WIND TURBINES NOISE AND HEALTH: FACT VS. FICTION SIMULCAST
July 15, 2010

Coordinator: Welcome and thank you for standing by. This call is now being recorded and is a live event being broadcasted by Webinar. Thank you. You may begin.

Chris Powicki: Good evening everyone. Thanks for coming tonight. My name is Chris Powicki and I'm with Cape & Islands Renewable Energy Collaborative. And - we're going to get started right now. So please take a seat. And we have about 50 people online. We're broadcasting this over the Web. And so if possible, it would be wonderful if you can be quiet during the presentation tonight.

My name is Chris Powicki. I'm with Cape & Islands Renewable Energy Collaborative. And we're very pleased to sponsor tonight's forum. CIRenew was formed in 2000. We're a membership organization and we try to do public events like this once a month. Usually we take the summer off but when there are important issues like wind turbine health and noise, we do take the opportunity to bring speakers to you as we can.

This forum was originally scheduled in Brewster in June. I appreciate those who came out in June and weren't able to see it and hopefully you will be informed by tonight's presentation.

Our next meeting will be on August 11 and we will be back in Brewster and we're going to be addressing the topic of zero waste. I teach at the community college and frequently I ask my students what's the largest renewable energy project on Cape Cod.

Nobody ever answers - ever gives the correct answer and it's the SEMASS incinerator, which is actually located off Cape Cod but we ship most of our trash to it. And so we're going to be having a forum looking at zero waste as option for the region and our speaker will be Neil Seldman from the Institute of Local Self-Reliance from Washington D.C.

He's a nationally renowned expert on the topic. And he'll be looking what can be done on Cape Cod to increase recycling, increase composting, increase reuse and reduce the amount of material that has to either be land filled or incinerated.

Tonight's event is co-sponsored by the New England Wind Energy Education Project. And so let me briefly introduce Jason Gifford who's going to say hello. Thanks.

Jason Gifford: Thank you very much Chris. I'm Jason Gifford and I want to take just a moment to introduce the New England Wind Energy Education Project. We partnered with Cape & Islands Renewable Energy Collaborative this evening so that this presentation is not only available to those of us here in person but also to a group of hopefully over 160 registrants who are participating online.

So I'm going to take just a moment to introduce the New England Wind Energy Education Project. I'm going to provide a brief overview of the objective project activities and funding of NEWEEP.

NEWEEP is a Webinar series and it's designed to provide objective information, deciding decision makers and the public throughout New England. And we do this by collecting and disseminating accurate, objective and up to date information on critical wind energy issues. We do this with an eye towards appropriately sighted wind generation.

This is a two-year project. So at a minimum we'll go through the end of 2011. It will consist of at least eight Webinars. Tonight's is the third. Webinar Number 1 was on the impact on property values. Our second Webinar was just two days ago and also related to wind turbine sound.

We're planning a full day in person conference in early 2011. That will be a multi topic and multi speaker event so we will advertise that and we hope that you will be able to join us for that as well.

All of the material from each of the Webinars, from the in person events that includes the PowerPoints, the audios, these events are recorded, an annotated bibliography in which we'll include a variety of perspectives not those - not only those of the speakers at the events but also perspectives of other people who study these issues and have information to share. So we are making every effort to make available to you information from all different perspectives on this issue.

The project is funded by DOE as part of the Wind Powering America Market Acceptance Program. And so as a result, the program is not industry funded or driven in any way.

I'd like to make just a few organizational and governance comments about the program. Both Sustainable Energy Advantage and the National Renewable Energy Lab were co-applicants to DOE in order to create the Wind Energy Education Program.

And so it is coordinated by Sustainable Energy Advantage but directed by a committee of regional stakeholders. And that group includes a number of

policymaking and other bodies. And our direction on topic and speakers and all other matters comes from this group.

I'd like to conclude with just a few comments about NEWEEP's philosophy and approach. Our perspective is objectivity. Wind energy has benefits but not every place is right for wind. And we take as our framing principle two things. First that the consequences of wind power are rarely as dire as made out to be by organized opponents and are often not as free of consequences as proponents might represent.

So as a result, our stake is in the process and not the outcome and that's whey we're participating in tonight's event. There are hard decisions to be made and decision makers in the public need to be armed with good information, not information only from parties who are either aimed to build or obstruct specific projects.

So we'd like a good outcome. And that's why we want a fair an accurate presentation of the issue. We'll never be able to convince everybody that NEWEEP doesn't have a bias but we'll try and we'll try this in the way that we gather speakers, the way that way that we provide bibliographies including gather data and positions that are counter to those of the speakers and by posting all of this information on the Web site.

So I'd just like to conclude by saying that we acknowledge and respect that there maybe multiple perspectives on each issue. And we'll work within our five remaining Webinars and our in person conference to work with you to gather those perspectives, make sure they're represented throughout the process so that everything is heard.

And now I'd like to hand the podium back to Chris to introduce our featured speaker. Thanks very much.

Chris Powicki: Thanks Jason. We're pleased to have Dr. Robert McCunney speaking tonight. He's a Research Scientist at Massachusetts Institute of Technology and he's also a physician. We felt like it was very important given what occurred on the Cape in the last couple of months with the cancellation of municipal wind projects and with real genuine concerns raised about the wind turbine Falmouth regarding noise that we bring a scientific perspective to bear on the issue.

Decision makers are getting bombarded with information. Some of it has gone through the interview process. A lot of it has not. They're getting information from proponents; information from opponents and like NEWEEP, Cape & Islands Renewable Energy Collaborative is interested in informing decision on behalf of sustainable energy. Again, we're not interested in the specific outcome other than good decision-making. And so that's why we asked Mr. McCunney to speak here tonight.

In the interest of our Web based audience as well as in the interest of keeping peace based on perhaps some differing opinions of those in attendance, we are going to have a Q&A session at the end of Dr. McCunney's presentation and we're going to ask that you submit questions on index cards.

And so I will hand out - hand these out and if you could write them down and get them back up to the front of the room, we will give them to Dr. McCunney at the end of his organized presentation. So with that, let's introduce or give a round of applause for our speaker. Thank you.

Robert McCunney: Thank you very much. It's a pleasure to be here tonight and I'm certainly trying to speak in the spirit of the two previous presenters to try to give you as much as I can objective information based on science. I'm not really a proponent or opponent as it were of wind turbine. I'm really more of a proponent that if science is used for public policy that the science is interpreted properly.

To give you some idea about how I got involved in this particular issue that is potential health affects of wind turbines, about last May I was invited by the American Wind Energy Association to be part of an expert panel that was charged with conducting a review of the scientific literature related to wind turbines in human health.

Prior to that time, I had no formal experience in the health implication of wind turbines. But as an occupational physician, I've been in practice now a little over 30 years. I've been concerned about the implications of noise on workers.

So I've been involved in setting up occupational health programs for workers exposed to high noise levels in various factories and various types of industries for many years. I've also lectured - annually lectured the Harvard School of Public Health on noise and health.

I've written some book chapters on occupational noise exposure. And for about seven or eight years I reviewed the audio metric tests of people who worked at MIT to make sure they didn't suffer noise induced hearing loss.

So this isn't in any way trying to beat my breast in terms of to what I've done but just to give you some perspective about my background even before I got interested and got more involved in the issue of wind turbines and human health.

Now what I did and what we did as part of the panel is we were asked to take an approach to see what was out there in terms of scientific literature. Now the focus of the panel and I'm really here not speaking as any representative of the panel. The panel was really my first foray as it were into the issue of wind turbines and human health. But since then I've obviously paid more attention to the scientific literature on this topic and have tried to keep abreast of what's going on.

But our initial approach within the panel was to look at peer reviewed papers. By peer review these are scientific papers that have gone through the peer review process and then essentially what that means is if I write a scientific paper and I want it published in a certain journal, I submit it to the editor.

The editor then farms the paper out from anywhere from one to three people to review the paper and say gee they missed this, how about this study. And they didn't interpret that data right and it goes back and forth until ultimately a papery is either rejected or accepted with revisions. The revisions are done and maybe the paper gets in.

Now the scientific peer review process had a little bit better layer of equality to the science. Just like in life where there's different types of restaurants, schools, baseball teams, you name it, there's certainly different types of science and with respect to the quality. So we wanted to focus on what was published in the peer reviewed literature.

Now the way that's done is in the Web site, and I'll get to my formal presentation but I wanted to give you a little background of this what we did. You're all familiar with Google. Well, in the scientific world there's a search

engine called PubMed, which is maintained by the National Library of Medicine supported by all your tax dollars.

And this PubMed search engine actually sites published papers from around the world. There's thousands and thousands of papers that are there. So if you want to look on a certain topic, let's say you're interested in wind turbines, wind turbines and health effects. You put it in a dialogue box, you search and you see what happens.

So there were a number of different approaches that we in the committee or the panel tried to do to make sure we didn't miss anything. Whether it was wind turbines and health or frequency noise and health, high frequency noise and health, extra auditory affects of the noise to make sure we weren't missing anything of significance.

