

Title: The Impacts of Nanotechnology and Nanoscale Materials
Speaker: Jeff Keller, PE, Burns & McDonnell
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Introduction: Hello and welcome to Knowledge on Demand, a podcast series brought to you by Burns & McDonnell. Since 1898, Burns & McDonnell has shared its engineering, architecture and construction experience with clients worldwide. And now, through our Knowledge on Demand series, we bring our experience directly to you.

Narrator: Hello and welcome to the Burns & McDonnell podcast series. My name is Joe Bathke and with me here is Jeff Keller. Jeff is a department manager in the Burns & McDonnell Infrastructure Group, and we are talking about the emerging issue of nanoscale particles. Hello, Jeff.

Jeff Keller: Good afternoon.

N: Jeff, let's start with a basic question. What exactly are nanoscale particles?

JK: Nanoscale particles — they're a group of materials that can be manmade or naturally occurring and they're very small. They're measured in nanometers, which is one billionth of a meter. To give you an idea of what a billionth of a meter is, a human hair is maybe 50,000-70,000 nanometers in width. It takes five molecules of water — molecules like you learned about in high school chemistry — only five of those to reach one nanometer in width. It's a very, very tiny dimension.

N: Where are these particles typically found, Jeff?

JK: Well, besides being found in nature, the naturally occurring nanoparticles, the artificial and synthetic nanoparticles are being used more and more in applications that range from plastics to bandages, antiseptics, golf clubs, golf balls. They really have a tremendous range of utilization because these nanoparticles, when used in conjunction with things we already have, make them better in one way or another — stronger, lighter, more conductive, less conductive. They're sort of a Swiss army knife of materials, and the more we learn about them the more applications we find. And what's really interesting is there are various lists — you can find them on the Internet — that describe different commercial products that utilize nanoparticles. And last time I looked there were maybe 600-700 in the United States, and they cover food products, they cover clothing, they cover electronics. Virtually you name it and you can find a product — a category — where you'll find nanoparticles being used right now in things you can buy right off the shelf.

N: Why are nanomaterials becoming more common?

JK: OK. Well, the big benefit of nanoparticles is that you can take existing products and make them much better, whether that means lighter, stronger, electrically more or less conductive. As an example, take gold, which is a material that we're all familiar with in a very common sense. We know what color it is, we kind of know how much it weighs. However, when you remanufacture gold into a nanoparticle — basically you use advanced chemistry to make it into very, very tiny pieces — nanogold is red, or blue, or purple. Its common sense properties sort of go away and it becomes something very different. And there's a whole slew of materials that you and I might be familiar with, but when you remanufacture them into a nanoparticle, it becomes a completely different material with different properties. So all these material scientists where we have these catalogs of materials with their melting point, what their conductivity is, all their physical properties, those just go out the door. And these new nanomaterials — nanogold, nanosilver, nanoplastics — they're completely different things, and it gives manufacturers a whole new ingredient list to pull from to make their product better.

N: Now with those potential benefits, why are scientists increasingly concerned about nanomaterials?

JK: Well, the concern is this: That, as I mentioned before, there's hundreds and hundreds of products on the market out there right now and the safety of nanomaterials, nanoparticles is still something that is being investigated. They've sort of had an early release for all these products. And there's neither the scientific background on nanoparticles to understand the exposure risks nor is there a regulatory framework in place to manage them. And so the fear is that before we have an idea of what the risks are to exposure that you'll have so many nanomaterial-using products that you can't get away from them. Now, there may be no problem, or there may be some problem. The truth is right now, nobody knows. And that should be a big problem for a lot of people. And so this investigation that's taking place across the world with nanoparticles is really focused on trying to catch up with the consumer market so consumers can know whether what they're buying is good, bad or otherwise.

N: How is the use of nanoscale materials regulated?

JK: Well, the short answer to that is, they're not, per se. How they are regulated is more based on what their claims of functionality are. As an example I would talk about products where nanoscale particles have been used. In these cases I'm thinking about, they're used for either antibacterial — some have a biocidal function. A product had a nanoscale-based coating on it, and it was being marketed to consumers as something where you can have this product — I think it was a computer mouse — where it eliminates bacteria from your mouse. You think about everybody grabbing the computer mouse, it's probably something where a lot of bacteria builds up. Well, there are regulatory systems in place for products that claim to have bacteriicidal function and those are established and well-understood. So it wasn't based on a nanoparticle

regulation. The regulation of this product was based on something that existed regardless of whether it was nanoscale or not. Nanoscale particles themselves have no regulation written for them explicitly. But they probably will, because they're going to cover so many potential uses and applications that there will have to be some type of framework in place to deal with them. But right now, the answer to your question is, there's none.

N: What form would new regulations take?

JK: Well, I don't know that anyone can say what form they can take right now. Probably they will be based more upon on the growing knowledge base of what nanoparticles are and what they can do. The big problem right now is there's almost no way to categorize them. We've categorized millions of materials that we know about, but these nanoscale materials all behave differently. So how do you organize them? How do you put them in their various bins and piles? And the regulation will probably be based on that. But it needs to happen soon, because you're going to have a growing awareness by consumers that these products exist, particularly because manufacturers are spending money to use them and develop them and they're promoting them. And ultimately you're going to have people asking, "Well, is this good for me or bad for me?" And at that point regulations need to be in place because you can't have people asking that question and have no answer for them.

