Health@Home Web Series – Webinar 1: Ventilation, Ventilation Ventilation

Lael:

Good afternoon and welcome everyone. My name is Lael Holton, with AECOM, providing contract support to HUD through the Community Compass Technical Assistance program. We are very happy to have you here, I have a few procedural things for you before we dive in.

First – everyone was muted upon entering; this will continue throughout the full webinar. Should you have a technical question or issue, please utilize the chat box on the bottom right, and direct your message to "Host" or "host and panelists", this way it doesn't overwhelm the chat box.

Second – for questions of the presenters, the Q&A panel, also at the right, will be open for the duration of the presentation. Please provide your questions relevant to the material in that forum, and we will answer questions, time permitting, at the end of the presentations.

I think that takes care of the basic housekeeping – oh yes, I did want to mention that this session (and all future sessions) will be recorded and then hosted on the Home@Health website.

Ok, let's get to the fun stuff! Here is our agenda – Michael Freedberg, our HUD representative will kick us off today. After that, Ellen Tohn will give you an overview of the Health@Home guidance document and discuss our principles of today – Keeping a home Contaminant and Pest Free. Teri Provost will lead us through a deep dive on radon rehabilitation and testing, Finally, Susannah Reese will provide us a deeper dive on pest management practices and techniques.

Once finished, we will take a few questions, via the chat box. submit your questions and we will do our best to tackle them! And now, I'd like to turn it over to Michael Freedberg, HUD, to get us started…Michael?

Michael:

Thank you, Lael. I'd like to welcome all of you on behalf of HUD. These Principles are excellent and what really sets this project apart are the Standards and how they relate to the Principles.

Ellen:

How during your rehab to make that a healthier environment. If you want to pull up the guidelines as I'm talking, if you Google HUD Exchange, health at home, this document will pop up. There's a URL link in here and we will obviously send you one when the webinar is done.

Michael mentioned our additional intention around health and housing right now with COVID. And, I would simply say that in addition to the things Michael pointed out, is that we know some poor housing conditions make us increasingly vulnerable for a variety of health outcomes which are also being linked to folks having potentially greater risk of having a more severe case COVID and those involve respiratory and cardiovascular in particular.

So, what are a couple of examples that link our home environment to our health. Three we just wanted to point out as examples, one would be asthma. When we look at national data here, about eight percent of children, eight percent of adults report currently experiencing asthma symptoms. And our

research, some of which you'll hear from our wonderful panelists, does tell us that 20 to 40% of asthma attacks can be linked to home conditions.
Those home conditions are some of the things that you'll see in the pictures to the right, environmental, tobacco smoke, cockroaches, moisture and mold, dust mites, that's the little creature in the right-hand column in the middle row, and mite and cockroach droppings. And lastly at the bottom, cooking which creates particulate matter and a variety other pollutants, particularly combustion gases being used like from a gas range.

Second example might be radon, where EPA estimates about 21,000 deaths a year can be linked to radon exposures, and that roughly a little over seven million homes may have radon levels above EPA's threshold and we'll hear in the guidelines in one of our subsequent sessions on contamination, our advice about testing and mitigation around radon that you can build into rehab.

And finally, fall, 25% or one in four older adults fall each year and the data tells us that about half of those falls occur in and around the home. So again, the way in which we do our rehab, can reduce all of these risks.

Today, you're learning about some of the guidelines as they apply to ventilation and creating cleanable surfaces. We have three additional sessions as Michael mentioned, scheduled for July, September and October, and we will follow up and provide you a link so that you can register for those sessions as well.

So, who did we write these guidelines for? There were three audiences in mind and I recall the poll Lael put up indicating that a significant portion of you are involved in local programs and we had you in mind in the drafting.

So, program managers and staff who work on local rehab standards, can define what a healthy housing program standard would look like or to ensure that your rehab standard includes heath elements. The second group would be intake staff, underwriters, case managers who can further customize the standard in conjunction with your participating jurisdiction who might be receiving HUD home funds, sub recipient staff if you're then moving the funds onto another organization where there's additional customization and finally, the people actually doing the rehab work, construction and rehab specialists who are going to implement what other rehab standard you have and its healthy homes elements, and making choices in that scope of work about what's going to get done and what's not going to get done.

We provided the guidelines and tried to write them in a very practical, user friendly format, and towards that end, we understand that people, everybody's brain works a little differently, and so we've tried to make the guidelines as accessible as possible. The way I was describing it to Michael is, we really have two doors into these guidelines.