So then the panel consisted of about, as I said, about seven people all of whom represented different disciplines. I think there were two - at least two maybe three physicians, there were acoustic engineers and audiologists in a way of representing the scientific dimension of our work.

So with that as background, I wanted to tell you what we found. What I'm about to tell you is not any fundamental research that I did or the panel members did. We just took a thorough look at what was out there in the literature and this was work that was ultimately published in December '09. But prior to this presentation, I've taken another look through PubMed to see if there's anything new that I should have been aware of before coming to a public forum such as this.

But let's start. First slide. I think it's important to know that with the operation of a wind turbine, the major exposure of concern in noise. In occupational and

environmental medicine of which I'm a specialist, the concern is always whether there's any link between the exposure on one hand and other hand the health effect.

For example, is there any link between exposure to asbestos in the shipyards in the development of lung cancer? Is there any link between working with solvents at a sheet metal shop for example and the development of asthma? Fundamentally we're always looking at any links between exposure A and B designated health effects. Now when it comes to wind turbines, the major operative issue as it were is noise. So let's take a closer look at that.

With respect to operation of wind turbines, there's two different types of noise. There's the noise that comes from the mechanical operation of the wind turbines and B, the noise from the turning of the blade, the so-called swish-swoosh sound. Next slide.

I think it's important in a discussion such as this to point out how noise is measure. Noise is measured fundamentally by two ways. One is how loud it is and that's measured in decibels, and the tone of the noise. For example, young children may have very high frequency sounds, birds and so forth. Or if you ever stood next to a base speaker at a rock concert or wherever the musical concert might be, you know that's there also low frequency noise.

And all of you have ever gone through an audiometric test that's where your hearing is tested, you know, you sit in a booth and what the audiologist does is start with low frequencies going all the way up to high and, you know, you raise your hand when you hear it.

So think of noise as being measured by both its loudness that is in decibels and it's pitch that's its frequency. And we'll frequently through my

presentation this evening look at those two terms. Now I think it's important for comparative purposes to see the decibel levels of various common activities with which you're all familiar.

Jet engines for example are about 140 decibels, a rock band about 110 and many of you may not remember this from high school mathematics but the scale is logarithmic which means the difference between 56 decibels and 60 decibels would be a doubling of the sound; 60 to 70 would be a further doubling.

So you can see hear that normal conversation is about 50 to 70 decibels. And we used to have a rule of thumb when I'd go to the - I used to teach residents in occupational medicine and we'd go to a factory to look at health risks. And I'd say one of the easiest ways to determine whether you may have a problem with noise is extend your arm and if you have to raise your voice so the person hears you, it's probably over 85 decibels.

So I want you to keep these figures in mind because as you go down lower, you'll see that the risk of or the noise in your wind turbines is about 35 to 45 decibels and this is based on a study of the National Research Council of the U.S. Government. Next slide.

Now wind turbines and sound - again according to the National Research Council sound power from a single wind turbine is usually around 90 to 105 decibels. That's pretty loud right there at the source. There's no doubt about that.

And for comparison purposes, if you own a factory or you work at a factory and the noise levels are greater than 85 decibels on an average eight hour time weighted average, people need to be enrolled in a hearing conservation

program which means hearing protection. It means periodic audiometric exams; it means education and so forth. So I just wanted to put these figures up for comparative purpose.

Noise on the other hand again, and this is from the National Research Council, from an onshore wind project are typically in the 35 to 45 decibel range at a distance of about 300 meters. Now there's all sorts of ways that these sound levels can be measured. Clearly the results are going to be dependent on the level of power of the wind turbine. But just put these into perspective. Next slide.

There are three points that I think you want keep in mind again as we go through these studies. And I think it's helpful just to refresh your memory on some of these points with which you already may already be familiar. Speech frequency is between 500 and 20,000 hertz, normal speech frequency. There's low frequency sounds and as I said that's more along like the base if you're standing next to a speaker or the music is usually about 220 to 250 hertz.

And then there's the so-called infrasound. Infrasound is less than 20 hertz. And the reason I bring this up is there are some people who feel that there are potential health affects associated with wind turbines have raised concerns about low frequencies and corresponding vibrations associated with those frequencies that may be an issue of some concern.

Next - so there are three kinds of sound emitted by wind turbines that receive attention, the infrasound, the low frequency sound and the so-called swish-swish sound. Now the swish-swish sound that's associated with the wind turbine has been determined to be at a frequency of about 500 to 1000 hertz. So the swish-swish sound is not really low frequency sound according to measurements nor is it infrasound.

You should also know, and I'll go though this in more detail later, that there have been studies in various countries looking into sound level measurements and the frequency distribution of those sound measurements in the proximity of wind turbines. Next slide.

I think this table's important to understand some of the points that have been made by people who feel there are serious health risks associated with wind turbines. And as you look up here on this table is the right hand side this is - this is all infrasound. That's 20 hertz.

So again, 16, 10, 8, 4 and so forth in that so called infrasound region. You can see on the lower row that as you go lower and lower in frequency, the noise level that you need in order to hear that frequency gets higher and higher.

So the fancy way of saying it mathematically would be there's an inverse relationship between frequency and sound level needed to hear the frequency which means the lower the frequency the higher the noise has to be. Which is why I put that first slide up there about 110 decibels being a rock band.

You can see, you know, to hear a frequency of about 4 hertz, you're going to need a pretty loud sound similarly even at 20 hertz. The people can hear it but the sound has to be pretty high. Next slide.

Now infrasound and hearing. The noise level refers to the loudness of the sound necessary for it to be heard and the respective frequency. And wind turbine - the infrasound emitted from wind turbines is at a level of about 50 to 70 decibels, sometimes higher but well below the level that you would need to have in order to hear the frequency - the sound of that frequency. Next slide.

Are there health affects? One of the other concerns that's raised and this has to do quite frankly I learned a lot about this in this process as well because I'm not an acoustic engineer. But apparently the low frequency sounds are much more difficult to control.

Low frequency sounds have longer weight lengths and they can travel longer distances and they can actually get through walls and so forth. If every - many of you in college probably remember the person above you or below you used to blast the speakers at 3:00 am. You heard it. You - maybe you heard it and you felt it.

So the low frequency sounds are more easily transmitted than the higher frequency sort of the high pitched like child like bird like sounds. Next - there's no evidence however that we were able to glean from our literature review that these infrasounds or low frequency sounds at the levels generated by wind turbines can adversely affect health. Next slide.

So what did we do with our literature search? As I said earlier, the first thing we did was just look at wind turbines and health affects. Very general. Sometimes you find an article and that may refer to three or four other articles at the end of the paper. So we tried to make sure we weren't missing anything. And there - in the literature review we wanted to address peer reviewed studies. Remember what peer review means. I mean it's not a guarantee that the study is perfect but it just adds another level of quality control.

There are actually three cross sectional studies of people that lived in the vicinity of wind turbines. They're primarily from Europe. If any of you have been through Northwestern Europe particularly Netherlands, Germany and so forth you see the wind turbines there all over the place. So there have been

studies there. So let's take a look at those studies and see what the results show.

Now this was a study of people - just under 2000 people among 70,000 eligible results all who lived within about two and a half kilometers. That's a little over a mile and a half of a wind turbine in the Netherlands. And they had sound level measurements and everybody that was eligible to participate answered a questionnaire and then the questionnaires were analyzed in relationship to the exposure, which in this case was the sound level. Next slide.

You can see this table. It's not as complicated as it may appear. The first row is just the sound level. And as you can see going from left to right, those five decibel increments are associated with a number of people who had sound level measurements outside their home at that level. And then the lower row is who reported being annoyed. And frankly, the questionnaire is directed to people do you feel annoyed by the wind turbine? Why do you feel annoyed and so forth? And these are essentially the results that investigators reported.

And as you can see, as the sound level increases from 30 to 35, only about a half percent reported being very annoyed. As you get higher, 40 to 45, more and more people report being annoyed. And that's' a feature that you'll see that comes out a lot of the studies that as the noise levels increase, there's a greater - a greater percentage of people who report being annoyed by those noise levels. Next slide.

So the authors noted also when they looked at the people who reported annoyance, they wanted to find out why they were annoyed and what made them annoyed. So they found out that the percentage of people who reported annoyance from wind turbines it was not quite as bad as aircraft.

It was between aircraft noise and shunting yards. Shunting yards are where railway cargo shipments and so forth not for passenger trains come in and there's all kinds of noise associated with those. So it was between those two features.

They also noted, and this has been a recurring theme that I've seen in a lot of the research on wind turbines that is in other studies, of a link between a person's attitude towards wind turbines and reporting annoyance. That when you take the people who are annoyed however that is, then you try to find out why.

The strongest factor of why people were annoyed is because they didn't like the wind turbine whether it was cosmetic or whether they didn't get economic benefit. There are a lot of different reasons reported in these studies. Next slide.

These same investigators, these are Swedish investigators who did another study. This was actually in Sweden where they evaluated not quite 2000 people as in the Dutch study but about 750. And similar methods where they distributed a questionnaire to people that had sound measurements. And the people who completed the questionnaires were between about 600 and 1000 meters. Six hundred meters would be six or seven football fields for example just in terms of distance. Next slide.

