and a Hardie Board under that, plus an additional five-and-a-half inches of insulation. The windows on the exterior of the building are also insulated with a thermal break in the frames that keep them from sweating and keeps the elements out. All this insulation, including the walls, roof, and ceiling reduce the amount of energy needed to both heat and cool the facility by protecting the interior from the weather outside.

This was a great start, but we took sustainability in Plant 7 even further. First, the robots used to move some of the carts and pallets, along with many of our forklifts are electric. Second, the in-house patent pending conditioned air system recycles and filters conditioned air, instead of pulling in unconditioned air from the outside. Third, energy efficient LED lights, along with ample natural light from more than 120 windows throughout the facility help reduce our energy consumption to keep the lights on.

While we may be recognized for the efficiencies found in Plant 7, our dedication to sustainability goes beyond our physical structures. Vermeer Equipment installs solar fields, recycles wood waste, builds networks to share energy and more. All hazardous waste used in our manufacturing processes in Pella is either reprocessed to be used again or is burned and used as fuel, yes, that's one hundred percent. And if we can reuse it, recycle it, or reduce it we do, wood, steel, plastic, cardboard, paper, oil, solvent, you name it. This makes us one of the largest recycling manufacturers in the state of Iowa.

As we continue to grow our campus in Pella and around the world we look forward to incorporating energy efficient and sustainable building practices into our vision. We are proud to be the first manufacture to win the BEC Award from the Department of Energy.

Athens County EMS Station #51:

Hi, my name is Chris Chmiel and I am Athens County Ohio County Commissioner. We're down in the Southeastern part of the state and Athens County is a very environmentally conscious community. We have the highest density of residential solar in the state. We have several solar installation companies. We're quite proud that the Building Envelope Campaign has given us an award for our EMS Station Number 51.

Basically this EMS Station we super-insulated the roof, the walls, under the slab, the windows. We went from the code minimum in the roof was R38, but we put in R51.23. The walls the, the code

minimum is R19 and we did an R37.85. We did a double frame, double wood frame wall with wet cellulose insulation. We also had R26 underneath the slab, which was two layers of three-inch EPS foam. Then the windows had a UB value of .22, which was above and beyond the code minimum of .35.

One of the things when we spent more money on the insulation it cost about $100,000.00 more, but in the process of the super-insulating the building that reduced our need for our HVAC units, which reduced the cost by $105,000.00, so basically building to a super-insulated building envelope paid for itself automatically.

We also did a lot of blower-door tests and we worked with our local contractors to make sure that every hole was sealed and we, we hit the targets of minimal air leakage. What was also great was we worked with all of our local contractors and gave them this experience of building a super high-performance building.

We also put solar on this building and we believe that this will be a net-zero, close to a net-zero energy building. I know our first couple of electric bills are it was like a $140.00 or $180.00, which is pretty good for about a 10,000 square foot building.

We're also very excited about trying to help the Building Envelope Campaign with some other new buildings that are going to be built in the near future in Athens. The county are going to be building a 911 Center. Also talking with a Head Start School and possibly a low-income tax credit affordable housing project.

So we really believe that our built environment is one of the best ways to reduce our energy consumption. We were a part of the Georgetown University Energy Prize competition several years ago. We're excited to have received this award from the Building Envelope Campaign and, and look forward to, to doing more.

BCH West Medical Building at Community Medical Center, Lafayette:

As a community owned nonprofit healthcare organization that understands the connection between human health and the environment, Boulder Community Health has always been eager to employ sustainable initiatives.

In addition to building the first healthcare facility in the nation to obtain LEED certification, they have ongoing goals to reduce their waste stream, increase their use of renewable energy, and implement sustainable practices wherever possible.

The health system is located in Colorado in an area known for significant temperature ranges and more than 300 days of sunshine a years. From the start the new West Medical Building at Community Medical Center in Lafayette was envisioned to incorporate a dramatic canopy that would shade the glazed atrium and could one day support a 99-kilowatt photovoltaic array. The envelope was designed to exceed code insulation values and southern windows feature horizontal shading devices, while east and west facing windows are equipped with vertical fins.