The first door is we've organized the rehab guidelines under the nine healthy homes principles which you see below. They are, keep it dry, keep it contaminant free, keep it pest free, keep it well ventilated, keep it clean, keep it safe, keep it well maintained, keep it thermally controlled, and build it in a way that people can be active in the way that they use the building. That particular applies a little more to multifamily.

And today, we're going to focus on keep it well ventilated and keep it clean. The second door into these guidelines would be for some of you, you might not think about the specs and the guidance and the

content under these principles. You might think about it under, as being relevant to building components or systems because that's the way your rehab specs are organized.

So, we also provide this content using that structure and provide guidelines under each of these home systems or building components if that's a more familiar or accessible way for you to access the information. And, I'm going to show you how both of those look.

So, the first is, how do we present it when we are providing the information under each of these nine principles. So, I'll show you the example here for ventilation which we'll talk about today. At the outset, we described why does this principle matter? I'm not going to read this because Nate's going to give you that wonderful information, so we give you a little of the why statement.

And then, we have a very pithy, short way of describing the rehab action that we think makes sense under this principle, and wherever we can, if there's more detailed information, we'll provide that in a hyperlink. So, here, point source ventilation on kitchens, bathrooms, dryers, exactly what we need, whole house ventilation and advice around filtration, which we'll hear from Nate about.

So, this is the way it looks under the principle-based approach. We also have an approach which is related to those building systems. I want to just highlight a few icons that we use in that formulation. For each of those rehab specs, we try to give you that crosswalk, how does it relate to one of the other principles with one of these icons.

So, if the activity, if the repair or replacement spec is going to improve indoor air quality, we'll use the blue arrow. If it will reduce other contaminants that might not be in the air, but are other contaminants that someone might ingest, say lead dust on a floor, use the yellow, safety and falls, does it reduce them? Again the individual looks like they're about to slip, and O&M.

For an example, one of the components that we include is appliances, and I just pulled the one here for clothes dryer exhaust, and you can see, in the way we present it here, we provide a repair and a replacement standard. You can see those highlighted with my red arrows.

And to the right, you'll see those little icons. You can see the repair standard for dryer exhaust which is really just making sure they're vented to the outside and sealed. That's an O&M type activity. And, the replacement standard involving new duct work would reduce the indoor air contaminants so that we don't have moisture coming through that duct work back into the home or other contaminants.

So, that's just an example of how it looks, and you can see how it relates to the principles there in the words ventilation and dry. So, that's the second door into these guidelines.

In addition, the guidelines provide some information about operations and maintenance. While you're not doing that in the rehab, that might be materials that you would give to the individual who owns the property and if it were a rental, that they might also pass on to their renters. We provide some sample handouts about green and healthy building and home products, cleaning products, paint, flooring, things that you might do during the operations of maintenance, additional supplemental materials that property owners might use about engaging residents with a variety of we blinks to additional information, and then obviously, a full set of references for those of you who would like to dig deeper into the technical information.

I am at this point, going to allow us to take that deeper dive into how the guidelines and standards can be used in home rehab, and today because we're focusing on ventilation, we have our resident ventilation expert, Nate Price, who is with the Indoor Climate Research & Training Group at the University of Illinois.

We brought Nate in because he has been providing training to the National Weatherization Program, particularly in the ventilation area for years, and they've really adopted many of the things we are recommending in the guidelines, and he has extensive experience, not just training, but also doing field inspection to see how things went awry and has a background himself as a renovation contractor. So, I'm going to hand it over to Nate.

Nate Price:

Thank you, Ellen. Sorry about that. Just having a little issue there, but good afternoon everyone. I really am excited about the opportunity to be here and talk to everybody today about ventilation.

When I first got the invitation for this, I was thinking that this is probably something I can talk about for three to six hours, but I've been told multiple times to try to limit it to 15 or 20 minutes. So, I'm going to do my best to do that.

And hopefully, I can do that by focusing mainly on some good standard practices that I've seen successful in my field experience and then also, just I'm going to highlight a couple things that are a little uncommon, that maybe folks aren't seeing every day, or wouldn't know to look for otherwise.

But before I do any of that, the first thing that I would ... do I have a ... sorry about that. So yeah, before I get into all the techniques and standards that I want to talk about today, obviously, you want to know why do we ventilate? What are the benefits of proper ventilation?

