

Marcus Bianchi: We're just giving some time for the participants to join. Lots of people join. Just giving a second for other people to join to start. Just one minute. Well I think this is a good start. I gave a couple minutes so just people could join. Welcome to the Better Buildings summer webinar. Better Buildings is a program of the US Department of Energy. Next slide please. So today we'll have a webinar, very please to have a webinar on Clear the Air: Healthy Indoor Air for Businesses & Tennant Spaces. Next slide please. I'm Marcus Bianchi. I am a researcher at the National Renewable Energy Laboratory in Golden, Colorado and I manage this space conditioning technology team of Better Buildings Alliance. Next please.

I'll be moderating this webinar. We'll have a few updates from the space conditioning team. Then we'll have like two talks, one by Professor John Zhai of the University of Colorado in Boulder and another one by Scott Williams, Williams Building Systems Engineering all talking about different aspects of indoor air quality in commercial buildings. And then we'll have a Q&A to follow. Next please. This is the space conditioning team at NREL, myself, Dr. Michael Deru, Dr. Ryan Meyer, Kelsea Dombrowski. We all work together to put those not only webinars but like a few documents together all in space conditioning to support the partners of the Better Buildings Alliance to have access to space conditioning technologies. We do have a mailing list. If you're interested in joining please contact us. If you have questions if you would to actually participate and receive like updates that's the email to join. Next slide please.

Just a quick few updates. We just got it published the Healthy Buildings Guide for Small Businesses which is actually in the background of this webinar today. So how can the small business owners and the property managers ensure healthy air quality in their spaces? It kind of summarizes some of the latest set of recommendations. So this is downloadable. You can actually go into NREL and do a quick search and find this resource. Next slide please. We do have a repository of information about HVAC, the HVAC Resource Map. The address you can just search for it but it's on the screen. And it goes through different aspects of commercial HVAC describing the technologies and linking to resources that could be helpful to understand it deeper and go into more details. Next slide please.

We did publish last year the Decarbonizing HVAC and Water Heating in Commercial Buildings. It's a resource. The link is there but it's a resource that could be useful for somebody to try to start

thinking about doing a conversion to all electric solutions for commercial buildings. Next slide please. We will manage the questions and answer from, for this webinar through Slido. So if you please go into Slido now, www.slido.com and then you put the event code DOE that will bring you to the questions and answers. I will be looking at those questions and answers and fielding them to the two speakers to make sure that we actually address some of them during this webinar. Next please.

So a few welcome polls so please let's go to Slido and look at them. Hopefully you have a chance to be there already. This is what is your role. We even give mine here so we have like a few answers there. Who is participating? This gives us an idea particularly not only for the speakers but for ourselves and who usually attends those and are interested in participating. We have 39 answers so far, 41. It's getting there. Ok. Good. It gives like an overview of who is doing that. Then next question, yes. Where is your company or facility on indoor air quality improvement? Lots of just beginning. That's a good number. Thank you for participating. Next one.

What is your biggest barrier to implementing indoor air quality measures? I would think that cost would be one but it's awareness that is there. Thank you. Thank you for responding. Next one please. What space conditioning topic are you most interested in learning about next? And you have a chance of writing other. Excellent. Thank you. Next please. Oh so those are the other, air exchange, low temperature hot water loop, filtration and insulation. Thank you. Next please.

Ok, now we have our speakers. I'll briefly introduce them. So we have Scott Williams will speak after Dr. John Zhai. He leads Williams Building Systems and Engineering. And since he actually would give like a brief introduction to himself I'll let him do that. Next we have Dr. John Zhai. He's a professor in University of Colorado in Boulder in the department of civil, environmental and architecture engineering. We have known each other for a long time and he's doing some very interesting work related to indoor air quality. I'll let him speak for in his talk next. Next slide please. Oh Scott will do beforehand? I guess I changed the order. Please Scott. Please go ahead.

Scott Williams:

Thanks Marcus. Go ahead to the next slide. I'm just going to be talking a little bit about the application and options to optimize indoor quality and energy performance. Go ahead to the next slide. My background is in consulting engineer originally designing

HVAC systems including ventilation systems for various building types. Portfolio owner engineer leader. I worked with Target for quite a while leading their portfolio of build over around the country. And most recently I've been independent consult owner/rep putting those design and owners hats on and helping owners in the healthcare area primarily optimize building performance through projects. And through this time I have been involved since around 2008 with the ASHRAE 62.1 committee which is the ventilation for acceptable indoor air quality standard.