But much of the thermal energy loss and gain in a building still occurs through the windows. And the team was curious to know if there was a way to make significant improvements there. Originally, we had specified a typical insulating glass project with a low-e coating and researched the potential of a four-surface coating specifically designed to lower the U-value. However, late in the construction documents phase a glass manufacturer happened to share a new product they were working on that could potentially be a game changer, hybrid vacuum insulated glass or HVIG for short.

We quickly realized that this project was the perfect opportunity to test out this emerging technology and Boulder Community Health was immediately onboard with the idea. The team contacted the manufacturer with a pilot project proposal and soon hammered out the details of an installation.

Standard vacuum insulated glass or VIG is comprised of two panes of glass with nothing in between them, not even air. The cavity is evacuated and kept from collapsing with a grid of tiny, almost imperceptible spacers. The vacuum itself does most of the work by reducing thermal connectivity between the materials, similar to insulated travel mug. The food service industry has found that these thin-glassed panels are perfect for grocery store freezer cases. But standard building storefront and curtain wall frames are made to accommodate today's one-inch think insulating glass units and it's not an easy switch to accommodate a VIG less than three-eighth of inch thick.

So rather than pushing for specialty receivers to accommodate the glass, the manufacturer proposed a hybrid version that married the VIG with typical inflated glass construction by adding an additional air space and layer of glass. In addition to creating a thicker profile that can easily be accommodated by standard penetration systems it improves the insulated properties even

further. With three panes of glass it also afforded the opportunity to incorporate two low-e coatings where appropriate.

While the original low-e insulated glass we had specified had a U-value of 0.29, the installed hybrid VIGs had U-values of 0.071 and 0.064. For those of you that find R-value more intuitive, that's like going from an R-value of 3-1/2 to R-values of 14 and 15. This provides for a significant reduction in heat and cold transfer through the glass, resulting in more stable room temperatures and year-round energy efficiency.

The addition of the second low-e coating and besides receiving higher solar radiation provide glare reduction and improved thermal comfort in sunny spaces.

Much of our decision-making was based on quick shoebox energy modeling and gut instinct. But participation in the Building Envelope Campaign gave us the opportunity to truly understand the impacts that these decisions were making. Software available to our energy modeler and glazing subcontractor was unable to generate the overall U-values of these advanced window assemblies. But Oakridge National Labs stepped in and offered their expertise to calculate them. We will definitely look to this tool in the future to help understand our options and make informed choices.

As a whole the project showed an improvement of 46 percent. Embracing the hybrid VIG technology allowed us to upgrade the building envelope while maintaining the same window-to-wall ratio, daylighting, and overall aesthetic. It was a simple, elegant solution that we hope to pursue again in the future when the product becomes available on the market.

BVSD Education Center: Hello, I'm Jeff Medwetz, Project Manager of Energy Systems for the Boulder Valley School District in Colorado. It's my pleasure to introduce you to our district and to our Education Center Project, which was recognized with the Novel 40 Award from Oakridge National Laboratories Building Envelope Campaign.

What this means is that our building's envelope showed over a 40 percent improvement when compared to a code-complaint building. The building envelope is exactly what it sounds like. It's the walls, windows, roof, and foundation of a building and it tends to be one of the most overlooked areas of available energy savings in buildings.

Our district stretches over 500 square miles from the peaks of the Continental Divide to the suburbs of Denver. We operate over 4.8 million square feet of buildings. In 2014 district voters approved a construction bond totaling $677 million dollars for renovation projects to improve every building in the district, as well as construction of new buildings. Project efficiency goals in the building bond were guided by our sustainable energy plan and building enclosures for new buildings were a priority for us, because the envelope accounts for approximately 30 percent of the primary energy consumed in buildings.

Since the building will be with us for decades the envelope is a great investment because it helps to improve indoor environmental quality by keeping the outside, outside and a tight building will result in a lower utility spend, which is our second greatest annual expenditure after salaries.

The Ed Center consisted of a series of buildings, parts of which were originally constructed in 1963. Because the facility had both functional and structural deficiencies the older east side of the existing building was demolished and replaced with a two-story addition. The project team engaged in a highly collaborative design process to reach the district's energy functional and budgetary goals. Then we contracted an independent third-party energy consultant to join the team to provide a number of services, including energy modeling, design reviews, mechanical and lighting commissioning, as well as, building envelope commissioning. The consultant also supported the design team by providing detailed energy performance analysis and daylight analysis was performed early to help make educated decisions for the enclosure.