Of course, Ellen mentioned some of the health benefits. There really has been an evolution as far as how building scientists and contractors and home owners see ventilation. It started as an occupant comfort issue.

We want to install ventilation to reduce odors and balance air distribution and allow us to heat and cool more effectively, and those things are great, but then we come to a point where we see reduced energy use as a potential benefit of proper ventilation as well.

By that I mean, if you install proper ventilation at home, that allows you the opportunity to do more air sealing or retrofit measures that are going to increase the performance of that building shell and the HVAC system which of course, is usually the biggest energy user in the home.

But, after these things have been apparent for so long and one of the things is becoming more and more apparent obviously, are the potential health benefits of good ventilation. There are tons of studies out there about health benefits and how ventilation practices can improve them, but the one I'm referring to here, it was done in part by folks at the Indoor Climate Research & Training Center where I'm from at the University of Illinois, and what they've found is not only were they able to, by just following the ASHRAE standards, which we'll get into a little later.

In weatherization homes, they found that they could reduce concentrations of contaminants, mostly including CO2, VOCs and radon. Formaldehyde wasn't significant reduction, but the others were noticeable. But not only were those contaminants reduced in indoor air, but they also saw that there was a reduction in self-reported health issues in the residence.

So, it's something that's actually noticeable, and in a fairly quick turnaround, a fairly short amount of time after the ventilation's been installed. So, even some of these health benefits can be a little bit more immediate than folks might think.

Of course, in order to get those benefits out of ventilation, you have to do it properly and I think that's exactly why these guidelines were put together, the health at home guidelines. It's a really great resource. After going through it, I really love how they tie all of the health principles together and they do a great job of showing you not only what good ventilation looks like, but how that relates to other principles like cleanliness or safety and energy efficiency, and it's important to think of the house as a system.

So, you're going to address everything in the ventilation guidance or guidelines and do all of those things. You can't just do one thing and think that that's going to improve things. Because, if you're not treating the house as a whole and all of the things, then there's potential to even do more harm than good.

So, you follow all the guidelines here, and you're addressing different building components and of course, one thing I always stress is that you have to make sure that these things are installed properly. Of course, usually that goes without saying, but it is something that you can mention over and over again and it still gets overlooked on occasion.

Examples I like to think of, improper exhaust venting, maybe you've got venting that's exhausting into an attic that's going to cause moisture issues, or if you have a furnace filter that's the wrong the size or isn't secured tightly, you're going to get air coming in around that furnace filter and that's going to just completely destroy the effectiveness of that filter.

But then, not only do we want to so everything on this list in terms of ventilation, but we also want to think about how the ventilation practices we're employing by following these guidelines are impacting other building components or other sections of the home. There's always a potential to overdo some things.

We want to make sure that we're not doing something that's going to have a negative impact on that home or the occupants. So, good examples of potential problems might be if you have natural gas appliances in that home and you install too much ventilation, which typically isn't a huge problem but you might end up having those natural gas appliances spilling combustion gases back into the homes because they're not allowed to draft properly.

Another example would be if you install a too restrictive filter in a furnace, then you might put increased wear on that furnace blower motor, or AC I guess, in an HVAC forced air system, and that increased stress on that motor might end up decreasing the lifespan and then you're just actually increasing the monetary cost to the client or the occupants by trying to help.

So, you want to address everything as a whole, and we want to do everything on the list, but we want to do everything on the list properly. Like I said, the guidelines do a really great job with showing you exactly how all those things tie together and especially highlighting some of the components or building sections that interact, I guess, more significantly with one another.

So, a few things that I'd like to highlight just briefly, dryer vents are something that, they're fairly straightforward, but some things that get overlooked, I've got a couple of examples here. The first one is this diffuser here in the middle.

That's something that I've seen quite a bit on dryer vents and a lot of times they're advertised as energy saving which I'm not exactly sure where that comes from, but they talk about putting the heat from the dryer back in your house and that I guess is somewhat true, but not only are they putting the heat from the dryer back in your house, but all of the moisture that is coming out of the dryer is going into the home and also, if it's a gas appliance, then combustion gases or combustion by products are probably entering the home as well.

So, those things are definitely something you want to get rid of every time no matter what. And then, I've got the termination heater on the upper right that is clogged, and that's something ... it's fairly obvious if you're looking at a dryer termination, whether it's clogged or not.