Just I'll say that one of the highlights in my career was back in 2008 I believe it was. We met out in Golden, Colorado at NREL's offices with a handful of other retailers discussing maybe an option with the Department of Energy of creating a shared, an organization with a shared goal of helping save energy and look at sustainability. And that started the Retail Energy Alliance which is sort of the predecessor I think to the building better building systems. So it's pretty amazing what from the handful of retailers back then to where it's gone today and the growth to the Department of Energy has been really impressive. Go ahead to the next slide.

So the objectives, I'll go through some of the ventilation standards that are out there and some of the changes, recent changes, how to apply some of the different procedures that are acceptable in ventilation standards. One of the procedures, the indoor air quality procedure has an opportunity to look at how do you balance the improved indoor air quality and energy performance and how do you achieve both. And I can give some examples of how that was done at retailer over a number of years. It's always a challenge to try to balance the energy for ventilation, energy and comfort against indoor air quality, the codes, the risks for the design teams and now with the pandemic the potential how ventilation impacts spread of viruses. Go ahead to the next slide.

Some of the ventilation standards that are out there, I mentioned ASHRAE 62.1. It's a standard for commercial buildings in the United States. But it's actually an international standard so referenced throughout the world for its indoor air quality operations and design. International mechanical codes and other codes referenced various forms. Some of them used parts of the ASHRAE standard. Some of them have their own specific requirements for ventilation. World Health Organization has ventilation suggestion standards and also limits on certain contaminants that are suggested for indoor environments. There's

the green building standards such as LEAD and that's got a lot of ways to improving building performance over time.

And then state and local standards often supersede some of the other ones and have their own specific requirements that must be met for design. CDC has recommendations for ventilation and that certainly came to the forefront in the COVID ventilation and some of the suggestions. I know I've worked a lot with hospitals and used some of the CDC recommendations to appropriately isolate areas of the hospital during the COVID surges. Go ahead to the next slide.

So what was learned during some of the COVID ventilation? I think it's been evolving over time as far as is it airborne, is it not airborne. I think the consensus recently is that it certainly was airborne and so the ventilation system has a significant impact on the spread of the virus. So some of the recommendations were looking at making sure that at least the minimum outside air rates are provided at commercial spaces especially during peak occupancy. Filtration, improvements in filtration, MERV 13 or better is one of the recommendations. HEPA filters which is a real high efficiency, 99.9 plus percent efficient certainly used in a lot of medical situations to better capture small particles such as viruses. Just to give you an example MERV, the higher MERV number implies better filtration.

A MERV 6/7 is often used in commercial buildings and that has an overall efficiency in the generally in the 30 to 35 percent range for capturing particulate. A MERV 13 is more like 80 to 85 percent. So it's pretty significantly the three times improved capturing performance. Portable filters in rooms have been shown to help significantly to both increase air change rates and to capture locally contaminants. So it's and it's also found, it's really important to have effective air distribution and air change rates so making sure that the air change in the room are in addition to outside air just the overall air changes are high enough to flush the room effectively and that system design has a lot to do with that as well.

I'll say there's a lot of products, add on devices that have been marketed for COVID and as part of the 62.1 committee we often see a lot of that as people wanting to pose including certain items within the standard. But I'd say the concern is a lot of those have minimal testing backup for them. And oftentimes the testing may not be done in a real world application. So some of the performance may not really be there once you put it into an HVAC system versus some of the lab tests that might show a different

performance. So I'll just say that there is good add on equipment out there but it is really a buyer beware type of situation of some of it is probably not worth the investment. And then there's throughout the COVID and this past weekend was the ASHRAE 62 committee meeting, the summer meeting talking about the updates to the ventilation standard. There was a lot of discussion in if viruses such as COVID should be included in the ASHRAE 62.1 standard which they really aren't now and I'll get into that in a minute but you can jump to the next slide.

So ASHRAE 62.1 which is sort of the predominant ventilation standard it's, the purpose of the standard is to specify minimum ventilation rates and other measures intended to provide indoor air quality that's acceptable to human occupancy and minimizes health effects, adverse health effects. So it's used for design and operation such as in addition to the rates of ventilation it will discuss how far exhausts have to be from intakes in order to avoid re-entrainment of exhaust whether it's from a virus type of exhaust or a toilet exhaust or other types of systems. And I'll emphasize it's a minimum standard and that viruses and bacteria are not included. Just meeting that the ASHRAE standard doesn't mean that you necessarily have protection from viruses.