The exterior wall assemblies were constructed using a nonstructural rigid insulated board sheathing and careful attention was paid to sealing the system to itself and sealing all transitions to adjacent materials. The combination of exterior materials produced a deep wall cavity that created built-in shading due to the deep reveals at each opening.

Window glazing is tuned for the specific façade orientations. Windows feature both vision and daylight sections of glass and exterior sun shade. And then all the attention to detail allowed the Ed Center's pressurization or air leakage test to exceed our goal by almost 50 percent, which exceeds code by over 30 percent.

Budgetary limitations were probably the greatest challenge for the project team. This required a thorough study of the envelope's materials and how to strategically address daylighting, all while balancing the impact on mechanical systems.

Another persistent challenge was the failure of water intrusion tests for some storefront assemblies. Water is the enemy of building enclosures, but the entire team discovered that a simple fix of new sealant at the storefront assemblies was the solution to the problem.

Boulder Valley's energy goals were supported by a durable, well insulated and tight building envelope for the Education Center and we're grateful for the engaged and collaborative team of our architects and engineers, energy consultants, commissioning professionals, and contractors who helped the project finish successfully.

We're honored that all the work on the project was recognized with a Novel 40 Award from the Building Envelope Campaign. This award reaffirms our commitment to provide our staff and students with healthy, energy efficient buildings, which start with the building envelope.

Catalyst: Hi, my name is Ivan and I'm a building performance analyst for McKinstry. I am here to highlight the Catalyst Project as part of the Better Envelope Campaign. The Catalyst Project is a mix of higher education and office building located in Spokane, Washington, as part of the South Landing Campus. My role as an analyst in the project has been involved in the performance of the building, helping informed decisions through design and construction as it relates to the energy use of the building.

The Catalyst Project has high ambitions in terms of, of sustainability and energy reductions and these two things are well represented in the building envelope. The building envelope is not a typical business-as-usual commercial construction. It uses mass timber in the form of cross-laminated timber or CLT. Through sustainable forestry mass timber construction significantly reduces the carbon impact in building construction. Compared to traditional concrete and steel, CLT has a much lower carbon impact and has the ability to store carbon from the atmosphere in the material itself.

The building is also blanketed with exterior mineral wool insulation, both at the vertical and horizontal assemblies. The windows are all triple-paned with thermally broken framing

systems. Great care has been taken in the design to reduce the number of thermal weak points. The construction process was diligent in minimizing the air leakage, testing at rates lower than the passive house standard. Overall the building is highly thermally insulated and airtight, minimizing the building's exposure to exterior elements.

All of these envelope measures compound and significantly reduce the building's need for heating and cooling. This is all tied in and integrated with a highly efficient heating and cooling plant at the campus, resulting in one of the world's largest zero-energy, zero-carbon buildings.

The importance of a high-performance envelope is evident in the Catalyst Project. McKinstry would like to thank Oakridge National Laboratory and the Better Envelope Campaign for recognizing the building and its envelope design.

Credit Human Headquarters, San Antonio, Texas:

Well the whole innovative project of the elements that I like to say the least sexy, but the most important are the building envelope. With the foundation of a great envelope all the other features that we add onto it are just really additive to the reduction of energy. So it's just a really important element.

Hi, I'm Steve Hennigan. I'm the CEO of Credit Human Federal Credit Union in San Antonio, Texas.

The most important things in a good building envelope are you're trying to control for three fundamental areas. You're trying to control for thermal, you're trying to control for bulk water, and you're trying to control air infiltration. Most buildings really only go after two of those items, air infiltration somewhat being left behind. In this case if you can really get the air infiltration numbers really, really tight it makes the building extremely efficient.

Started with a really great set of glazings and then we wanted to make sure that the inner and outer walls had thermal bridging and then we wanted to actually put a membrane layer on the top throughout for the really just solid air infiltration. Then ultimately we wrapped the building in a wool layer. When you put the whole assembly together it's really designed to just be an out-performing wall.

They actually even did mockup design before they actually started building the building, the actual building walls.