And what they found results vary similar to the Dutch is that when once you get to about 35 to 37 decibels, good 5% of people report being annoyed by those levels. And as you go higher, greater than 40 decibels, about 15% report being annoyed.

This study went into a little more detail about trying to find out why people were annoyed frankly. And what was striking to me and a lot of others in looking at the results of the study -- this isn't my study; anybody else can look at the same study and see the same results -- the odds ratio which is a way of evaluating how significant a certain factor is in the study, that people - the odds ratio was based in attitude towards wind turbines and visual impact toward wind turbines.

So this is a quote from the study those who had an unfavorable attitude towards wind turbines were over 13 times more likely to report being annoyed by it. Very significant findings. Next slide.

The same investigators studied just under half the same amount as the previous study, about 350 people in five domestic areas. The wind turbines were of this power generation of 660 kilowatts. They also did a frequency analysis that looked at low frequency sound. And the sound levels ranged from the mid 30s to about mid 40s in decibels.

And remember that first slide I showed you that showed the length between the frequency of the sound and the sound level necessary to hear that frequency? Clearly just putting that slide next to this you'll see that these frequencies could not be heard. And the distances from the wind turbines ranged from as close as 150 meters, a little longer than two football fields, and 1200 meters. Next slide.

So among the 132 people in the 32 to 35 decibel range at a distance of about 500 meters, about 6% report being very annoyed in this study. And again, like the other two studies, a person's attitude towards wind turbines was the strongest factor associated with the annoyance. Next slide.

So how would we summarize at least these three environmental studies? They're the only three that were out there that we were able to find actually. Based on the similarity of results of residents in the vicinity of wind turbines in Sweden, a number of conclusions can be drawn.

One, certainly a small percentage of people report being very annoyed by the sound from wind turbines at less than 35 decibels. As the noise levels increase, more people report being annoyed and the perception of annoyance from the sound of wind is strongly related toward attitude toward the wind turbines. And people who are most likely to be annoyed are those who don't like wind turbines for some reason or another. Next slide.

Also we tried to look at infrasound and low frequency sound. So I want you to understand the structure that we tried to approach to understand this issue of potential health affects of wind turbines. I want to just look at the studies themselves, look at people who live in the vicinity of wind turbines. So those three studies that I just described is all that's out there.

So then you think gee is there something about the exposure? Is there something about the benzenes? Is there something about the asbestos? Is there something about the lead that's causing a different effect? Is there something about the noise that would be different in this situation compared to other studies we know about noise?

So okay. Let's take a look at low frequency noise and health affects. Let's take a look at infrasound and health affects to see if there are what are called experimental studies.

By experimental studies I mean exactly what the term means. You go to some laboratory and they have seven people sitting in a room and you test them for

symptoms they may have from exposure to low frequency noise or infrasound. In fact studies like this have been done with the old Apollo Space Program and I'll describe those momentarily.

We weren't able to find any link between low frequency noise from wind turbines and health affects. There wasn't anything reported. That doesn't mean there's nothing there. It's just there's - it's not a problem. It's just nothing's been reported.

You should know for balance though the Food and Drug Association actually approves infrasound for therapeutic massage at 70 decibels. And if any of you have ever worked getting a medication through the Food and Drug Administration, it basically takes 10 years from bench to bedside.

You know, if you make a new - invent a famous drug that's going to cure diabetes, it's going to be 2020 before patients start using it. So the FDA is not an easy organization to slip something through. They approved infrasound for 70 decibels. Next slide.

Now I wanted to go over with you - now these are not peer reviewed studies. And the reason that I'm citing them is because sometimes you can get valuable information from non-peer reviewed studies for all sorts of reasons; and these maybe government reports.

But one of the problems in doing a report that we did is trying to address non-peer reviewed studies is unlike the peer reviewed studies, there's no systematic way of referencing them to make sure you get everything. That some of these now because of the availability of the Internet, some reports are showing up.

This is a Danish study done a couple of years ago where they looked at a whole variety of wind turbines. Wind turbines are in many different places of Denmark, certainly right off Copenhagen and so forth and now in the water area.

They determined this Danish study that wind turbines do not emit audible infrasound and they said actually that other noise sources such as road traffic emit lower - low frequencies of a higher level. Actually road traffic emits more low frequency sound than wind turbines according to the Danish study.

They also said there's an approximate 15 to - 5 to 15 decibel attenuation of noise from outdoors to indoors. Attenuation is obviously it's a reduction if it's 80 decibels outside which is incredible but it was (55) inside. There's also something very interesting about the attenuation in a little anecdote.

One of the concerns they had earlier in my career was whether women who were bearing children, pregnant could work in high noisy areas. Believe it or not there actually have been studies that show that the uterus can dampen the noise up to 30 decibels, which means that if there's an 80 decibel sound that the fetus or - yeah the fetus at that point would be experiencing about 50 decibels.

It's important to understand that the body surface does have attenuation properties both in terms of the sound level as well as the frequency and we'll get into that momentarily. Next slide.

There's also a British study done about four years ago and they found just exactly the same what the Danes that the low frequency noise associated with road traffic was greater than the sound of the wind turbines.

That the infrasound associated with modern wind turbines will not be imperious to the health of a wind farm neighbor. And these are conclusions from the authors. None of this is either the opinion of a panel or me personally. This is all in the actual reports themselves.

The measurements of infrasound of modern wind farms at distances of 200 meters were between 25 and 40 decibels. And as you remember, that first slide people aren't going to hear this. And the authors also referred to a World Health Organization report that stated there's no reliable evidence that infrasounds below the hearing threshold produced physiological or psychological affects. Next slide.

In the British study the most common cause of complaint was not associated with low frequency noise but with the occasional audible modulation of the aerodynamic noise; basically the swish-swish sound. People didn't like the swish-swish sound at night.

And they reported also, again a quote from the report, of the 126 wind farms operating in the U.K., five reported low frequency noise problems. Therefore such complaints are the exception rather than the general problems for wind turbines. Next slide.

And there was also a U.S.A. study. This was done in Texas and just published a couple of months ago actually where they evaluated about 15 wind turbines and the results again a third time the Danes, the British and now the Americans saying that infrasound isn't audible.

To even the most sensitive people about 300 meters, that's about three football fields, from the wind turbines and the low frequency sound above 40 hertz may be audible depending on background sound levels.

The also said that a maximum noise at a distance of more than 300 meters from the nearest residents, wind turbines do not pose a low frequency or an infrasound problem. At this distance the wind farms - I don't know if people know about ANSI the American National Standard Institute that evaluates all kinds of things used in industry.

But according to ANSI standards, these levels below frequency sound are the same as what you'd need in bedrooms, classrooms and hospitals based on background sound levels. Next slide.

Now low frequency noise and health affects. You've seen a little bit of the summary of the British, Danish and American studies. That the health related effects of living in the vicinity of wind turbines and corresponding exposure to low frequency sound have also been evaluated in the Netherlands where in addition to annoyance they're looking at health problems.

And the investigators in (Vandenburg) found no link between noise levels and risk of Diabetes, high blood pressure. Tinnitus is ringing in the ears. I can't imagine how that would be a problem from these noise levels.

But high noise levels can certainly cause Tinnitus. Tinnitus is that ringing in your ears that sometimes people get from aspirin, from high noise levels, all sorts of reasons people get it. But you wouldn't expect it from the noise levels associated with wind turbines and no cardiovascular disease.

To the contrary, the illnesses were more common at the lower sound levels than the higher sound levels, which really argues against the cause and effect relationship.

For example, in occupational medicine when you look at a research study to determine whether there's a cause and effect relationship, that is that the asbestos caused the lung cancer, that the led caused the kidney disease, that the solvents caused the asthma, you want to look at what's called a dose response relationship.

In plain English, that the higher exposure associated with the higher risk. And here you have higher noise levels associated with the lower risk. If in fact there was some link between the noise and these health problems, you'd expect there to be greater problems then as the noise levels increased but the contrast is was just the opposite. Next slide.

Just to give you a little background too, these are some of the experimental studies to which I referred earlier. And in the Apollo Space Program in the 60s and 70s astronauts in training were evaluated for the affect of low frequency noise and infrasounds on them.

And you could imagine the hostile environment that astronauts have to operate in. And the Apollo Space Program the subjects were actually exposed to between 120 and 140 decibels low frequency noise without harmful affects. Remember that you're approaching the jet engine level; that's rock band level, that's pretty high noise.

In the U.S. Space Program, the studies indicated that 24-hour exposures to 120 to 130 decibels are tolerable below 20 hertz. Now granted everybody's not an astronaut. I realize there's a lot of individual variability among people, but nonetheless I think these results do, you know, provide some encouraging support for some of the conclusions that have been drawn in other settings.

So modern wind turbines produce sound that is assessed as infrasound at typical levels 50 to 70 decibels below the hearing threshold at those frequencies who concluded that infrasounds - this is by Jacobsen, another Scandinavian author, who concluded that infrasound from wind turbines does not present a health concern. Next slide.