But, things that might not be obvious, is you might have almost perfectly intact duct work that meets the standard or the guidelines, and it looks perfectly fine when you come into a home, but if you don't look inside to see if it's clogged inside the duct work, there's a potential for it not to be as effective as should be.

And then, the bottom right photo is a broken damper that's not actually a dryer vent, but it's a good example of what happened in this case was a client had a damper that wasn't closing properly, so they went out and duct taped over that damper. So, not only is that appliance not exhausting properly, but it's got a potential to harm the appliance itself.

Additionally, if you have broken dampers, especially on dryer vents, they're usually a little bit lower towards the ground, so the potential for pest infiltration is pretty high. HVAC filtration, just briefly on this, one thing that I get asked very regularly is we have these MERV ratings on the filters and the higher the MERV rating, the better the filter is.

And, I guess technically that is true. There is this study done at Berkeley National Lab, showed that a MERV 14 filter was able to reduce fine particles by 39%, concentrations of fine particles by 39%, versus a MERV six filter which was reducing those particles by six percent.

So, that would lead somebody to believe yes, MERV 14, let's go with that every time, but that's not really the case. There's other considerations you have to make, cost concerns. If you're talking about programs that are dealing with low income clients which a lot of us are, then that means those higher MERV rating filters are going to be more expensive.

So, clients aren't going to be able to purchase those as easily. Also, there's increased maintenance. Those more restrictive filters need to be replaced more often and then, similar to like I was saying earlier, you can install a filter that's more restrictive and also that can put more stress on a motor, on that HVAC system.

So, the guidelines, the health in home guidelines here, I think recommend MERV eight filters and that's a pretty standard recommendation because it's a great compromise between something that's going to effectively filter the air and also it's not going to cause a lot of these issues that could potentially end up in damage or harm to the homeowner.

My example here on the right in that photo, that's a homeowner that hasn't changed their filter in two or three years and it clogged up to the point where it was being sucked into the furnace compartment and if you've got clients that hasn't replaced their filter for a couple of years, it's going to be hard to expect them to replace one form often than a couple months. But, that's a client education component that definitely we would like to see employed, along with these retrofits.

Duct works or duct sealing, that's generally a good idea no matter what. You're improving efficiency. That's a common reason for duct sealing, but also a couple other reasons. Structural damage is definitely a concern.

My photo on the top here is an example of a supply duct leak in an attic, so that supply leak is introducing all this warm, moist air during the heating season into the attic and that moist warm air is causing condensation on the underside of the, that's the roof sheeting there, and on the trusses.

So basically, that's going to result in most like mold and eventually structural damage, so that roof's going to have to be replaced. If those ducts are sealed in time, then we've saved the homeowner and occupant a lot of headache with structural repairs and roof repairs in the future. And then, an example of reduction in contaminants I've got here on the bottom, and this happens to be the case of a leaky return duct in a crawlspace.

So basically, any of that return there that's going to be introduced back into the home is coming from the crawlspace. It's going to start introducing, most likely, moisture from that crawlspace, potentially radon. It also could introduce insects and other pests so there's definitely a great opportunity to save some damage there.

But the other thing that I often don't ask about in regard to ducts, is duct cleaning, and you see the advertisements all the time from HVAC contractors, at least I do. And a lot of them, they say, "Hey, we're going to come out and clean your ducts," and they tout the health benefits of that. And, that definitely can be the case if you have significant issues in those ducts.

Say you've got a past infiltration or you've got mold or water damage, and I've seen that before. In those cases, duct cleaning can be a great benefit. But on the other hand, if you're just doing it as a matter of course, that process can introduce contaminants into the home that weren't there otherwise, either from the solvents that they use for the cleaning or just the act of cleaning itself by brushing that duct work and bringing those things that have settled in those ducts back into the home, at least for a short amount of time.

And then, the big one is going to be ventilation systems, so what are some options for effectively meeting the ASHRAE standard which is referred to in the guidelines here and it's the basic standard for ventilation systems in homes.

Here you can see they basically approach it from two different angles. They talk about either local exhaust systems or whole house exhaust systems, and in this case, bathroom ventilation is one of the most common ways and cost effective ways that I've seen programs meet the ASHRAE standard.