That had a lot to do with wanting to test and understand the building components before we actually had to build it. It's not only a technologically advanced building, but it's a one-of-a-kind building as far as all of the architectural details. You know the brick details are endless. How the walls all tied together and how we were frankly going to make the air barrier work with all these systems being tied together.

So we put a huge effort into building that mockup right down the street and we learned a lot from that mockup, because we realized a lot of things that wouldn't have worked. But that was a huge, huge step in skipping pass some of that learning curve, because we were able to deal with it on a small mockup you know half the size of this room, instead of learning it on the building in the middle of construction.

The other thing that we did is that we did 100 percent testing of every brick type. Basically there's a gel coating on that wall system to make sure that no air is getting through it and then you perforate it. You want to make sure that perforation is completely sealed. As they were building the wall assembly we had a tester that was testing every one of the brick types. So when they started on the south façade they had a high failure rate, which means they comes back and they remediate it because they hadn't covered it up yet, so they remediate it before they go onto the next layer.

And as you begin then to remediate that the team gets the feedback from how they were making errors, they'd adjust the process. So by the time we got around to the third wall the production technique had been perfected by the workers. And so you know this process just lead to a better and better and better and better wall assembly all around the building.

One of the big test days for the general contractor was the blower door testing and you can imagine putting a blower door test on an eight-story building. They had to seal it all up. We'd set a, a standard for the building of .1 cfm per foot at 75 pascal and they actually achieved it on the very first test. They actually got it down to about .088. So it was just an amazing accomplishment for that team that had you know really worked hard and they were rewarded well for the results.

So as we do more and more of these projects it's like anything else we're going to get better and better at it, the learning curves will increase, the trades, the crafts, and the workers that are doing the specific work on these buildings and I know particularly the crews

that were on the exterior façades of this building they are very proud and, and to be a part of this.

A lot of times on a job things are budget driven or time driven, this job felt a little different. The battle cry from day one was, "It has to be right," right, like it has to be as close to perfect as possible.

Well I just want to really first thank the Department of Energy for the campaign, because I think it's a really important element for building designs going forward. For us to be a part of this first year campaign I just – we couldn't be more pleased. You know just really glad that our, our building made the test. So hopefully this is will stimulate more buildings to be done this way and they allow the Department of Energy to you know just really progress and further the programs that they are trying to advance with regard to energy efficiency.

B246: Originally built in 1896, Barracks 246 in Fort Myer, Virginia has been home to cadets in training for the 3rd U.S. Infantry Regiment, also known as the "Old Guard," the 3rd Infantry is the Army's official ceremonial unit and escort to the President. The building itself is in the heart of the Fort Myer Historic District and as such is a protected historic resource.

The historic windows which are shown shaded were supplemented with new, double-glazed interior storms. This strategy allows the existing windows to retain their historic appearance in compliance with the Historic District requirements.

Careful coordination of the insulation layer with a new interior structure allowed the team to align the insulation with the airspace between the historic windows and the new interior storms, creating a continuous insulated layer throughout the building.

Prior to renovation outdoor temperatures easily passed through the single weight glass historic windows. This analysis shows a dramatic improvement that increases comfort in the occupied space without additional mechanical inputs.

Critical to the restoration of historic buildings is the consideration for moisture migration and freeze-thaw cycles. When insulating old brick masonry walls the ability for the wall to dry is extremely important. Too much insulation could result in water freezing inside the wall, which can cause the brick to crack or spall.

Our team analyzed multiple systems to determine the ideal thickness of insulation and the best application of a vapor permeable membrane. The team settled on a continuous layer of three-inch mineral wool with an air space behind the insulation layer to allow water vapor to dry without impacting interior finishes.

To protect our patrimony every aspect of energy and envelope improvement that could negatively affect these historic structures must be considered.

The existing mechanical systems were beyond their useful life and inadequate to serve the building. A new dedicated outside air system and increased ventilation allowed for control of not just the temperature, but also the humidity and air quality.

The existing attic spaces were in poor condition with low ceilings and minimal discontinuous insulation layers. The wood framed roof had its own set of challenges and consideration must be given to ventilation of the framing to minimize the chances of trapped moisture which leads to deterioration of the wood.