You should also know for balance in any study, any occupational and environmental study, you have to consider what are known as confounders. For example if someone who has lung cancer and you found out gee they worked at shipyards as a sheet metal worker in World War II and the Korean war now they have lung cancer; they also smoked. How do you sort out whether it was the asbestos or the smoking? That's called a confounder.

How do you sort out somebody who has nerve damage working 15 years with certain - like n-Hexane, they also have Diabetes. Diabetes is the confounder. So in this case there are confounders because your normal heart tones believe it or not are infrasounds. They're one to two hertz.

So heart tones are one to two hertz and that's - you want them to be that way. So it's not something - it's not as though there's something sinister or potentially damaging on its face of infrasounds or low frequency sound because there's infrasound going right on right now in your body.

Similarly with lung sounds. Lung sounds are a little bit higher in frequency but certainly in the low frequency range. Lung sounds, you know, when you go to the physician's office and stethoscope's put on your back, take deep breaths and so forth, that's as you can see between 5 and 35 decibels at about 150 to 600 hertz. Next slide.

Now low frequency sound. Research of low frequency sounds has shown that an audible low frequency sound does not normally become objectionable until it's about 10 to 15 decibels above the hearing threshold. Hearing threshold - remember the old hearing test? You know, the frequency and you raise the volume until you hear it.

People hear that at different levels. I mean we're different in many different ways. But apparently the low frequency sound does not become objectionable according to research studies until it's much higher than the hearing threshold. Next slide.

You should also know that there are - there's been a lot of variety of health related information has been introduced in the context of wind turbines and health affects. And I thought that I describe at least some of those to give you another perspective.

There's been a condition described as wind turbine syndrome and there's a book written by a Pediatrician named Nina Pierpont who wrote a book called Wind Turbine Syndrome. And if I could try to get to the heart of the chase, the apotheosis raised is that low frequency sound and corresponding vibration can adversely affect health. Remember that first table I showed you where as the frequency goes down lower and lower, the sound level needed to hear that frequency gets higher and higher.

So one of the theories behind the so-called wind turbine syndrome is the frequency goes down, there's higher vibration, it's the vibration affecting your health. Now as of at least May in a search that I did in PubMed under the term Wind Turbine Syndrome, nothing showed up, not one paper. And I haven't seen it as a recognized diagnosis in the medical community.

No unique symptoms or combination. Frankly the symptoms that have been described seem to be what's been described about 30 or 40 years ago in the context of annoyance from noise. So it's a similar pattern when some people feel annoyed by noise for whatever reason, some of these symptoms have been reported. Next slide.

What the view of our group was -- I'm trying to look at all the literature and I showed you what's out there at least as of a few months ago -- that low level sounds from outside the body do not cause a high enough excitation within the body to exceed normal internal body sounds and that's the confounder we talked about where there's other exposures of similar magnitude.

And the similarity between symptoms of noise annoyance and those of wind turbines indicate this diagnosis is not, at least according to many, a pathological affect but an example of the stress affects of exposure to noise virtually any type. Next slide.

So again, the Wind Turbine Syndrome appears to be to be on two hypotheses that the low levels of air born infrasound from wind turbines at one and two hertz directly affect the vestibular system. The vestibular system helps us with balance. The vestibular system for example operates - if you got to wash your face, close your eyes so you don't fall into the bowl for example. The vestibular system helps you know when you're about to fall to brace yourself.

So one of the theories is that the low levels of airborne infrasound from wind turbines directly affects the balance. There's about three different types of balance. I mean it's not only the vestibular system. There's also the cerebellum at the back of the brain and your eyes and so forth. But at least the vestibular system plays a major role.

So the other theory is this low level of airborne infrasound from wind turbines at these low frequencies enter the lungs via the mouth and then vibrate the diaphragm, which transmits this vibration to the viscera. The viscera is the internal organs so the intestines, liver and so forth. Next slide.

So that's how - bottom line is Wind Turbine Syndrome as described seems to be a variation of symptoms reported in the context of annoyance from noise. Vibroacoustic disease is another condition that's been raised in the context of potential affects of living in the proximity of wind turbines.

And in the case of wind turbines and it's hypothetical relationship, we only have limited information that's called case series where two or three people seem to have a certain collection of illnesses or diseases that they think is related to eating microwave popcorn or living next to a hazardous waste site or whatever it might be.

That's a case series or case report and I think case reports have certain value. I've certainly written case reports myself in the literature to introduce gee, there may be something going on here between this exposure and this health affect.

It's not to discount case series or case reports because they have value. They just have limited value in drawing causal connections. The main value of case reports is to raise ideas. It might be studies in other settings with different types of investigation. Next slide.

So a review of PubMed on the term vibroacoustic disease, there were about 36 references. And what surprised me was all of them but two originated with the same group from Portugal. And it seemed unclear why the rest of the academic world does not appear to address this vibroacoustic disease concept

essentially under the domain of one particular group. Next slide. And again, these were case series.

So how do you interpret the scientific literature? In the case of wind turbine noise and its hypothetical relationship to Wind Turbine Syndrome and vibroacoustic disease, there have been not case control cohort and longitudinal studies that have been published. In fact basically the weakest type of scientific evidence case series is available.

And it's with some caution that I say this but I mean there is a hierarchy within the scientific world in terms of the quality of studies necessary in order to draw causal inferences between exposure to any hazard and any particular disease.

These are fundamental principles that are used when you're evaluating the affects of smoking on health or asbestos in lung cancer. You know, whatever the issue may be, coal and lung disease, you're always trying to look at equality of the scientific studies that are there. And at least from what we have seen that the studies that are out there are really unpublished in the peer reviewed literature case series. Next slide.

So how - what conclusions can I make of this based on looking at the literature? And again I want to emphasize that - and anybody can do the same think we did, which is we tried to look at available - publicly available peer reviewed literature. You don't have to be a physician or a scientist to do PubMed. Anybody here in the room can look at the articles and determine your interpretation of them and then look at the experimental studies.

So from this effort, I think some conclusions can be drawn. One is the noise from wind turbines does not pose a risk to hearing loss. I don't think there's

any worry about that whatsoever. I think that's a statement that can be made with some assurance.

I mean there are - the lowest risk of noise induced hearing loss according to the National Institute for Occupational Safety and Health is in the range of about 82 to 83 decibels eight hour time weighted average for about four years, 40 not 4. So you're nowhere near that with respect to wind turbines. So there's really no risk of hearing loss.

Now there's no question that these studies support that some people are annoyed by wind turbine noise. And the higher the noise level goes, more and more people get annoyed. I think that's pretty clear based on the science that we've seen.

And the major cause of concern from that noise at least based on our review of the literature and mine particular, is the fluctuating nature of it. It's not there all the time. Obviously when the wind slows down, the turbines don't turn. Sometimes when it's really turbulent, you'll - more will turn.

The noise may be more susceptible at night than daytime when people have no other competing sources of noise. But there's no question that people do report that.

And the sub audible low frequency noise and infrasound from wind turbines based on what's out there does not present a risk to health and we're making these conclusions on the fact that direct measurements near homes in the proximity of wind turbines and also the experimental study such as I mentioned with the Apollo Space Program.

So there's two bits of reasonable scientific data that have been published to give some assurance that the low - sub audible low frequency in infrasound noises are not of concern. And that the Wind Turbine Syndrome is really a new disease or an accepted medical diagnosis but the symptoms certainly appear very, very similar to what's been described for about 30 to 40 years in terms of annoyance to noise - environmental noise.

Well thank you very much. I appreciate all your attention. It's been fun to try to give you my perspective and I really invite questions. Thank you.

Chris Powicki: Sure. (Yeah. Sure). Right now for the folks online we're collecting cards from the audience and we're going to read them aloud and then Dr. McCunney will give a shot at answering them.

So first question. As a doctor, how do you explain the fact that people are not sick prior to turbines beginning and then they get sick and when they leave living near turbines the illness goes away?

Robert McCunney: Well that's a good question. There obviously is something going on there. If people feel certain symptoms whatever they do, whether they eat something or they go in a certain area, air bothers them or whatever, there may be something going on there. Some people are affected and that's what I indicated there in those studies that certainly some - as the noise levels increased more and more people become annoyed.

Man: (Unintelligible).

Chris Powicki: Next question. Was Dr. Nina Pierpont's Wind Turbine Syndrome book peer reviewed as requirement for publication?

Robert McCunney: Let me try to answer the other question because I think a gentleman here said they were sick. I'm really reluctant; I mean first of all as a physician, I accept any symptom a person tells me that's real. I don't - certainly wouldn't want to give the impression that some people might - that any symptom a patient reports to me is real. And I think the issue is not whether the person has the symptoms but what the cause may be and what the appropriate treatment might be.

So I really can't address the question about how people are sick because I obviously haven't seen them. I'm not going to do what the Senator did three or four ago and looked at a videotape of a woman who was in a coma for 18 years. He looked at her for 30 minutes and made a diagnosis. I don't do that. Next.