There are slight differences between, if you're going to do a local exhaust and a whole house exhaust, the main one being whole house exhaust, you're talking about something that's going to be running a lot more. So, they need to be rated for continuous use and also they have a lower sound rating because they don't want that background noise to be distracting or bothering the occupants as much.

So, you can see there's just slight differences. But for the most part, you definitely want to employ some exhaust in bathrooms, but you've got options to do either or depending on what you need to do to meet that standard.

But just to get a little bit more in depth with that, local exhaust, you're just thinking a typical bathroom exhaust fan and it's for the most part the case. You can get these fans at most big box stores and most of the ones that will meet the standards that ASHRAE outlines will advertise that pretty heavily.

It's always good to verify though, just make sure that you look at the sound ratings and the flow ratings to make sure that they do meet the standard. But, these are fairly inexpensive fans. They're going to be a little bit more expensive than your run of the mill 60 CFM bath fan, but they can run 125, $200. So, that's just a little bit more expensive than you'd typically pay, but they're easy to install and as far as how they're controlled, you can use just a typical on and off switch or you can use something like this passive humidistat which you're ... That's basically just a way to regulate the humidity in that room so it's not up to the occupant to determine whether that fan needs to be on.

That fan can automatically turn on when it gets to a certain threshold of humidity which is primarily what we're trying to address in bathrooms. But then, if we want to use that same retrofit or that same measure to instead satisfy the whole house standard, then we've got a couple different options.

These fans, like I said, they're going to have a little bit different rating requirements and they're going to be a little bit more expensive, but the controls are somewhat more automated. So, with this particularly model of fan, you can use an intermittent switch and that will basically make sure that the fan runs at least a certain amount of time per hour at a certain flow rate.

But, it's still able to be activated by the occupant if they would like. But, there's also options to do a continuous flow if it's on a motion switch, so it's going to run all the time at a certain speed and then it can ramp up to an increased speed depending on if it depicts motion or not.

And like I said, the prices for these are going to be a little bit more expensive, especially when you start adding the motion detectors and some of the other fancy options, but they're automated to the point where you don't have to do ... sometimes they can even save money because you might not have to run additional wiring or things like that for your contractors if you have to put in a whole new game box or light switch or things like that. It can save some time and therefore some money. But, they are definitely a little expensive upfront.

Ellen:

Hey Nate, this is Ellen. Just giving you a two minutes 30 second warning.

Nate:

Okay. Yeah, like I said, I can ramble on all day. I will finish up with a couple things. Kitchen ventilation, here's your actually standard for kitchen ventilation. One thing I want to mention about these, is just like the other fans, they're going to be a little bit pricier.

You can't just go into a store and buy your run of the mill range hood and expect that to meet the standard. But, they're not super crazy as far as restricting you to things, so $100, but then if you need to, you can spend as much money as you want on some of these. I've seen some fancy ones that cost five or $600.

That's where you want to make sure that your duct work's done properly. You want to insulate it. You want to avoid these turns and twists in the duct work because that's going to restrict the airflow and it's not going to be, your flow's not going to be at the rated flow. Make sure it's properly terminated so you're not getting issues like this where you're exhausting moisture into attic spaces or unconditioned spaces.

And then last couple of things I want to touch on are some additional options. These are less standard as far as typical practice. They're not used as much for a couple of reasons, but they're great options when you run into situations where you might have some issue in installing the typical bathroom fans.

Continuous flow range hoods, so these will meet the actual standard for continuous flow ventilation. Add the kitchen range hood which is great, which they meet all the requirements and you can install that and sometimes installing a range hood is 10 times easier than a bathroom fan.

So, that's a great option. But through wall fans, if you don't have a ceiling surface to mount the bathroom exhaust fans on or mobile homes is a great place that I've seen these used where you have to, the wall's the only place to vent.

Inline exhaust fans, they're installed directly in the attic. They can be installed almost anywhere in the home, and they are rated for continuous use and they satisfy the ASHRAE requirements for continuous use. Balanced ventilation system and the HRV and ERV systems, those are something that are going to be a lot more common because they not only exhaust, but also they have an intake, so they're not affecting the pressure on the home as much and the HRV and ERV systems are even more preferable because they're tied directly into the duct systems or the HVAC system, and that's going to help you evenly distribute the air throughout the house which is a huge deal when you're trying to address ventilation.

So, I do have some contact information on here eventually, so if there's anything anybody has questions about, I'm going to get booted off of here, but please feel free to contact me at some point and if you want to talk more about ventilation, I'd love to. So, Ellen, I get it back to you.