N: Now Jeff, how much does the public really understand about this technology?

JK: There have been a number of studies done. Recently there was a study done in 2004 and a study done in 2006 where respondents were asked what they knew about nanotechnology, which is a broader set that includes nanoscale particles. What they got out of the survey was that in 2004 about 80 percent of respondents had no idea about nanotechnology. In 2006 that number dropped to 60 percent, so awareness is growing. But when you talk about nanotechnology, they could think they know something, but really know nothing. It was a very broad question. And the fact that most people aren't asking questions when they buy products, when they see it advertised, sort of indicates that there's a very low awareness in the public now. But most of the activity that's gone on regarding regulatory action has been brought on by public awareness groups, public advocacy groups, so that awareness is spreading and it will continue to spread over the next five to 10 years. And the industries that use nanoscale products in their manufacturing process, they're going to have an obligation — in fact EPA has already stated this year that the burden to make sure products are safe currently lies with the manufacturers. But beyond that, you know, these nanoscale particles are really very expensive, they're more expensive than gold, the example I used earlier in this podcast. Really expensive stuff. So it's to their advantage to make sure that these materials don't, for example, escape into the environment outside of their product or that they get released out of their product while in use. They want to keep them there, bound up. And so industry has a burden. I would imagine that utilities, municipalities are going to have an interest in knowing more about nanoscale particles because people are going to ask them.

One of the areas of interest in nanoscale particles is them being CECs — compounds of emerging concern, which is a fancy way of saying pollutants — that people are just starting to look at. And because a lot of manufacturers are using nanoparticles, there's a risk that they could be released into the air, into the water, into the soil. And what does that mean? Anything? Nothing? Something? Those questions are going to get asked. It behooves the municipalities, the utilities to be able to have some kind of an answer, even if it's an incomplete one, so that the public knows that the people in charge of their utilities, for example, are getting up to speed on this, that they're not behind the curve. Then the last item to think about with regard to these nanoscale particles being pollutants — when we're barraged with on a daily basis global climate change, water pollution, air pollution, soil pollution. Associated Press reports came out just earlier this year about all the pharmaceutical products in our water, in our streams, there's a real risk if you add in nanoscale particles to this, that you get sort of a threat overload to people and they just can't hear any more. So it's important that when we think of these materials and the risks that they may present, that we present it in a balanced fashion, that it's a potential risk, that it's being investigated, but that there's no evidence right now that it's a tremendous problem. People aren't going to the hospital for exposure to nanoparticles, but it's something to try and get back on top of and something that everybody needs to be aware of at some level.

N: Where is nanomaterial technology headed?

JK: Well in the future, as I mentioned before, there are so many areas of our life where nanoscale particles and nanotechnology in general are going to spring up. It'll be in the time you wake up in your alarm clock, to the music you listen to, to the clothes you wear. It's going to be all over the place. And eventually, hopefully, the regulatory and the research element of it will be up to speed as well as we talked about earlier. Right now, the federal government is spending a good sum of money towards research. It's a billion dollars a year distributed over maybe 16 different federal organizations. But only a very small piece of that is towards research on environmental impacts, human health, this sort of thing. The rest of it is really towards the promotion of the use of nanotechnology in products. Now in terms of water and wastewater, which is where I hail from, the big concern there of course is, as I mentioned, nanoscale particles as contaminants in the water. Do they get removed by our traditional wastewater treatment? Do they get removed by our water treatment? Is it something that we're going to be finding in our drinking water? And I don't think there's an answer for that. The initial research indicates that a lot of the treatment technologies that we use or are at least on the market, do have the capacity to remove a good portion of these materials. The ironic thing though is that even if it becomes a significant problem, there's a silver lining to all of this. Which is that some of the technologies that are on the horizon that utilize nanotechnology and nanoscale materials. Things like active filtration, real-time probes for operation of plants, some of the technology in terms of electronics and communications, structural components, coatings, all those things can help make our plants more effective and be more able to remove contaminants including nanoscale particles. So you might end up in



the future using nanomaterials, nanoproducts to remove nanoscale materials out of your water. So there's a little bit of irony there, but that's the way things tend to happen. You know, we wouldn't have all this great technology in front of us and not have the pollution that we deal with. Within Burns & McDonnell we have a lot within our Environmental Group dealing with the cleanup of pollution and assessing contamination issues. Well, that's part of living in a modern society. And so nanoscale materials are going to stay with us in the good and the bad. And what we can do here as consultants is to utilize the good and help mitigate the bad to improve the life of everyone around us.

N: OK, thank you very much, Jeff. This concludes this installment of the Burns & McDonnell podcast series. If you would like to discuss the issue of nanoscale materials further with Jeff, you can reach him at (816) 822-4371 or his e-mail address is jkeller@burnsmcd.com. That's burnsmcd.com. You can also review some of the materials Jeff has written about nanomaterials at our Web site www.burnsmcd.com and do a search in the upper right-hand corner of our homepage for *nanoscale*. Thank you very much.

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