And part of that is it's really hard to determine how much viruses – what's the goal I'm trying to reach a certain level of ventilation for viruses. And that's a difficult one in evolving science. But again minimum standard meaning that you can certainly go above it. And it's meant to, the design team and owner have to decide where to go with it. There's three different procedures you can use to meet the ASHRAE standards. The ventilation rate procedure, that's where you just take an area based so many square feet for a certain type of occupancy such as retail or a hotel or commercial building and it has a CFM per square foot. And then based on the number of people that are expected at CFM per person and you just add those two numbers up and you'll get you minimum recommended ventilation rate based on historic acceptability.

There's the indoor air quality procedure and that's something we've talked about a little bit more today. That's more performance based approach where you by understanding the sources of contaminants in your space and what you're trying to maintain as far as limits of those contaminants you can better balance your ventilation rate with indoor air quality and energy. And then there's the natural ventilation procedure which brings, allows you to bring in outside air directly through openings in the building to provide a natural ventilation approach. And there's

been updates recently to the standard for that. Please go to the next slide. So recent updates. The current ASHRAE 62.1 is a 2019 version. There's a 2022 version coming out soon. It's a continuous maintenance document which means that their addendum are published continuously by the committee that will update that standard between cycles.

And so in addition to the standard itself you have to watch for addendum that might update it based on newfound information or correction of misinformation. Some of the changes recently that the natural ventilation requires consideration of outside air. So with natural ventilation understanding your contaminants in outside air to make sure that you're using that outside air predominantly for ventilation, that you're not degrading the indoor air quality because of it. Humidity control is now being expressed more in dew point versus relative humidity because dew point is more of an absolute measure of moisture in the air and there's times when relative humidity could provide risks to condensation and indoor air quality issues due to condensation within the space.

One of the changes of air cleaning devices that generate ozone are prohibited where there are devices out there, electronic devices that would potentially remove one contaminant but in the process create ozone which is considered another contaminant so that was considered not acceptable as far as meeting the ASHRAE standard. And then the ventilation approach had an option to simplify for design teams. There's more recently addendum aa was applied and this was after many years improving the indoor air quality procedure. ASHRAE now specifically specifies design compounds and limits for those compounds that should be looked at when looking in a commercial building indoor air quality and it requires objective testing of the finished product to make sure that its meeting the requirements as expected by the design. And it improved the equipment testing both for measuring contaminants and for if it's a filtration system understanding how that system is tested. Go to the next slide please.

Now why even consider a method such as the indoor air quality procedure? It is more difficult and more challenging to implement but there's opportunities as well with that that using a performance based approach. NREL did a study a number of years ago for the Department of Energy showing that in modeling one retail store was able to save over 600,000 kilowatt hours per year in using the ventilation indoor air quality procedure for ventilation versus a prescriptive approach. And that retail store system using the indoor air quality procedures since the late 1990s was able to save over

100 million kilowatt hours of electricity in air conditioning and over 20 million therms of gas heat. So pretty significant carbon reduction as well from a sustainability standpoint, opportunity well maintaining under air quality. There's also reduction in latent load by not bringing in as much ventilation air during moist times and it has capital cost savings by reducing the size of the equipment required to bring it, to temper that ventilation air. Next slide please.

So how do you use an indoor air quality procedure performance based? You really need to understand the contaminants in the space or the potential contaminants in the space if you're building a new building. And then you can either try to remove those contaminant sources or through filtration remove them after, within the space after it's completed. And then understanding design limits for those specific contaminants and the new ASHRAE standard and addendum does specify some design limits. There's also subjective confirmation in the indoor air quality procedure so both the objective and subjective requirements to make sure that it's working the way it should. So with an indoor air quality procedure you might have more air, ventilation air required. You might have less. But by understanding your sources of contaminants and controlling them hopefully its just right. Next slide please.

Just in applying it it's a challenge again opportunity for design teams to use that. The way it was used in the retail chain was by testing multiple buildings in the chain under different climate zones at different times of the year. We were able to apply that to other buildings that had similar occupancies and zones. So say a challenging but opportunities are there. Next slide please. So I'm going to jump through this next to the next slide just to show the opportunity. So with the performance based, prescriptive based you can see that the amount of ventilation required in the retail store because of source control and cleaning procedures was significantly reduced versus a prescriptive rate. So had opportunities for energy and capital savings over time that were significant. Go ahead to the next slide.