Chris Powicki: Okay. Could you please speak to the health risks that arise with chronic sleep deprivation and are you aware that the Geneva Convention defines forced sleep deprivation as torture?

Robert McCunney: First I apologize for not answer the other question. I think Nina Pierpont before she published her book had a number of people review it for commentary but I don't know. All I know is that that work hasn't been published. It's searchable in PubMed. I think that's the easiest way of explaining it.

Can I please to the health risks that arise with chronic sleep deprivation? Yeah. Chronic sleep deprivation is a serious matter. There's no question about that. And I'm not an expert in chronic sleep deprivation but from my general knowledge, clearly it can increase risks of high blood pressure. It can increase risks of myocardial infarction. Sleep deprivation is not something you'd want to encourage.

The - I'll get you in a second; I'm sorry do you have a question? I'm sorry. I apologize. I guess the rules of the discussion are you can write something down and I'll get to your question. Other people have done that.

The - am I aware that the Geneva Convention defines poor sleep deprivation as torture? I'm not aware of it but it wouldn't surprise me. I wouldn't recommend sleep deprivation.

Chris Powicki: What's the best way to combat all of the inaccurate and misleading negative information that opponents are advancing on wind turbines?

Robert McCunney: I can certainly tell that just by the nature of the presentation that I made and I really don't - I approach this topic honestly with no ax to grind one way or another. In fact I thought it was interesting to see what might be out there. And I approach this thinking that I'm balanced but I understand because of my conclusions, people might think otherwise but that's the way it goes.

What's the best way to combat all the inaccurate and misleading negative information the opponents are advancing? Well, I fundamentally I think people need to be listened to and make sure that their concerns are properly addressed.

I think it's difficult for people who aren't familiar, and I don't - believe me I don't want to be high handed about this, but I think people who - whatever you do in life if you do it everyday you're better than somebody who doesn't do it much at all or rarely.

And people who are unfamiliar with the different types of scientific studies I can understand where it might be confusing for some person that says this study says and another person says that, that study says that.

In my view at least, and this is only my approach, I realize there are many reasons why people may want wind turbines and many not want wind turbines. My goal here is that if you're going to be making public policy based on science to try to make it on the best available interpretation of the science as you can.

There maybe other reasons why you don't want wind turbines or there may be other reasons why you do want them. But at least my bias is make sure that you interpret the science in a proper way for public policy. And I think the answer to this question is by presentation of good science and being willing to listen to people - to listen to people. I don't know if that works but it's an effort.

Chris Powicki: Robert Bryce's recently published a book entitled Power Hungry: the Myth of Green Energy and the Real Fuels of the Future states humans cannot live close to wind farms because of the low level noise caused by the massive blades. That noise say neighbors and critics disturbs sleep patterns and can cause headaches, dizziness and other health problems. How would you respond to that statement?

Robert McCunney: Well I think some of the studies have tried to look into these particular concerns and as I said, I have no doubt what so ever that there are people who are annoyed by various levels of noise associated with wind turbines. That's for sure. The study shows that. Makes sense to me but humans cannot live close to wind farms; I guess the operative question is what is close? I don't

want to sound like a lawyer but really what is close? Is it 100 meters? Is it 1000?

You all know enough physics to know the farther away you go from source of noise the more it declines. In fact as you double the distance you get 1/4 of the noise farther out. And you all know that from high school physics. So the farther one is away from the wind turbines, clearly the less likely there will be concerns about health implications or even noise annoyance.

That noise say neighbors disturbs sleep patterns. I have no doubt whatsoever that some people may be affected in terms of their sleep by the type of noise depending on where they're living and how it affects them. I hope that answers your question.

Chris Powicki: What about people living a quarter to a half mile from the turbine?

Robert McCunney: You know, these are really good questions that I'm not able to answer on the top of my head. I mean I think every question has to be directed towards - just think of it logically. Depending on the size of the wind turbines, you know, how much kilowatts it's generating and so forth and how big it is and how much energy it generates.

It's going to have a lot to do with the sound levels, how high they are and probably the types of frequencies as you go farther and farther away from the source. So my recommendation would be to try to reach a level of sound outside a person's home and I don't know what that distance could be. Maybe it's sometimes 500 feet; maybe other times its 1500 meters. I think it would really depend.

Year there are. That's a good point. She raised a point that there's one and quarter mile. Each of these studies had different distances and you could actually construct a study where you could do measurements at various intervals. That's very easily done. So the answer to the question is I don't know because I think each situation will be different as to what the noise level will be in terms of distance from the types of wind turbines there.

So rather than saying how far something should be away, I would propose that you say I want to keep the noise levels below this level whether it's 50 feet or 3000 feet.

Chris Powicki: When one child yells, one thing happens; when five children yell, it's a whole other story. What happens to the noise from one turbine versus the noise of for or five turbines that are cited within a given distance from a certain house? How does that affect the noise level? What are the interactions between those turbines and the sound they're emitting?

Robert McCunney: I think the answer - the answer is obvious. The more wind turbines that you have, you're going to have higher noise. And I think each circumstance is going to be different.

Now one of - as I understand it because of my experience in occupational noise exposure, one of the beauties if you will of noise in health at least in the occupational setting, and I'll try to get back on the wind turbines, is that noise induced hearing loss is preventable.

People don't have to get it. And the way you do it is you control noise at its source. You minimize generation in the noise wherever it is. There are all sorts of dampening procedures and so forth that can be done.

Now I'm far from being an expert in the noise generated noise control measures from wind turbines. But it would seem to me that maybe the answer is in blade design, lint curvature, I don't know but that may be the wild card. Clearly it wouldn't be that hard to control the mechanical noise of the operation of the wind turbines because here you have noise at its source. There are all kinds of noise control products. It can be done.

I don't know enough about controlling noise from the blades but it would seem to me that it might ultimately be the design. Yeah. It may not be I don't know.

Chris Powicki: Who paid you to speak here tonight?

Robert McCunney: I don't know I don't even know. I haven't been paid so I don't know who pays me. But I think for disclosure purposes, you should know that when I was invited to be part of the American Wind Energy Panel, we received a grant. And you should also know that no one from the American Wind Energy Association or the Canadian Wind Energy Association I think who co-sponsored it has anything to do with the editorial content because I wouldn't have - I wouldn't have been involved.

Moreover we're very familiar with this at MIT. When you get a grant for a conference, you have to maintain academic integrity and yeah I have to acknowledge the way white paper was funded by that organization.

But I can also say, and you'll just have to believe me, that my editorial integrity in reviewing the studies or commenting on them was not compromised in one bit nor was the even any threat of it. I'm not on retainer by a AWEA I've made no further - rather no further projects with AWEA. So in terms of full disclosure I hope that helps.

Chris Powicki: I will be glad to buy you a beer after tonight's discussion. Have you ever interviewed residence of Vinalhaven, Maine who were interested in the turbines and for the turbines until they were actually turned on?

Robert McCunney: No. I haven't interviewed them. As I mentioned earlier I - my experience in this topic is really limited to participation on the panel where we prepared the white paper and subsequently to that effort trying to keep abreast of literature that's published.

My primary professional experience with noise has been implications on the workforce primarily nose induced hearing loss. And of course there are other adverse effects of noise. It's not only on hearing. But much, much higher levels than what you see with wind turbines.

Chris Powicki: How do you explain the theory that the only people who have negative impacts are those who were opposed before construction when you consider the fact that toddlers and small children are waking up throughout the night experiencing ear pain?

Robert McCunney: The latter comment I have no experience with so I'll have to take it at face value. What's the first part of the question?

Chris Powicki: The fact that - I think you answered it.

Robert McCunney: Oh how do I explain...

((Crosstalk))

Robert McCunney: ...well all I can tell you - oh, I think the first question was how do you explain the theory - it's not a theory it was just from that report. That only people who have negative - it's not only people. Believe me, there are other people too. It's not just only people who have a negative impact.

To refresh your memory, the study showed that a lot of people were annoyed and they tried to find out what was it about the people who reported being annoyed that might be of value. So the researches did this. This isn't my interpretation.

They actually presented a table in the report. If anybody's interested, I can reference you to the article and you can look at it yourself. I don't know. I'm not trained in psychology or psychiatry or some of the other disciplines that might understand why certain people who report don't like something then has certain symptoms associated with noise. I don't know. I just presented the data as the investigators in the study did.

Chris Powicki: How close would you feel comfortable having a wind turbine cited near your home?

Robert McCunney: You know, that's a good question. And as I said earlier, I think the answer would be based on the sound level. That's what I would want to look at. And there have been a number of approaches that have been undertaken to try to figure out what the most appropriate sound level is.

There have been some studies that have looked at what is the sound level at night, you know, without wind turbines. And then if you put a wind turbine in that ambient background level shouldn't increase by a certain level; everything from five decibels to ten decibels up to tossed about.

And I'm not an expert on all these regulatory initiatives. My focus is limited to what I presented tonight. I can tell you that I live in Cohasset, which is right across from the Hull wind turbine, and I can see it from my house and it never occurred to me to be worried about it even before I got more involved in this particular topic.