Ellen:

Thanks very much Nate, and if you do have questions, go ahead and put them in the Q&A. We may not get to them all today, but we'll have a transcript, and we'll send you back responses in the follow-up.

Our second principle we wanted to touch on briefly today is keep it clean, which honestly, I think of as keep it cleanable. We really want to have surfaces in the home that folks can easily clean and this is even more important now these days, when we're thinking about COVID. So, we want to be able to clean up allergen, pest dropping, pesticides and now, virus particles.

In an appendix that we have on the guidelines, you'll hear about cleaning practices. In terms of rehab, the guidelines in the appendix will talk about cleaning practices and in our subsequent webinar that we're going to talk about contaminants, we will be diving a little bit more into cleaning practices specifically with COVID in mind.

In terms of what you do in a rehab, we want to focus folks on using durable and cleanable surfaces in high use areas. So, these are floors and entryways in bathrooms, in kitchens, in entryways and make sure that those surfaces are easy to clean, and last so there are rating systems around laminate flooring that we note here that shows you the durability and there are some examples we provide in the guidance when you're making those choices, to pick a flooring that has less off gassing of contaminants, to again reduce indoor environmental exposures.

And, just so I provide one example her with FloorScore, which is related to resilient flooring. The pictures on the right are obviously a wood floor on the top and a laminate floor on the bottom, which would meet the FloorScore standard and hopefully the laminate floor durability standard.

So, we really want folks to think about in these wet and high use areas, durable, cleanable surfaces. We have a suggestion at the end of each workday to really use effective job site cleaning, so not just any vac. A HEPA vacuum is definitely preferred because it will filter out more particles.

Additional information will be coming in a future session about cleaning practices, so I'm going to keep that short so that I have time to hand this off to Jill. We'll hear about a multi-family renovation project which addressed ventilation, but was much broader, and Jill will describe for us how that changed indoor environmental conditions in the building and also health.

Jill is a certified industrial hygienist who's worked with the National Center for Healthy Housing for over 20 years, and I've had the great pleasure of working with Jill for many decades. She and the center team do some of the best research in the country on affordable housing, renovation and health.

She has a Masters from Johns Hopkins School of Public Health who we're hearing a lot from these days in the COVID world. So, I'll pass it to Jill.

Jill Breysse:

Thank you, Ellen for that kind introduction. As Ellen said, I'm here to talk to you about what we called our GREAT case study. GREAT stands for green renovation of elder apartment treatments, and you can see the building in the background. That's a post renovation picture.

Although it was a gut rehab, not a moderate one like the guidelines focus on, it is a great, pun intended, example of how well the principles discussed in HUD's new housing rehab guidelines are illustrated. It can be applied to the green renovation of this low income, 101 unit apartment building in Mankato, Minnesota, which houses primarily older adults.

HUD funded a healthy homes technical study that looked in improvement in housing condition and the impact on health due to this large renovation project, and we collected data at both baseline and at one-year post renovation.
So, older adults are more susceptible to adverse housing conditions than younger individuals, first off because they tend to spend more time indoors at their home. That's not as much of a case right now with COVID-19, but certainly under more normal circumstances.

They're also more likely to live in older homes. And, these older homes might have older heating and cooling systems with no fresh air and they leak, leading to thermal stress in both the summer and the winter.

They can be damp or noisy, stuffy or dark, which can cause anxiety or depression. And, they may have been built prior to the Americans With Disability Act, or other laws, which may mean that they're difficult to navigate, particularly if a person needs to use a wheelchair or a walker.

And, people may therefore, end up being trapped in their home or indeed, even on just one floor of their home, and they may have many safety hazards due to deferred maintenance. So, on this slide, you can see a shot on the left of the building before renovation, and I'm going to talk a bit about the ventilation first, the ventilation principle.

And, on the renovation side of the slide, you could see that they have a hydronic heating system with individual through wall air conditioners. This was an exhaust only ventilation strategy, with no mechanical fresh air ventilation. They did have operable, albeit leaky windows in each apartment that contributed to mold and moisture issue. The windows had basically leaked since the building was built in the early '70s.

At post renovation, they had put in a new heating and cooling system with a central geo-thermal ground source heat pump that feeds a water loop connected to individual heat pumps in each apartment and that first picture at the top is a picture of the heat pump in one of the apartments.