A second critical factor in improving the envelope was the requirement to preserve the historic and dark gray slate roof. Mitigating heat gain in the attic had to start with the reduction of the overall load in order to allow for the most energy-efficient systems to adequately serve the space and preserve occupant comfort.

A ventilation space between the roof shingles and the insulation layer drastically reduces the effective heat gain from the shingles while simultaneously allowing for a continuous air path to vent the wood framing.

Locating the increased insulation layer at the rafters, combined with the roof venting system greatly improved comfort in locker and shower spaces.

Training and meeting rooms were opened to the rafters, creating a space where warmer air can stratify at the top, while the cooler air remains below. The combination of both passive and active strategies allowed for greater reductions in mechanical systems sizing without compromising occupant comfort.

The glazing assembly now performs 67 percent better than it had. The walls and the roof are almost three times as efficient as they

were and HVAC improvements have eliminated the window unit air conditioners seen throughout the attic spaces prior to the renovation. These strategies resulted in an overall improvement of the building envelope performance value of 47 percent, while preserving an important historic resource for future generations.

American Geophysical Union:

Thank you for watching the American Geophysical Union's video about our net-zero energy renovation of a commercial office building, the first ever completed in Washington, DC.

I'm Janice Lachance, AGU's Executive Vice President of Strategic Leadership and Global Outreach and I have lead the project for the last three years.

AGU's building is 62,000 square feet, located in the Dupont Circle Neighborhood of Washington, DC. Lead by our volunteer board of directors AGU realized that updating our headquarters could be a very visible commitment to our mission of advancing earth and space science for the benefit of humanity and the environment. Also realizing that it could be a model for others interested in sustainable building practices, they chose to become the first net-zero energy renovation in the nation's capital.

To achieve net-zero energy AGU's design focused on four key principles, reduction, reclamation, absorption, and generation. To achieve these goals on a tight urban footprint we considered and tested 50 strategies and ultimately selected 23 that could be combined to meet our net-zero energy goals.

For today's discussion let's focus on the building's envelope, the windows, the walls, and the roof. The windows are high-performing triple-paned glass that were optimal for us from a cost and lifecycle perspective. To shade the glass we used dynamic or electrochromatic glazing, where the glass shades itself to reduce the amount of solar heat gain that passes through the windows. No shades, blinds, or curtains are needed.

We've also linked the windows directly to the building's energy management system. The windows react to the heat and that helps control the temperature. The windows are also tied to the lighting. As the windows tint darker the lights get a little bit brighter.

There are also overrides available throughout the building. Every single pane of glass in the entire building can be operated independently from any other pane of glass.

Next the walls. We added eight inches of closed-cell spray to the exterior walls, resulting in an R-value of 15.7 and that more than doubled the insulation during the retrofit. The envelope has a 30 percent window-to-wall ratio.

Lastly, the roof. Unlike other buildings that may not be in highly dense urban areas our ability to use solar power is very limited. At the same time we also wanted to make sure AGU's staff and our tenants were able to use the roof for breaks or meetings and to experience the great view. We installed 13,200 square feet of photovoltaic panels elevated above the 12,130 square foot roof. The 250-kilowatt PV arrays can generate up to 100 percent of the building's total energy when combined with the other net-zero design strategies. In addition, solar panels provide shading for our staff and tenants when they are enjoying the roof.

Today we focused on the building's envelope, the windows, walls, and roof and these are only three examples of how the AGU building renovation achieved our goal of net-zero energy.

Do visit our website to learn more and we appreciate your attention. Thank you.

ASHRAE World Headquarters:

This is Gregory Walker of Houser Walker Architecture, principle architect for the ASHRAE Net Zero Energy Headquarters Renovation. As our team began the design process we knew the building envelope was going to be called upon to resolve a number of critical components that would drive a successful outcome for the overall project.

The components that we knew would drive a successful building envelope design included addressing the insulation at the walls and roof; limiting the air infiltration to a very low rate; determining the proper window-to-wall ratios for each elevation in orientation; creating high-performance window assemblies; and determining how to most effectively utilize external shading assemblies.

As we began we were also mindful of the existing conditions that we needed to address in the design, including a series of precast panels that had defined the prior envelope, as well as a highly insulated exciting roof. Our team also determined early on that if we could right size a number of the building envelope concerns, including the window-to-wall ratios and daylighting that we could reduce the overall EUI points by about 6 to 6-1/2 and really enable us to reach the baseline target that ASHRAE had set of 21.4.