So for future considerations as more individuals or groups using the air quality procedure that information goes back to the 62.1 committee understanding what contaminants are in buildings and how to better control those. Defining good indoor air quality is really a challenge especially now with COVID as part and viruses as part of the equation or potentially. Sensor technology continues to improve so to measure things it's a better way to control things. And filtration technology continues to improve by – so once we

know what contaminants are in there we can potentially remove those with filters. Next slide.

So in conclusion the green building practices have greatly reduced contaminants in the building material itself and then in the materials that are brought into the building. So using the indoor air quality procedures allows you to take advantage of some of the improved construction practices in improved indoor air quality to better match the ventilation rate with the contaminant levels. And as we look at ultra low building energy use in the future I think it's more important to focus on ventilation as one of the major sources of energy use. And then with COVID as mentioned good ventilation is really a key to helping reduce the risks in spread. Go ahead to the next slide.

Source control. So I've always been an advocate where if you can understand what contaminants are in your space and in the retail area formaldehyde was one of the primary contaminants and it has dropped significantly over the years because of demand from the end user to reduce that. But by reducing it at the source you eliminate through the entire supply chain including what the ultimate consumer brings home into their homes and eliminate that potential indoor air quality concern all the way through. So I think that source control is a great way to focus.

So meeting the challenges that are trying to give good indoor air quality and energy performance you really need to look at an engineered, it's worth looking into a more engineered system than the prescriptive approach might provide to better balance the energy comfort, indoor air quality, codes, risks, virus control, other things. So it may be a little bit more work but I think as we go forward it will be a necessity. Next slide. So thanks. I think we'll have some questions later on.

Marcus Bianchi: Go ahead John.

John Zhai: All right. Thank you. Thank you Marcus for inviting me here. My name is John Zhai. I'm a professor in architecture engineering department at the University of Colorado Boulder. So one of my research areas is indoor air quality. I'm a fellow of ASHRAE and ISIAQ and IBPSA. Today I'm going to share some research we conducted in the last few years, talk about mitigation, COVID 19 in public commercial spaces. Next please.

So as we understand the three mechanisms as indicated by WHO and the CDC for the COVID transmission. So number one is close

contact because of large droplets spread out when people are talking, coughing. That typically transmitted within six feet. And also there could be small particles transmit through the air which can go beyond six feet. And certainly there's also surface contact with fomite. Those three general were all widely accepted mechanisms by all kinds of professionals. As CDC indicated most infections happen, more than 90 percent of cases happen indoors. Outdoors is less than ten percent. Actually if you look at those outdoor cases more than eight percent of outdoor cases happen in gathering events. If we remove those gathering events we'll find outdoor environment typically will have less than one percent of infection cases which relate to the mechanism because we typically have a large social distancing, high ventilation and less, smaller concentration virus. Next please.

So yeah. We look at all the droplets released from all kinds of human activities. For example looking at talking typically we release about 3,000 droplets per second and in which have about 200 virus particles. And if we talk about sneezing which is ten times more than talking and the travel distance will get into 26 feet. Next please.

But if we look at the amount of 3,000 particles, droplets from talking for example we find that actually more than 80 percent of particles are large particles which means they're more than 25 micron. Most of them are falling between 50 to 100 microns. That means those particles can quickly drop on the floor typically within six feet. That's exactly why CDC recommended the social distancing away from six feet. However we do have about five percent of small practices which is typically less than five micro and those micron we did a calculation. That can transfer more than 2,500 meters if there's not any boundaries or barriers. So those are the concern for another bunch of scientists talk about airborne transmission. Although they have a smaller probability but they do exist in this contaminant. Next please.

Yeah. So if you look at this famous equation, this is called Wells-Riley, Wells-Riley infection risk. I don't want you guys to look at the equations. I know as a professor I always like equations. But in this case we don't want to look at what are all the parameters affecting the infection. If you look at the bottom part those all relate to emitter site, infector site. So you look at what's the concentration virus exhaled from the emitter. How much air is emitted which relates to the emitter's activities and also depending on the exhaled virus quantum number which is the minimum number of virus can cause people sick, the average. Right? So this

for example this number will be significantly different between delta and omicron. And this is from the source side. And then we talk about the sink side. This is about the receiver so really talk about the concentration of virus at the receiver and also with the activity of the receiver and how long the receiver stays in that position. So that's about all the sink control.