And also, part of the renovations, they ducted fresh air supply to each apartment, fly-by roof top units which distributed a constant volume of air through duct work into each apartment, and that's the top picture on the right. This air was continuously exhausted via a bathroom fan that was vented outdoors through powered roof ventilators.

And, the ventilation was decoupled from the heating and cooling system to provide a more reliable distribution throughout the building. But, I did want to illustrate how the other healthy homes principles were achieved in this rehabilitation.

In picture one, you can see that's another illustration of the geo thermal system. Picture two, is a picture of a former outdoor balcony, and I'm using this to illustrate the dry principle. The outdoor balcony was too cold and weather impacted for people in Minnesota to access most of the year.

So, they brought it inside, and they made other building envelope improvements that made the building drier and more comfortable. They replaced all the windows, as you can see in picture two, many of which had leaked, and they vented dryers and bathrooms to the outdoors.

Pictures three and four are illustrations of the safe principle. In picture three, which is a shot of the kitchen where they put in ground fault circuit interrupter outlets, they also put these in the bathroom. They installed carbon monoxide alarms. That's a gas stove that you see there in the picture. Another illustration of safe is in picture four, which shows well-lit hallways and they installed visual cues around every door so that folks who were visually impaired could more easily locate their apartment.

Also, in pictures two through four, you can see examples of both cleanable, and maintainable principles, with bare cleanable floors and they installed easy to clean surfaces throughout. The final three pictures there on the bottom, five, six and seven, are illustrations of the healthy living principle.

As I said, because this was Minnesota, they made sure they brought some of the outdoors in. You can see that in picture five, with wide walking lanes, comfortable places for people to meet. They installed an exercise room with equipment that disabled and older adults could easily use and they also put in an outdoor walking area with wide walkways and a covered patio.

As far as contaminant free, I don't have a picture of that, but this is a green renovation, so they use low VOC paints, sealants, adhesives and construction materials. They did test the radon at the ground level before renovation, but all the samples were at or below the detection limit, at .4 picocuries per liter, except one, which was at 1.5. which is below EPA's action level of two picocuries per liter.

Immediately after the rehab was done, commissioning and testing of the primary ventilation system showed excellent outcomes. As far a fresh air ventilation, 100% of the one bedroom apartment met the 20 cfm design criteria and with 85% also meeting a more stringent 30 cfm criterion.

There's just one, two-bedroom unit in the whole 101-unit complex, and that one did not meet the design flow rate, but I think they were unable to figure out a reason why for that one. The apartment exhaust, that continuous bathroom exhaust, the vast majority of units did meet the 25 cfm criterion with only one failing by more than 10%.

And, at one-year post renovation, they found that there was a nearly 44% reduction in energy use versus pre renovation. And, this is a substantial improvement considering the addition of fresh air to all the units in the building.

We also conducted some environmental monitoring as part of this study, and we found that the temperature in both the summer and the winter met the design criteria. It was much more consistent. There was many more fewer complaints of thermal stress from the residents in the building.

The CO2 levels significantly improved at one-year post renovation, and that's obviously, we think, due to the controlled fresh air coming in. We did some measurements of indoor air quality and found no significant change in total volatile organic content or formaldehyde, not surprising since this was a green renovation.

And, we did some allergen measurements and settled dust, and did not find significant levels of those either. Looking at the housing condition at one year post renovation, we found significant improvements in the frequency of fan use in both the bathrooms and the kitchen and substantial improvements in moisture related issues.

And, this was a big one, because that was a major problem in the building before renovation began. A no smoking policy was instituted at the same time as the renovation and this finding that tobacco smoke inside the home decreased is due to both the smoking policy and the air sealing of units, because we did find that some people continued to smoke in their units, but the people who lived next door could no longer smell the smoke.

All right, finally looking at the health outcomes. At one year post renovation, mental health showed improvements, both based on two different measures, and physical health also showed improvements with fewer falls at one year post intervention, and improved general physical health.

We conjecture that the fall decrease is due to the walkable, more open areas both inside the apartments and in the common areas. In conclusion, we found greatly improved building and apartments that met these important critical healthy homes principals. This led to improved mental health, reduced falls, and improved general physical health and substantially less indoor smoking.

Because this was a package of interventions, we can't link any particular aspect of the renovation to the health findings, but in a similar study, we found a significant correspondent between an apartment's sustained reduction in temperature and improvements in the residents' quality of life, decreased emotional distress, and improved sleep.