Now based on what I know, what I would do is I would go through and tabulate all the studies because you see some of the information there and put out the sound levels versus distance and try to get some interpretation of okay at a distance of 500 feet the sound levels are 40, 1000 feet they're 35.

But its still going to be limited by the type of wind turbines you have and how many of them you have. But to try to answer the question directly I think, you know, keep it below 35 decibels; something along those lines; maybe 40. I'll have to be honest with you I don't know.

I haven't given careful enough thought to this question to give you a good answer. But I would approach answering your question by tabulating the results that I just described that I haven't tabulated yet to try to make sense of it.

Chris Powicki: What is the recommended decibel level for an average person to remain asleep and how does it compare to wind turbine decibel levels?

Robert McCunney: That's a good question and I don't know the answer to it. I don't know how low noise has to be or the sound has to be to promote healthy sleeping. I can tell you that sudden impulse like sounds are more disturbing than chronic humming sounds like the humming of a motor is less objectionable than say a sudden sound associated with a car honking or a explosion or lightning and thunder or - obviously you wouldn't hear lighting; but thunder for example.

And in occupational studies that's described as impulse noise. There's either continuous noise from the operations of motors and so forth and then there's impulse noise, which is - and clearly impulse noise is much more troubling to most people.

Chris Powicki: Some of the studies you reported looks at turbines of varying sizes. Are larger turbines potentially noisier and louder? How does size influence sound production?

Robert McCunney: Yeah a very good question and I really don't have enough background to give you a good answer. I know fundamentally that as a wind turbine gets larger, there's going to be more noise. But as I said, some of the mechanical operations can be controlled at its source.

I've also heard that there's better and better design of wind turbines. And again, I'm not an engineer. I'm not really familiar with some of the nuances. But from what I've been told at least that the newer turbines tend to be less noisy whether that's the case I don't know.

Chris Powicki: There are several questions that address turbines in local communities. Here's one and I think I'm generally going to talk these out because my guess is that the doctor's not familiar with the details but here's an example. The town of Bourne for Mass Military Academy has a turbine in Buzzards Bay.

All of Taylor's Points, the neighborhoods surrounding the turbine, can hear it. No matter where you're located you can hear it. Have you heard concerns about that project and why were no studies done and discussed relative to local turbines?

Robert McCunney: I'm sympathetic to the person who posed that question but I just don't know enough detail to really give you a really good answer actually. I think one way of knowing is before a wind turbines cited is get some measurements of noise that they're relatively straightforward to do with sound level meters and even frequency distribution's not complicated to do anymore. That'd be one approach and you could have a pre and post evaluation.

Part of the problem with some of these studies, and even the studies that I talked about, is that there's no pre and post assessment. I mean that'd be one way of checking whether there's a link between the symptoms people have described and the wind turbines is you could have a pre and post study. Another way would be to look at a control group where you evaluate residents who don't live near a wind turbine.

Now that can be tricky because everything else has to be the same, you know, no power plants, no (unintelligible) there are a lot of different confounding factors that I talked about earlier that would need to be addressed.

Chris Powicki: How many studies have been done on the turbines that are within 1000 feet of homes, not one and a half miles or up to five miles as in the AWEA, CANWEA report?

Robert McCunney: So since the CANWEA, AWEA report these other studies I described in more detail particularly the American study of Texas there were about 15 wind turbines in Texas. So there have been additional studies that have tried to look at the noise levels.

Now to answer your question specifically, I can't answer that off the top of my head. I'd have to go back to the individual studies as I tried to answer to an

earlier question and just tabulate what the distances are. I mean I could even see it right now.

You'd have one column would be the power generation. Another column would be the distance. Another column would be the sound level associated with that distance and the frequency weighting. And you'd start to get your answer and then you could create a curve out of that.

And you could start making some decisions about what's too high and what's not too high. I don't know the answer off the top of my head but that's how I would go about answering that question.

Chris Powicki: I live in Falmouth, Massachusetts and unfortunately I do not live in a uterus. For those of us who are deeply annoyed with the sound at 40 to 45 decibels or greater, how are we to get a sound sleep when living within a half mile of the wind turbine.

Robert McCunney: Well, I'm sympathetic to the person who posed that question. You may have seen there is a dampening affect that you get from closing your windows. You can reduce the decibel level. Believe it or not, I mean that may not be something that's acceptable to people. I mean but you asked me a question. That's the first (idea). We have an expression keep it simple stupid. Do the first thing - do the easiest thing first. So the first thing would be close the windows.

You may not be able to close the windows when its 98 degrees and 95% humidity and you don't have air conditioning. I don't know because you're going to get sound transmitted through the windows.

There are also better insulation techniques if people do renovations. I'm not saying that should be done but a lot of the good insulation material that's available now also has noise dampening properties, but really that maybe too little too late.

Frankly that's about the only thing I could think of off the top of my head. Again, I'm not an expert in that but I'm just trying to apply what I know in other settings.

Chris Powicki: Do you know what turbines the NRC, National Research Council, used to determine the 35 to 45 decibels at 300 meters?

Robert McCunney: No. But I - no but if the person is seriously interested, I'll get you the reference for the answer to that question. But I don't know it off the top of my head.

Chris Powicki: What do you say to the comment that those with other physiological, anthropological research traditions would disagree with your assertion that statistical large sample results are of higher quality than case studies?

Robert McCunney: Well, first of all, this isn't my opinion. If people - I would advise not necessarily listening to me in terms of interpreting scientific literature. All of - many of you here (I don't want to sound flippant), but the U.S. Government supports the National Cancer Institute. That's our National Cancer Institute.

We support the World Health Organization. We provide about 30 to 35% of the World Health Organization's budget. Within the World Health Organization there's the International Agency for Research on Cancer or as well call it IR.

And if anybody's interested in understanding in how the International Community of Scientists interpret studies to affect - to determine causality or cause and effect, I could refer you to the monograph of the International Agency on Research on Cancer where it lays out the value of various types of studies prospective longitudinal studies, retrospective, cross sectional case control, case series and so forth in terms of the impact and drawing causal inferences from the results of those studies.

If people want, you could look at the Web site IR - iarc.fr for France. It's located in France and look into the guidelines for interpreting research studies. So that these really aren't my policies. These are really international guidelines for interpreting scientific evidence for determining causality.

Chris Powicki: Some of the studies you quoted, you (distance from) turbines one from Sweden people lived one and a quarter miles from turbines. Based on your research, what is an appropriate set back and distance for industrial scale wind turbines or would you use another measure for set back?

Robert McCunney: You know, that's a good question. It's a frequently asked question is how far you should be from a wind turbine and the direct answer is it depends. And I'm not trying to evade a good question because it really depends on the type of wind turbine that's there. Obviously terrain has a lot to do with how sound is transmitted. Flat terrain noise is going to be more readily transmitted than say hilly terrain.

And these are questions that can be answered. I mean there should be enough engineering data out there that a lot of these answers to these questions can be modeled so you can get reasonable ideas about how far to situate wind turbines from homes so that people aren't adversely affected.

There ought to be a compromise in all this. I mean I think in many things in life a little bit of give and take and try to find out what's best for everybody concerned because it's not in everybody's - it's not in anybody's interest; the developers have people concerned about health implications. It's not in the person who is experiencing these health related issues.

Chris Powicki: How do turbines affect our pets?

Robert McCunney: I'm sorry?

Chris Powicki: How do turbines affect our pets?

Robert McCunney: Again these are good questions. This forum is showing me how little I know about a lot of simple things. But it's fascinating, you know, and now you're asking me about pets. The direct answer is I don't know. But you know what's really interesting about pets; many of you may know this. Do you know how many animals dies in the Tsunami in Indonesia? Very, very, very few. In fact none they sensed the vibration.

So I think animals have - well obviously they have different sense. I mean people know how dogs can smell. Their olfactory nerve is much better than a lot of ours. So I don't know. Maybe the vibration affects them. I don't know and I don't know. I'm not sophisticated enough or had a study to answer that question.

Chris Powicki: If it's not low frequency noise that's annoying people, why talk about it? Talk about aerodynamic modulation, the swish-noise that annoys people at night.

Robert McCunney: Good point about low frequency noise. The reason that we brought up the low frequency noise is there had been people that had advanced the theory

that low frequency noise in the corresponding vibration associated with the low frequency noise is adversely affecting human health. So that's why the topic was addressed head on. The second part of that question?

Chris Powicki: About swish-swish (unintelligible).

Robert McCunney: Yeah. You're absolutely right. From what I've read and from speaking to people it's the swish-swish sound that most bothers people. Also the infrequency of it. I mean it's not like a continuous sound that you're going to hear so the intermittent nature of the sound and the swish-swish sound.

Now remember the swish-swish sound has been evaluated. That's about 500 to 1000 hertz; clearly a lot higher than that low frequency sound.

Man: (Unintelligible).

Robert McCunney: The swish-swish?

Man: (Unintelligible).

Robert McCunney: Yeah that's a $64,000 question. It certainly can be annoying. And I think annoyance can have a whole range of effects where it could be certainly troubling to a person. If affects their sleep. It could be - annoyance could be standing too long in a line at the post office or being stuck in traffic. There's a lot of different types of annoyance. I'm not trying to minimize it but annoyance means different things to different people.