If you look at the next slide please so this is just like Scott mentioned. This is in every single textbook, classic book, air conditioning textbook. So those are traditional and still current measures we can use to control contaminants. The first one is source control. That's quarantine, whatever. That's isolate, remove the source. That's the number one most effective way and the second one will be the ventilation. If the air is clean then we can use the clean air to dilute the infected air. That's a second solution as we talk about natural ventilation, mechanical ventilation, HVAC, etcetera. The last one is if the air is not clean or not sure whether clean or not then we have to use purification, all kinds of UV cleaner, portable air cleaner all belong here. So still after 50 years during this pandemic we still talk about these traditional control measures. Next please.

So let's look at the mask. That's the first PPE, the personal protection equipment. That's the first control for the source control and for the receivers control. Here I just wanted to indicate. If you look at the large particle, we talk about large particle like more than 25 microns actually when you look at homemade 100 percent cotton t-shirt mask they're pretty good if you look at 97 percent efficiency for large particle, remove large particle. However those masks are not good for removing small particles, only have 51 percent. However if you look at surgical masks they're pretty good, as good as 95 mask in that sense. Another thing interesting is CDC recommended bandana at the very beginning, right? But if you look at those numbers even for large particle bandana doesn't do a good job. It only has 44 percent protection. That's why at the very beginning I personally strongly recommended either use a homemade mask, it would be better to use than bandana. Next please.

But we know masks can help. I can show you results later. It does show well protection using a mask. However a lot of circumstance we cannot wear masks if for example we go for dinner and for some specialty events or the quality of mask may not be good and the way people wear masks may not be perfect. So we still have to talk about engineering solutions, how we mitigate the infection risk. Next please.

So this all, Scott already mentioned those recommendations from ASHRAE during the pandemic, a bunch of stuff. I don't want to repeat it but to highlight a little bit continuous run, two hours preoccupancy and post occupancy run, the air, maximize outdoor air, use energy recovery to save energy, 40 to 60 percent RH, 68 to 75 degrees Fahrenheit temperature, use MERV 13, adjust the filter frequency and use portable air purifiers. That's pretty comprehensive in the industry for most commercial retail spaces. Next please.

Here I just want to share some results we've done for a bunch of buildings. This is commercial buildings. We also do for retail or do the hotel, for schools, etcetera. So this is one example. This is a middle range large office buildings with 134 occupants and the people stay there for nine hours with full capacity. There's no reduced capacity. It's full capacity and we assume there's one person sick in the first floor core zone. And we compare with our not equal one and most of you know our not equal one is a threshold. If more than one means one person infected more than one person. If less than one that's infected less than one percent.

So the one is a stable position. We use that as a threshold to evaluate whether the measures works or not. So the shade line, you see the white shade means wear a mask plus engineering solutions. And the other columns just did the engineering solutions without a mask. So in this special case for commercial vendor with full capacity we find it very interesting all engineering controls with mask wearing can keep infection from propagation even with the base case, with MERV 8 plus 0.65 ACH basic design. It works pretty good. However if we remove the masks, nobody wears masks now we find most of them cannot meet the are not one. So only the case with 100 percent outdoor air plus room level UV can help. So that's a recommendation without the mask. This highlights the importance of masks but also in this case we need to enhance the ventilation rate and also use the space cleaning device.

And also one of the interesting findings although ASHRAE is recommending MERV 13 in our research we find that MERV 11 actually is already pretty good. So when we upgrade from MERV 11 to 13 the marginal gain is much less than we expected. Next please. So this is another example showing a classroom, a small classroom, 1,000 square foot with 37 students and the teacher is sick. The teacher will be there for seven hours. So we do care about the exposure time as we spoke earlier. So in this case look at all these cases with shade lines we find even with masks cannot

help preventing the infection. We have to use air cleaner. At least a 2,000 CFM air cleaner with masks can keep the infection from propagation. Well if students don't wear masks then we need a much, much bigger CFM air cleaner for the space. We're talking about many thousands CFM. Keep that in mind typical for air cleaner is about a 300 CFM. So how many cleaners we need for the space in most cases is unrealistic. In this case we have to talk about other solutions like a reduced occupancy, the capacity, etcetera. Right? This is a small space for 37 students. Next slide please.

So we summarize all the cases from office, school, retail, hotel. Very interesting we find there's strong correlation between the exposure risk percentage versus the exposure time divided by total supply airflow rate. We're not just talking about ACH. We're talking about exactly how air is supplied to the space. So these two lines one is representing treat the whole building as a single zone, single one box. The other one is multizone like has box, different conference rooms, different office space. So but they follow pretty linear relationship like I show here. Next please.