To help aid us in that effort our friends at Integral Group and Elementa helped devise an envelope sensitivity analysis that helped tell us what each of these key components needed to target and where the points of diminishing returns would occur. This was incredibly useful to have early in the process, as it allowed the entire team to be aligned around what were the end metrics that we needed to hit and know that if we hit them we could be confident in the outcome that would follow. This analysis was also incredibly important for our HVAC engineers so that they could design the project in tandem with the envelope and we didn't have to rely on one or the other to be finished or fully resolved before moving forward.

As we began designing the exterior envelope it quickly became apparent that the only way we would be able to address the insulative and air infiltration performance needs for the envelope was to run a continuous system over the outside of the existing precast panels. This was Option B as shown on the right.

In doing so we had a couple of options to look at and for schedule and budget reasons we went with an EIFS-based system that had a fully drained stucco finish on the exterior.

As we looked at the window-to-wall ratios we had a target of 40 percent to begin, but as we did the specific design we found that a 33.5 percent window-to-wall ratio on the east and west and a 41.9 percent on the north and south would not only address the energy concerns, but also allow us to address ASHRAE's spatial daylight autonomy concerns.

Another often overlooked aspect of envelope design was to consider what could we do with the roof? And in this case we found that 18 well placed skylights on the roof would also help us achieve the daylighting autonomy goals.

Finally, we also considered how to best leverage a lightly tempered atrium, which just meant that we ran the set points higher and lower in the summer and winter and it allowed us to bring in generous amounts of daylight to a space that was going to be used primarily as vertical circulation.

In summary, we were able to make all the original design targets that the team had set early on in the project and we did so utilizing conventional building practices, conventional materials, and staying within a conventional renovation budget. In this regard we hope that the ASHRAE Headquarters renovation provides a kind

of template for future owners and designers to consider as they pursue their own high-performance renovations.

Prairie Trails School: Hello, my name is Troy Kerr and I'm a project manager with FGM Architects and I'll be presenting our project at Prairie Trails School in River Trail School District 26. Our project was a comprehensive retrofit of an existing facility into a net-zero energy, high-performance building.

River Trails School District 26 is small but diverse. It is a district in the northwest suburbs of Chicago. It services around 1,600 students at four schools. The building we are looking at today, Prairie Trails, will service the kindergarten and pre-K facility beginning in August of 2021. Prairie Trails School is located in Mount Prospect, Illinois, northwest of the City of Chicago and about five miles north of O'Hare Airport. There are two buildings situated on the Prairie Trails campus. The school which is here designated by the number two and the district maintenance facility designated by number one, which helped to house our PV panels, but was otherwise uninvolved in the project.

Prairie Trails was originally built in 1966 and has remained largely unchanged in the years since. Most of the buildings original systems remain intact at the time of our project. Due to increasing enrollment the district needed to bring Prairie Trails online as a fulltime school. Doing so required that many of the outdated systems be updated and given the district's commitment to sustainability the decision was made to pursue making this facility net zero. In addition to retrofitting the building systems the project utilizes roof-mounted photovoltaic panels to generate the electricity needed to offset building energy usage.

This is a plan of the school. It's important to note that no new square footage was added as part of this project. Everything was achieved within the footprint of the existing building. In this diagram the classrooms are highlighted in blue and are located on the east and west sides of the plan, in this case north is to the right. The school office functions are shown in yellow. The district administrative offices are shown in orange. The multipurpose room, located here in the center of the building is highlighted in green and the building support spaces are shown in grey.

The project and especially the net-zero energy retrofit were made possible in large part due to a grant received from the Illinois Clean Energy Community Foundation. One of the grant requirements was that we pursue third-party verification of our net-

zero energy performance. In this case the team opted to pursue passive house PHIUS+ Source Zero certification. PHIUS certification required that we update all major systems in building to be extremely efficient. This included the roof, exterior walls, windows and doors, mechanical, electrical, and plumbing systems. For the purposes of this presentation we will be focusing on the improvements made to the building envelope.