So, I'm pleased to have presented this. I think it's a great example of how the healthy homes rehab guidelines can help make a home safer and healthier. Thank you.

Ellen:

Great. Thanks, Jill. We started at about three minutes late, so I'm going to take the latitude to put forth two of the questions that I see in the Q&A to our presenters and we'll wrap just a couple of minutes late.

Nate this question for you. One of the participants asked, how do you know if ducts need sealing?

Nate:

Okay, great. So, that's a great question and it really depends on as a homeowner, you have different options as you would in one of these programs versus a different program. For instance, in the weatherization program, we would do duct testing with maybe pressure pain tests or duct blaster testing and that would give us a really solid number on duct leakage.

But in a lot of cases, those aren't options because of cost and time constrictions. So, another alternative would to be consult an HVAC contractor or some other type of energy auditor that could tell you ... They could probably give you a good idea just by doing a visual assessment of the duct work, but really to know what the improvement's going to be, you're going to need to do that additional testing. So, hopefully, that answers that question.

Ellen:

Yeah. That's great. And Jill, I want to come to you with two quick questions. One question has to do with a specific study and the participant asked, what makes geothermal heat pump a more viable option in rehab versus say, a ductless heat pump or a regular ducted heat pump? We don't often think of geothermal in a rehab.

And then, I'll ask you the second question so you can answer them both at the same time. Curious that you didn't see any changes in respiratory health because we've seen those in other studies, improvements, so I'll let you comment on both.

Jill:

Okay, thanks. I'm going to answer the second one first because that's much closer to my area of expertise and Nate, if you could actually think about how you might answer the geothermal question, I'd appreciate it because I am no ventilation expert.

So, we were not able to see any changes in respiratory outcomes in this particular study possibly because of the sample size and possibly because we did not limit enrollment to people who had respiratory issues, which makes it much harder to tease out a change.

We have, however, done some other studies that found improvement in respiratory outcomes from housing intervention. In another Minnesota green renovation, this time of a family apartment building, we saw improvements in asthma and non-asthma respiratory problems in adults, and in non-asthma respiratory problems in kids.

And then, in King County in Seattle, we did a study where we enrolled children, only children with asthma and we saw a significant improvement in asthma control due to a combination of weatherization, community health worker education and healthy homes intervention, like improved ventilation, moisture treatments, mold reduction, carpet replacement and plumbing repairs.

Ellen:

Thanks Jill. Nate, any commentary on the geothermal question?

Nate:

Yeah. Just briefly. If I'm understanding the question correctly, the reason that you would want to, that geothermal' s preferable to a standard heat pump, ductless or a regular ducted heat pump would be because the way that you're modifying the heat transfer with that system, it's too much to get into, but basically the ground temperature or the water temperature that you're using in a geothermal can be much more consistent and your heat transfer's going to be a lot easier to regulate in a geothermal than a regular heat pump that's exposed to outdoor air.

Ellen:

And, would it be fair to say Nate, geothermal is typically a little more expensive than air source.

Nate:

Yeah. Because with the geothermal, you have to do drilling or trenching and depending on how you want to set up that system, it requires either a lot more space or a lot more money in order to install. But, they definitely can increase efficiency.

Ellen:
Great. All right. I think we've hit a couple, not all the questions. We will have a transcript and we will have responses to the other questions. We've just run out of time for today. I'd like to hand it back to Lael to wrap this up. Lael, you there? Can you wrap this up?

Lael:
Yes, I am. It was not letting me take ...

Ellen:
Well, it sounds like he's having trouble with his audio, so why don't I just wrap this up here. We will be sending out after the webinar, a recording of the presentation and it will be available on the Health at Home website, which again you can Google HUD exchange Health at Home.

The next session is on contaminant and pest free, where we hope to also share some additional information on reducing COVID exposures. In our follow-up email you'll get a link about how to sign up for that session. And, if you have more specific questions, you can reach out to Lael at the email shown here communitycompasstraining@aecom.com, aecom.com. That's hard to say.

I want to thank everyone for their time and listening, and we look forward to you being with us again, and when everybody gets back out in the field, for trying out detailed DMs practices. Again, if you have an interest in this PA training, then we will provide you a link to access that where you'll be able to help a limited number of participating jurisdictions in refining their rehab standards to include more healthy homes practices. Thanks very much.