And we did the physical testing in a real restaurant. And this is some animation. You can see the first one to the left that's the air purifier is off. So you can see when people are talking all of the droplets can spread out even under the central air conditioning systems, spread out and can affect the people in front, opposite to the emitter. But whenever we turn on the floor purifier, put on the floor and for the side both of them absorb most of the released contaminant as you can see. And also we did quantitative analysis. Those talk about the particles, number of particles accumulated. We find that people one is an emitter, the two is opposite position, two and four basically release, get a lot of infection. But if we use floor units or the floor side unit it can have a good protection. We also try the table unit, those air cleaners we can put on the table, the small unit. Typical unit is 110 CFM. We can put the five table unit on the table and we can see what happens. It does also help release, reduce the infection. Next please.

And further we did a CFD analysis. This is the computation of fluid dynamics for the whole restaurant, full capacity, 177 occupants and you will see the supply air from the ceiling supply and the central return from the ceiling. And also we test to put eight floor air purifiers as you can see over there at the side and on each table we put also a table unit, a small table unit. Next please. So as you can see the indoor air is very complicated. There's a hot plume from the human and the cold jet from the diffuser.

Depending where we are the air movement and mixing is complicated. It's not just mixing as we wished. Next please.

So if you look at the A is central air, the B is central air plus floor unit, C is plus floor unit, table unit. So if you look at the infection probability of infection we use one percent at the breathing zone level which is 1.1 meter height from the floor. So with only central air you will see most of the areas will be covered more than one percent infection risk. If we use a floor unit the zone is reduced, infection zone is reduced to the corner. If we add to the table units the zone is much smaller now. Next please.

So this is just some animation showing, the first one is showing no purifier. You will see the droplets released from the talking because of buoyancy how plumes tend to go up. When they get into the middle way because of the cold air pushing down so you will see spread out of the droplet to the space which goes everywhere. And the right hand, that's a floor unit purifier. In this case you can see most of the airborne contaminant will be absorbed into the floor unit. Next please.

And this, you look at this with a table unit. The same thing with the table unit here we'll see this table unit can absorb the contaminant towards the diffuser, right, and clean their contaminant and you can see the velocity of most of the air flow towards the diffuser. Next please. And we tried an even bigger case. This is a ballroom case with a banquet with 1,320 people. In this case all the supply from the ceiling with that full outlet at the back wall and we test the four different locations for contaminants. Next please.

So this animation left if you click on it you'll see without portable air cleaner, only central air you will see the contaminant really spread out across the table and even go beyond to the other tables. If you click on the right you will see with the table unit now the airflow pattern and contaminants distribution is totally different. You will see a strong jet flow from the table upward. If you look at quantitative results again the purifier only handles 12.36 percent particles.

However you see the reduction of deposition on the bodies reduced about more than half. And if you look at the ceiling it's actually getting to about 50 percent deposition. This is because the strong jet flow from the diffuser actually pushes the contaminant towards the ceiling. This is something we didn't expect at the very beginning. We saw mostly we should count on the cleaning effect

of the purifier but interesting the air jet from the purifier actually pushed the contaminant towards upward. Next please.

And this again showing the velocity vector and the PI contour. As you can see the top three, the CAB those are just the central air system only. You will see how this contaminant can spread out. And the bottom one the CATB that's with the table unit is confined on this table only. Next please. So really after this just like Scott mentioned right now there is a big debate in the field. People talk about those needing discussion. What is the key? How do we design next generation buildings? What about the new air standards? Right? We don't have an answer for it now. There's absolutely a lot of debate on it. Next please.

So one thing we need to talk about if this study done by a company to look at if we use 100 percent outdoor air to reach 5 ACH you will see significant cost increase and the carbon emission increase compared to the business as usual as the current standard which is not acceptable. You can see for all the climate zones. Right? You have huge increase. Other than that we can use recirculate air which is clean air rather than 100 percent outdoor air we can reduce this load very significantly. Next please.

So the main takeaway from this talk is we have to consider both ACH and the total air change rate, the total air change flow rate, not just ACH, ACH times volume and also talk exposure time. And we have to consider all clean air, not just outdoor air, fresh air. We have to talk about recirculate clean air as part of a solution and we have to look at the portable air cleaners. Certainly we have to look at the adequate capacity and the last one we have to look at indoor air distribution. A lot of studies assume the space is a perfect mix and unfortunately they are not. They are strongly case dependent. Like you said the jet flow from the air purifier can actually change the air flow directions and then change the infection risk. Next please. I believe that's it. Right on time. Thank you everybody.