The roof started as a tar and gravel built-up roof over minimally tapered insulation sloped to drain. The roofing was replaced with a new EPDM rubber membrane and the insulation was increased to 10-inch minimum thickness or R65. The original exterior walls were made of load-bearing CMU, with an exterior face brick. We removed the face brick and kept the structural CMU in place. New structural metal studs were added in the former brick location, followed by new gypsum sheeting, new fluid-applied air barrier, four inches of new rigid insulation, new thermally broken rails, and new fiber cement siding, both of which can be seen in this photo. In addition, we added six inches of rigid perimeter insulation around the foundation.

Here are two details of our new walls. On the left is the detail where the below-grade insulation meets the above-grade wall. On the right is the detail where the wall meets the roof insulation, both were critical junctures to ensure continuity of the thermal and air barrier assemblies.

All of the windows and exterior doors were also replaced on the project. Existing windows were aluminum, not thermally broken, with single paned glass. Doors were a mix of aluminum and hollow metal. The new glazing consist of aluminum curtain wall with triple pane glazing. New doors are thermally broken aluminum or insulated fiberglass at locations of opaque doors.

Our envelope performance was an area of focus for the PHIUS review. The next few slides show the impact of envelope improvements on overall building performance. Here we can see the energy balance of heating and cooling for both summer and winter. In summer a large majority of the cooling comes from the slab on grade, while about 25 percent of the heat gain comes from the exterior walls and windows. In winter nearly 70 percent of our heat loss is through the exterior envelope even in our much improved conditions.

This slide shows the heat gain and loss through the windows. Here you can see that the large windows in the classrooms on the east

and west side of the building provide the largest sources of heat gain and loss.

This slide shows the heat loss through various building components. Here you can see that the slab on grade is the overwhelming contributor to heat loss. In our case the slab on grade was the only envelope component that remained as is, all others were replaced.

During the construction process we performed a number of tests to confirm the construction conformed with the design intent of the high-performance assemblies. This included thermal scans of the envelope and blower door testing. Interestingly the envelope passed the blower door test on the first try with flying colors, however, leakage through the exhaust dampers on the roof-mounted mechanical units caused the test to fail initially. This was corrected later, but it was interesting to note that the envelope components were actually not contributors towards the failure of the test at all, but rather mechanical units which is not something that's typically considered.

These last few slides will go through some of our envelope components during construction. In this slide on the left you can see the new structural metal studs, the cold-form framing, going up over the existing CMU. Also in this slide you can see the new gypsum sheathing going up. On the right is the excavation for the new foundation insulation, again that was six-inches thick around the perimeter of the building.

On this slide on the left you can see the gypsum sheathing in place with the new fluid applied air barrier going over it. Spray foam insulation, you can on the far left, was utilized at the parapet condition to join the wall assembly and the roof assembly together with no thermal transfer. On the right is the new below grade insulation going in. Stainless steel flashing was applied where the insulation met grade to protect the insulation from any lawn maintenance activities.

On the left is the new door and window system going in, again it's thermally broken curtain wall and thermally broken doors. You can also see the tie-in of the air barrier to the window assembly. This was a critical juncture to ensure that we met the air leakage requirements. On the right is the new insulation with the new rain screen attachment or thermally broken rail system.

In closing the envelope improvements at Prairie Trails were an integral part of the deep energy retrofit that contributed significantly to the transformation of this existing building.

Thank you.

Hayley McLeod: Awesome, that was great. I loved hearing about all of the buildings that were recognized this year. To make sure that we do get all 14 I wanted to tell you a little bit about this last project that wasn't able to, to submit one of those videos, but this was a community housing project, Vergennes Community Housing, that was submitted by Evernorth and is located in Vermont. They received a Novel 40 Award.

So this is a newly constructed mixed-income multifamily rental property with 24 apartments and indoor and outdoor amenities. The development was designed with a passive house air ceiling target, native plantings, low-flow fixtures, fresh air ventilation system, low VOC finishes, and passive daylighting strategies were applied to this project. To improve their energy use they used photovoltaic systems, LED lighting, and triple glazed windows. Additionally, this property has a heat recovery ventilation system and a high-performance mechanical system.

This is a walkable and bikeable site that has a community gathering space, in-fill development and access to public transportation.