And I've found to try and understand this whole issue is it's hard to get an objective definition of what annoyance means in terms of the health implications. A lot of people have struggled with it. There have been these

debates about whether it's a health affect or not even not even going in there. Just describing what annoyance means to maybe you or to me or to other people in the audience this is not an easy exercise. In fact I haven't seen it vigorously addressed yet unless somebody else has.

Man: (Unintelligible).

Robert McCunney: I'm sorry.

Man: (Unintelligible).

Robert McCunney: Maybe, maybe not. It depends. I mean that's the only honest answer - only way to honestly answer your question. I mean it really depends some people - everybody knows people that everything rolls off their back and their never bothered by anything...

((Crosstalk))

Robert McCunney: I'm sorry?

Woman: (Unintelligible)

Robert McCunney: Right.

Man: (Unintelligible).

Robert McCunney: Right.

((Crosstalk))

Robert McCunney: Sure.

Man: (Unintelligible).

Robert McCunney: Well, as I said earlier - as I said earlier, I think annoyance there's a whole range of affects and clearly on one extreme annoyance can get to the point that it bothers people; maybe upsets their stomach, makes them feel that they have a headache, difficulty sleeping. There's no question annoyance at extreme can cause symptoms and I've acknowledged that on a number of occasions in tonight's presentation.

But what might annoy one person to have the affects that I just described might not be sufficient to cause the same problems for somebody else. There's such a variability, individual variability in how people respond to annoyance, which made it - makes it so difficult to arrive at a definition that everybody agrees on.

Chris Powicki: We're going to not take statements from the audience. I'm going to move on. Here is another question on annoyance though. Compare the noise annoyance from nearby road traffic say 200 feet away particularly trucks to that of a wind turbine 1000 feet away at a residence. If the A weighted measurement from the turbine at the house is less than 10 dBA of above the ambient, should the wind turbine be denied? Should the truck traffic be rerouted?

Robert McCunney: Well, these are public policy questions and I'm no expert in public policy. Let me try to answer - is this the one? Compare the noise annoyance from nearby road traffic 200 feet to that of a wind turbine 1000 feet away.

Some of the studies tried to do that and I think the answer is it depends. If the A weighted - as to whether road traffic is worse than wind turbines or vice

versa. I think you can find circumstances where either one maybe more annoying than the other depending on the local circumstances.

If the A weighted measurement from the turbine at the house is less than 10 dBA scale above the ambient should the wind turbine be denied? Well again, I'm not an expert on public policy. But I've seen proposals just like the one that's been indicated here that as long as after the wind turbines installed it's not greater than ten decibels above background. I've seen other proposals that say it shouldn't be above five. I don't know enough right now to answer that question. (Noise level)...

Jason Gifford: I just wanted to comment briefly that we held a Webinar on Tuesday which included a panel on which appeared two acoustic engineers and many of the technical questions that are being asked tonight may be answered in their presentation and in the audio and the - our posting of that will also include all of the questions and associated answers.

So those will be posted on the New England Wind Forum. If you could Google New England Wind Forum, you'll be able to find it. Since the Webinar was only yesterday, it will take us until the 27th to have all the information posted. But again Q&As, presentation, and audio will all be there and I'm happy to direct anyone to that afterwards.

Chris Powicki: Thanks Jason. How does the fluctuation in wind speed affect sound levels from the wind turbine?

Robert McCunney: As the blade increases its velocity, there's more noise. Whether there will be further ambient noise I don't know whether there's studies out there that have looked at it. I'm not aware of them. Where you'd measure the velocity of the turbines and the corresponding noise at different distances.

This young lady over here asked me about two to three hours of sleep. Only a fool would say two to three hours of sleep is healthy. I mean I've gone through a lot different friends. I think I've had one friend who could get by on four or five hours of sleep. So I'm sympathetic. If you're only getting two to three hours of sleep, that is health problem. I don't know what the cause of it is but I mean it's certainly - something needs to be addressed.

Woman: (Unintelligible).

Chris Powicki: Did the studies you reported report the ages of those in the study and whether age level affected their annoyance level?

Robert McCunney: I don't think so. That's called age stratification. You can do that in research studies but I don't think they've looked at percentage of people at various age increments who've reported health concerns.

Chris Powicki: How would you define a malfunctioning turbine by noise standards?

Robert McCunney: I don't know that those definitions are out there. I mean as far as I'm aware. I mean I - if you want a rule of thumb, it shouldn't be greater - at the very - no more than ten decibels higher than background outside your house. Some people think five; some people think non; there shouldn't be higher than background at all. So there are a lot of different opinions on this topic.

Chris Powicki: In the (Henderson) 2000 study I wanted to understand whether the odds ratio was screened for causality? We're people opposed to wind and therefore more annoyed or were they more opposed to wind because they were annoyed?

Robert McCunney: As I understand what the investigators did they sent out a questionnaire to people who lived in proximity of wind turbines. There were a whole series of questions that were asked. And because they tried to find out, I mean, they tried to find out why people were annoyed and why the reported annoyance.

And there were four or five different factors that they looked at including proximity to the wind turbine. You would think theoretically that the closer you were, you would have a greater percentage of people annoyed. That would be a logical thought. And then you'd go to sound level and a lot of other parameters. And the one that jumped out at with highest risk was the attitude towards wind turbines.

Now it was a cross sectional study, which means at one point in time - cross section studies we do let's say a cholesterol level of everybody here in the audience. That's a cross sectional study. Longitudinal studies we do it today. We do it next month.

Like the (unintelligible) study do it a year from now and three years and look for trends. These studies are cross sectional. What that means is you don't know whether the chicken came before the egg or the egg came before the chicken.

Chris Powicki: Given the low number of people involved in the European noise study and the high standards for statistical significance, should public health policy only be based on statistical significance or might there be non significantly - non significant affects that are still a potential concern.

Robert McCunney: First of all, statistical significance is not the major hurdle in terms of interpreting the results of a scientific study. Certainly statistical significance adds weight to the results but there are many, many factors that need to be

addressed from a scientific point of view to draw causal inferences that is to draw a connection that A caused B. Statistical significance as the author indicated there's only one element of it.

Quite frankly if you see a number of studies and you see patterns emerging, even if they may not be statistically significant, they maybe persuasive enough to warrant attention. So I agree. I don't think over emphasis should be placed on statistical significance.

Chris Powicki: Do you believe that the noise problem can be real. Last month in Vermont I believe you told Dr. (Neisembaum) that you believe noise problems can be real. Is this true?

Robert McCunney: Yeah. I stand by what I said in Vermont and I'll say the same thing tonight. There's no question that there are people who are troubled by the noise levels associated with wind turbines.

Chris Powicki: Noise vibration signatures are usually taken on something rotating equipment. When the levels increase, it's usually a sign of a problem developing; (glaring) failures are an example. Can you comment on that?

Robert McCunney: You know, I think it's a good point. I'm just not familiar with that science. I'm not an acoustic engineer but it certainly makes sense to me that if something mechanical is not operating properly, it's going to generate noise. Probably a lot higher than it would otherwise. Think about mufflers and so forth.

Chris Powicki: Have you done or seen any comparative research on the affects of sound on people who are living near other power generation facilities such as power plants, both fossil and nuclear?

Robert McCunney: There are environmental studies that have looked at those sources of noise. I'm just not familiar with them frankly. There have been studies of people living near airports, people living near waste reclamation plants and so forth. So those studies are out there.

And we just focused on the studies associated with wind turbines and as you can tell, some of the studies tried to compare the affect of the noise of wind turbines to other environmental sources of noise like road traffic and railroad car, and airplanes and so forth. But I'm not familiar with that literature.

Chris Powicki: Could you describe in more detail how road noise and conversations can be louder than turbine noise?

Robert McCunney: Well remember the diagram I showed earlier with the noise levels associated with certain activities? Normal conversation may be about 50 to 70 decibels. Clearly if someone's shouting, it's going to be higher. Road noise from the tables out there about 50 to 60 decibels. So I think that's one of the reasons I put that table up there at the beginning so you could see comparative noise levels.

Chris Powicki: Have you read Dr. Pierpont's book or studies and are you aware she's an MD and PhD in population biology behavior ecology for Princeton?

Robert McCunney: I've read Dr. Pierpont's book and I've looked into case series of ten families. I think it represents about 39 people.

Chris Powicki: If U.S. law says that you cannot sleep deprive prisoners, why then are turbines allowed to make noise that keep people awake at night?

Robert McCunney: Of course sleep deprivation is inappropriate from a lot of different points of view. And I don't know that I can answer that question any better than I tried earlier. Ideally wind turbine development should be such that people don't suffer adverse health affects.

That's one of the reasons I went into occupational medicine in the first place is I wanted to make sure that people who work didn't have to get sick and have risk of cancer from work whatever that may be. And I think there should be balance between environmental initiatives and human health. So the people don't suffer adverse health affects.

Chris Powicki: You said that in the Tsunami no animals died. They heard the vibration and left the area. Is this what would happen to our wildlife?