Marcus Bianchi:

Thank you so much John and Scott for the presentations. We got some questions. I mean I think I posted on the chat but I'm collecting some of those questions in the Q&A part of Slido. So if you have questions that would be interesting to post the speakers please post it there. I actually was looking at them and I responded to some of them so I replied with links to the guide itself that we published and to previous presentations. One question that was asked in like more than once. What about energy consequences, cost impacts of improvements in IAQ and what about legal

liabilities? I don't know if like either one of you would like to comment on that. I just started by saying that NREL last year made a series of simulations trying to determine what are the impacts of the epidemic task force recommendations in buildings' energy use and I posted that too. Please one of you who would like to address that.

Scott Williams:

I'd be happy to go ahead and start. Certainly there is an energy impact and that has to be looked at because using more energy also has a detriment to outside air quality, both carbon and other. So it indirectly does impact indoors. So there's a balancing point there that has to be understood. In addition to the energy would be just even systems because you can't just automatically increase your outside air rate on existing systems that weren't designed that way for capacity or even sometimes add extra filters that your fan systems may not be able to handle it. So there's a lot of impact. Now it's just understanding how to do it and then it's how to apply it is going to be a whole new ballgame, especially trying to do it in existing buildings.

Marcus Bianchi:

Thank you.

John Zhai:

Yeah. I can add a little bit on it. From the fundamentals we know if we double the speed, right, the velocity or double the volume for rate you're basically four times the delta p the pressure drop. And you talk about the fan power, that's the cube reached eight times the energy use. So what I'm saying is if you wanted to increase total air exchange rate there's a huge implication to energy consumptions. Another way to do it is change the filter like Scott mentioned. It would change the MERV 13. But there's also consequences of that to energy savings because you increase the MERV rating, you increase the pressure drop. So you have to increase the fan power. Again the mechanical fan in the whole building takes about a 40 percent total electricity use of a building. It's 40 percent so it's really significant.

Now if you want to increase that and if you go to 60 percent that's a huge burden to the owners, operators. So you do have to consider the consequence of these IAQ procedures. And also the other things like Scott mentioned natural ventilation, actually a lot of countries use that, China, UK already promoting that, even using natural ventilation for hospital. But unfortunately nothing passed the US. Right? We're still demanding mechanical ventilation for some purpose. But it will be very interesting that ASHRAE opened the door to look at another opportunity for natural ventilation.

Marcus Bianchi: Just a follow up question about that just because it's my curiosity. What about when you have issues like the big fires that you and I John have been facing. At times yesterday my outdoor air quality was pretty bad. So when you talk about natural ventilation you have to account for that. How do you do that?

John Zhai: That's a great question. Like I said we have to count on clean air, outdoor is clean, that's the assumption. Then we can use ventilation. Right?

Marcus Bianchi: Sure.

John Zhai: But for that case if outdoor is bad like in Beijing, Shanghai right now people talk about PM 2.5 terrible. In that case the recommendation will be close the windows and doors as tight as possible. Don't even think about opening it but we still need fresh air. In this case the purifier will be the key. So now we can turn on the purifier, the portable purifier or just use 100 percent recirculated air. Ok? So we count on the filters or the UVs to clean the contaminants. Certainly this air doesn't provide additional oxygen. It doesn't provide that. But it will certainly clean the contaminant. That's the solution number three as I mentioned, the classic solutions.

Marcus Bianchi: Excellent. Another question that had a lot of thumbs up. Any advice for implementing IAQ measures across more than a dozen sites? So like if you have to consider multiple buildings if there any particular advice on how to do that different from just like dealing with a single building?

John Zhai: Well in that case I will refer to the ASHRAE recommendations that I listed. That is the pretty generic for most of commercial buildings like schools, retails although ASHRAE also developed those building specific recommendations. They have like for restaurants, I believe for schools reopening guidance. But the ones I listed those are general recommendations. For example keep the right temperature range. RH range and either maximize outdoor air rate and change the filter to the max allowed for this building, stuff like that. I think that's the general recommendations.

Marcus Bianchi: Thank you.

Scott Williams: And I'll just add the indoor air quality procedure as I mentioned works well with multiple sites because it recognizes that if you understand if the sites are similar in a lot of end contaminants and operations what you find in one site might apply to other sites. So

you can do extensive testing on a subset of the sites and perfect your performance and then apply that to other sites. So it allows the owner to sort of spread out the cost of maybe extensive testing to multiple sites across their chain or portfolio.