The property was constructed with durable design and materials that meet Efficiency Vermont high-performance standard for multifamily housing and resulting from the collaboration of a diverse team of passionate experts this development incorporates the needs of the residents, the community, and the environment.

So that is our 14th building and now you have heard from, from everyone who we awarded this year. So if we were in person I would ask for you to give a big round of applause to these and hopefully we can be celebrating in person next year. So congratulations again to all of our awardees from this year.

Next slide.

So we do have one final poll for you guys and this is just because Slido is not linked in to the Go To Webinar functionality. I want to know whether you need you any more information from me about the campaign. So you know you, if you hop back over to Slido you

can either indicate whether you've already signed up and you already communicate with us or whether you would like for me to reach out to you and then you'll have the option to drop your e-mail address in if your answer is "Yes." Again, this is because the Slido functionality is different than the Go To Webinar and so I do need you to indicate "Yes" and enter your e-mail address, although your e-mail address will not pop-up on this screen here.

So I will give you guys a few minutes to you know come back to your screens, find that Slido tab, respond to this poll, and enter that e-mail address if you, if you would like for me to reach out after this webinar.

If you don't get to this or don't enter e-mail address right now my contact information will be up at the end of this. You can also reach out to us on the Envelope Campaign website. So it's definitely it's not your only chance to get in touch with us.

We can give this another couple of seconds, but it looks like these, these numbers have leveled out a bit. And hurray for all of you folks that are already signed up and already get our, our monthly newsletters and all that good stuff.

So yeah I think we can, we can go ahead and close this out and move onto the, the next slide. Perfect.

So that is a wrap on the 2021 Building Envelope Campaign Recognition. Again, thank you so much to all of our participants for submitting buildings this year, for submitting those videos for us. Again, hopefully we can all celebrate in person next year.

As I mentioned earlier this webinar is a part of the 2021 Summer Webinar Series. We still have two great presentations happening in August, so please visit the Better Buildings Solution Center to register for those.

Next slide.

We do specifically hope that you join us for the one on August 3rd, that's our very next webinar and it is titled *Waste Reduction*, excuse me, *Waste Reduction: Lessons Learned and What Comes Next*. For two years DOE has worked with over 40 Better Buildings and Better Plants partners to identify and share waste reduction strategies for multiple sectors. So if you will please join us you'll get to hear all about lessons learned and what comes next.

Next slide.

To watch recordings from the Better Buildings Virtual Summit or previous Better Buildings Webinar Series or technical presentations from the National Labs please visit the On-Demand Webinars Library where all previously recorded presentations are archived and where this one will eventually be.

With that I would like to thank again all of our participants for taking the time to submit those videos, it made for an awesome webinar to hear all about, all about all the different projects from this year. Do feel free to contact me directly with additional questions. You can also e-mail the campaign directly, although I monitor that account so you will get to talk to me either way. If you have any more technical questions and I don't know the answer I will certainly set you up with someone who does.

I also encourage you to follow Better Buildings on Twitter for all of the latest news. You will receive an e-mail notice again when this offline Q&A is ready and when this archived session is available on the Better Buildings Solution Center.

So thank you very much everyone. Happy Tuesday and congratulations again.

[End of Audio]

Additional Speaker Q&A:

Better Buildings does not endorse or recommend any product or technology provider. The answers in this document are solely the opinions of the speakers based on their professional knowledge and experience.

Additional Questions

Audience Member:

> "I'd like to know if wildlife was considered in the glazed windows at NC State's plant science building. We have had a hard time combatting bird impacts on our buildings, wonder if that was considered at all?"

Response:

> "Yes, we considered the potential for bird strikes. For the majority of the building, the aluminum sun shades should help deter bird strikes as they're spaced 12"-24" on center. The majority are also tilted, so there's less of a chance for birds to nest, though some potential still exists in the spandrel zones.
> For the greenhouse, we examined several bird-friendly coatings and applied products. However, the programmatic need for UV control in the greenhouses trumped the desire for bird-friendly coatings. That said, observations on site during construction were that the adjacent parapets were more appealing to birds (especially carrion birds and birds of prey), as they provide a more appealing perch with a similar vantage point over the surrounding campus.
> Perhaps more confusing was the raccoon who climbed to the third floor framing during steel erection…"