Robert McCunney: I don't know.

Chris Powicki: Have you treated people with health complaints like sleep deprivation due to wind turbines, wind turbine syndrome or any other types of diseases or is your opinion based on reading other studies?

Robert McCunney: I've had experience with sleep deprivation with a number of conditions. One is obstructive sleep apnea. I don't know if people have heard of obstructive sleep apnea where people may need to sleep with the CPAP.

I've had experience with shift workers particularly interstate truck drivers who are plagued with sleep deprivation. And it may seem exotic but even senior executives who are troubled with jet lag who have to fly 12, 14 hours have meetings in Asia, Africa and so forth. So I have some experience with sleep deprivation as a clinician independent of the sleep deprivation that's been reported in the context of wind turbines.

Chris Powicki: Since amplitude aerodynamic modulation seem to be the source of annoyance, would you agree perhaps that absolute and relative sound regulations are the wrong way to approach noise issues and if vast degrees of amplitude modulation are perhaps a better area of focus?

Robert McCunney: That may very well be the case. Amplitude modification. But I think that the way when the situation's been approached as far as I'm aware is by measuring sound levels and more recently frequency distribution of the sound.

Chris Powicki: Do they manufactures of turbines supply a standard noise profile of their models or does the public have to define them when developments are proposed?

Robert McCunney: Man I don't know. These are excellent questions. If you guys are putting together how can you ding the speaker, you've done a good job. I don't know the answer to that question because as just think again of the wind turbine. You have a mechanical box, which generates noise. That can be controlled at its source. I'm not so sure about the blades.

My sense is it's really in the engineering design. And some questions posed to me is why are there three blades? Why not four, five, why not two? I don't know. But I ultimately think that the control of that noise is going to have to be in blade design as well as distance from source.

Chris Powicki: How do you explain Spain's new laws relating to turbines that they can not be operated within a mile from homes?

Robert McCunney: I don't know the basis of Spain's regulation. My sense is it probably has to do with the noise level that they may have measured in the proximity of

homes. The World Health Organization has tried to address ambient noise levels in the proximity of homes and you've seen levels thrown out as 35, less than 35, less than 40, less than 45 because (in fact) and there are a lot of points of view on that.

Chris Powicki: Have you read the recent article in Audiology Today documenting the impact wind turbines have on health?

Robert McCunney: I haven't seen that paper.

Chris Powicki: Okay. If not would you do so and let us know at a later date if you change your opinion (unintelligible).

Robert McCunney: I've been in science long enough to know if new information comes you better be open to looking at it and if you need to you change your opinion. I'm very open to changing my opinion about anything persuasive.

Chris Powicki: How would you view the Hippocratic oath and in light of wind turbines and health issues?

Robert McCunney: Well there's a fancy word out there primum non nocere, which means first don't do any harm. It's part of the Hippocratic oath. I think the first approach is make sure that there's good science and I understand science. And that's what I tried to do. I didn't make any of this up.

Anybody here in the audience who wanted to put the time and effort in it could have done the same thing to see what's out there and see what's published. Try to look at what the authors conclude themselves and don't change the author's interpretation.

(Woman): (Unintelligible).

Robert McCunney: Well I think people should be heard. Certainly as a physician, I believe my patients and again I'm not an expert on public policy but there are public forums for where you should be able to speak your mind if you feel a certain way. I would fully support you speaking your mind. I mean I don't know what - any gag orders I know nothings about that.

So I told my involvement with the American Wind Energy Association was they asked me to be part of a panel, look at the literature and write it up and that's it.

So I don't know anything about gag orders. But I would encourage anybody to speak their mind whether it's verbally, whether you want to write and op ed piece, letter to be editor, write your own article. You should have your perspective heard. This is a democracy and people should be able to present their point of view.

Chris Powicki: Aren't there a lot of reasons for sleep deprivation that have nothing to do with turbines even when you're living under them or near them?

Robert McCunney: Yes of course. But I say this with some caution because certainly in a forum like this if I say this that is all the confounding causes - remember not all lung cancer is due to asbestos. Some is simply cigarette smoking.

There's a lot of reasons why people have sleep deprivation. Maybe it's noise, maybe it's not. People get sleep deprivation for medications, medication problems, alcohol abuse, substance abuse, GERD, gastroesophageal reflux disease; when they lie flat, they start aspirating, obstructive sleep apnea, stress.

The rule of thumb we learned in medical school if you have trouble falling asleep, its anxiety. If you wake up in the middle of sleep, it's often depression. So clearly there are many, many reasons for sleep deprivation. Food, the type of food you eat; you have a cup of coffee before you jump in bed; there's many, many reasons why people have sleep deprivation. Certainly noise is one of them.

Chris Powicki: Based on all the studies you've read, do you have an opinion as to why annoyance from wind turbines noise maybe reported at levels of 40 dBA and less whereas other sources such as road traffic have not generally generated complaints as such levels?

Robert McCunney: It seems to me that it's that swish-swish sound that we've talked about a number of times tonight; at least that's how I looked at the literature.

Chris Powicki: Do you have knowledge first hand of people suffering wind turbine syndrome or even sleep deprivation from turbine noise?

Robert McCunney: No. No one's come in to see me about that that's actually raised a concern. I mean I'm not - not yet.

Chris Powicki: How can you support the conclusion in your report that states adverse health affects alleged to be associated with wind turbines are insufficient to advocate for funding for further study?

Robert McCunney: Well, first of all at the risk of sounding horribly glib, anybody like myself who's in an academic setting and publishes, there's always room for more research. There's always room - believe it or not people are still studying smoking and health affects. They're still studying asbestos.

They're - and I don't mean to be glib by saying that. There's always room to do more. I think the intent of that comment, and that was really a committee comment, was that the information that's available does not appear to justify more intensive study than is already out there; that reasonable conclusions can be drawn from the information that's available.

That's not to say you can't always do more. Yu can always do more to help understand. Some of the great questions that have been posed tonight, how far away should a dwelling be; the answer is based on the noise. Maybe noise levels could be done frequency distributions measurements and so forth.

Chris Powicki: And this is going to be our last question. Can we whisper sweet nothings in your ear at 35 dBA?

Robert McCunney: Depends on who's doing the whispering. Thank you very much.

Chris Powicki: Thank you. Thanks very much for your attendance tonight. On behalf of Cape & Islands Renewable Energy Collaborative and the New England Wind Energy Education Project, we appreciate your attention, all your questions and your interest in a sustainable energy future. Thank you.

END

On-Line Participant Questions

During the simulcast's question and answer session, on-line participants entered their questions into a "chat box." The questions below were copied as they were submitted. The answers to these questions can be found in the transcript above, though, many of the answers were in response to questions posed by the audience rather than through the on-line question form.

Bob Grace **Asked:** Question: In Pederson 2007 study, I wanted to understand whether the odds ratio was screened for causality. Were people opposed to wind and therefore more annoyed, or were they more opposed to wind because they were annoyed? Thanks you.

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suzanne sayer **Asked:** You mentioned a Dr. Pierpont. What research has she done and where?

Milton Fistel **Asked:** Milton Fistel Consultant Engineer from Swampscott MA. When will Dr.McCunney be available on the NEWEEP web site?

Peter Skrzypczak **Changes Question To:** Have other species [than humans] been studied for effects of Infrasound and VLF and ULF [frequencies], i.e., sound pressure waves? For example, African bull elephants are known to communicate for hundreds of miles using infrasound in their herds. Other species also use such communication. Are there any reported changes in beahviors, populations, habits, or habitats for non-human species of life [insects, plants, animals, microbes] ? [Peter from Marlborough]

Milton Fistel **Changes Question To:** Milton Fistel Consultant Engineer from Swampscott MA. When will Dr.McCunnery be available on the NEWEEP web site? Is there a run of thumb for the the minuimal distance that the noise does not annoy people.

Peter Skrzypczak **Changes Question To:** Have other species [than humans] been studied for effects of Infrasound and VLF and ULF [frequencies], i.e., sound pressure waves? For example, African bull elephants are known to communicate for hundreds of miles using infrasound in their herds [at levels that are not audible to humans], ostensibly due to the ability for it to travel long distances . Other species also use such infrasound communication. Are there any reported changes in behaviors, populations, habits, or habitats for non-human species of life [insects, plants, animals, microbes] ? [Peter from Marlborough]

Blossom Hoag **Asked:** It would be interesting to know how blade design contributes to noise and if different companies' blades or turbines comtribute more or less noise.

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cheryl l **Asked:** Have you read the recent article in Audiology Today, documenting the impact wind turbines have on health? If not, would you do so and let us know at a later date if you have

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cheryl l **Asked:** Have you read the recent article in Audiology Today, documenting the impact wind turbines have on health? If not, would you do so and let us know at a later date if you have changed your opinions you have provided tonight?

Christopher Menge **Asked:** Based on all the studies you've read, do you have an opinion as to why annoyance from wind tubine noise may be reported at levels of 40 dBA and less, whereas other sources such as road traffic have not generally generated complaints at such levels?