John Zhai: Another thing I wanted to add is although I highlight importance in nonuniformity of the space air but most of the small spaces they're a pretty good mix. And that's why a lot of studies, ASHRAE guidelines are based on the perfect mixing assumption like a small office, a small restaurant or stuff. They're pretty good for those general assumptions.

Marcus Bianchi: Excellent. Thank you. One question that actually I find it pretty intriguing. It seems like people are actually clicking. So ok. Here. Can you say more about source control? What should I eliminate from my space to improve indoor air quality? How do you do source control in commercial buildings and what are like the prioritization that could take place there.

John Zhai: Let me give a first try and Scott can follow. Source control is most effective in the special contaminant case that's the sick people. Right? People got sick. Then try to have them go home. Don't even – that's why all the companies have this policy. If you don't feel comfortable, feel sick, might be sick don't even come to the office. That's the number one. And a lot of offices do the screening, right? Like in the airport they do the measure the temperature, all this stuff. That's another way to protect it but those are just for virus pandemic.

But if you should talk about general contaminant sources for example VOC or the PM 2.5 those are stuff we already establish pretty well knowledge on the potential sources. For example the VOC can come from the furniture, the carpet, right, the painting materials, the cleaning solutions, etcetera. So we try to eliminate that at the first place. People choose the materials for construction or to buy the furniture we have to make sure we buy the low VOC or no VOC painting, stuff like that. That's all called source control.

Marcus Bianchi: Thank you. Scott?

Scott Williams: Yeah. I agree with that. As I mentioned the green building push has done a great job of reducing VOCs in a lot of construction material and we saw that during testing over decades that the contaminants have gone down significantly even directly after the opening of a new building. It was no longer a need to really flush it out to get rid of those construction contaminants. And then also

even my experience with Target a lot of the contaminants were coming from the products that were being sold and that also has improved greatly over time because people were requesting reduced contaminants in their clothing and other products, furniture that you put together. So that again has improved greatly so that's a good opportunity for source control, just the demand from consumers all the way down through understanding what are the contaminants even as far as cleaning materials that are used in the building or equipment that might be having carbon monoxide if it's a propane furnisher for example in a store. So there's a lot of potential sources and by measuring it you can find what those might be and then hopefully address them.

Marcus Bianchi: Thank you. We are out of time and I'm just going to give the last minute to the organizers to actually show like what's next. Thank you both speakers for presenting and thank you for the participants. So there are like a few webinars in the future. Please visit and find their contents. Thank you so much for participating.

[End of Audio]

Clear the Air: Healthy Indoor Air for Businesses and Tenant Spaces

Additional Resources

Learn more about the topics discussed on the webinar by visiting the resources below.

Better Buildings Resources

- Healthy Buildings [Guide](#) for Small Businesses: A Quick Reference to Improve Indoor Air Quality
- HVAC Resource [map](#)
- Decarbonizing HVAC and Water Heating in Commercial Buildings [resource](#)

Explore more resources on the [Better Buildings Solution Center](#)

Other Resources

- ASHRAE Standards for Ventilation and Indoor Air Quality [webpage](#)
- Potential Risk Analysis of Medical Staff When Performing Endotracheal Intubation in Negative Pressure Isolation Ward ([link](#))
- Mitigating COVID-19 in Public Spaces ([link](#))
- Distributed Probability of Infection Risk of Airborne Respiratory Diseases ([link](#))
- Application of Portable Air Purifiers for Mitigating COVID-19 in Large Public Spaces ([link](#))
- The Efficacy of Social Distance and Ventilation Effectiveness in Preventing COVID-19 Transmission ([link](#))
- Facial Mask: A Necessity to Beat COVID-19 ([link](#))
- Investigating the Influences of Ventilation on the Fate of Particles Generated by Patient and Medical Staff in Operating Room ([link](#))

Up Next in the 2022 Better Buildings Summer Webinar Series

Financing Solutions that Drive Energy Efficiency in the Water Nexus

Tuesday, July 12th from 11 am - 12 pm ET

The efficient use of water results in lower operating costs, a more reliable water supply, and improved water quality. Join to learn how market leaders in the hospitality sector finance and deploy projects that tackle energy efficiency and water conservation nexus.

[Register here](#)

Follow Better Buildings on Twitter and LinkedIn



@BetterBldgsDOE



company/better-buildings