2019 NanoEHS Webinar Series
Nanotechnology-Related Standards: Availability and Applications

July 9, 2019
Webinar will begin at 12 PM EDT
Audio will be broadcast through your computer's speakers

SPEAKERS

Dr. Mark Ballentine
U.S. Army Corps of Engineers

Dr. Scott Brown
The Chemours Company

Dr. Katherine Tyner
Food and Drug Administration

MODERATOR

Dr. Ajit Jillavenkatesa
National Institute of Standards and Technology

Welcome

Stacey Standridge
Deputy Director
National Nanotechnology Coordination Office

>> Stacey Standridge: Good afternoon and thank you for joining today's nanoEHS webinar. I am Stacey Standridge, Deputy Director of the National Nanotechnology Coordination Office. I'm pleased to welcome today's moderator, Dr. Ajit Jillavenkatesa, Senior Standards Policy Advisor at the National Institute of Standards and Technology. Before I turn it over to Ajit to introduce our excellent panel of speakers, I would like to mention that the National Nanotechnology Initiative is hosting a stakeholder workshop on August first and second (2019) in Washington, D. C., on the future of the NNI. We hope you can join us and share your perspectives. For more information on the workshop and other upcoming webinars, please check nano.gov; you can also follow us on twitter @NNInanonews.

Ajit and all of our speakers, thank you so much for your time this afternoon; and with that I'll hand it over to you, Ajit.

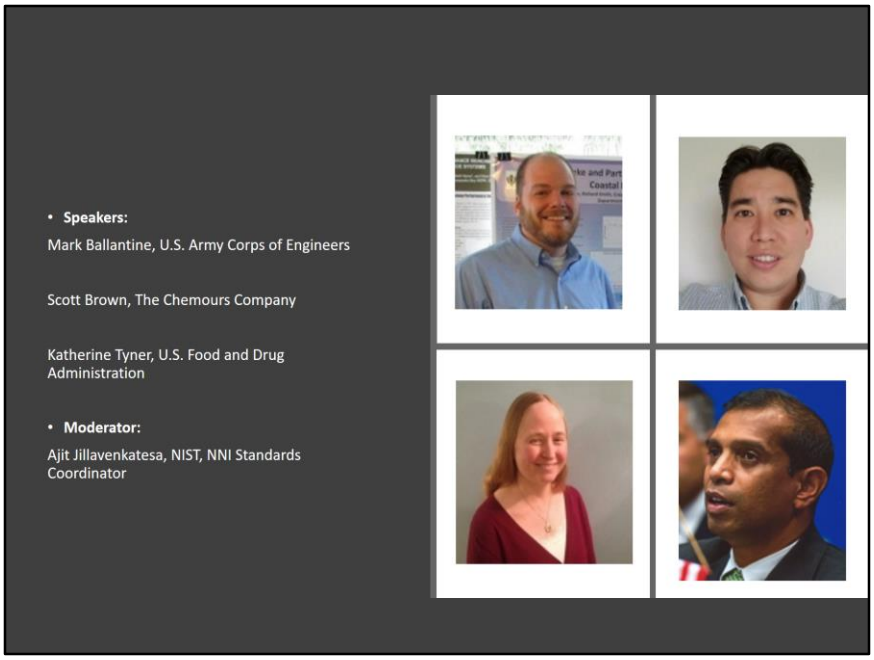
Nanotechnology-Related Standards: Availability and Applications

National Nanotechnology Initiative
Nano-EHS Webinar Series

July 9, 2019

>> Ajit Jillavenkatesa: Great, Stacey, thank you very much. Good afternoon to our participants. Stacey, Rhema, Kristin, on behalf of the excellent lineup of speakers we have today for the webinar and certainly speaking for myself, too, our sincere thanks to the National Nanotechnology Coordination Office for organizing this webinar. We had another standards-focused webinar almost about two years ago; this is a fantastic time to take stock about the progress that has happened since then. Because of the foundational and the fundamental nature of standards, and particularly standards as they apply to EHS aspects of nanotechnology, I think the time is just right for us to revisit and get different perspectives about the value of standards in the nanoEHS space.

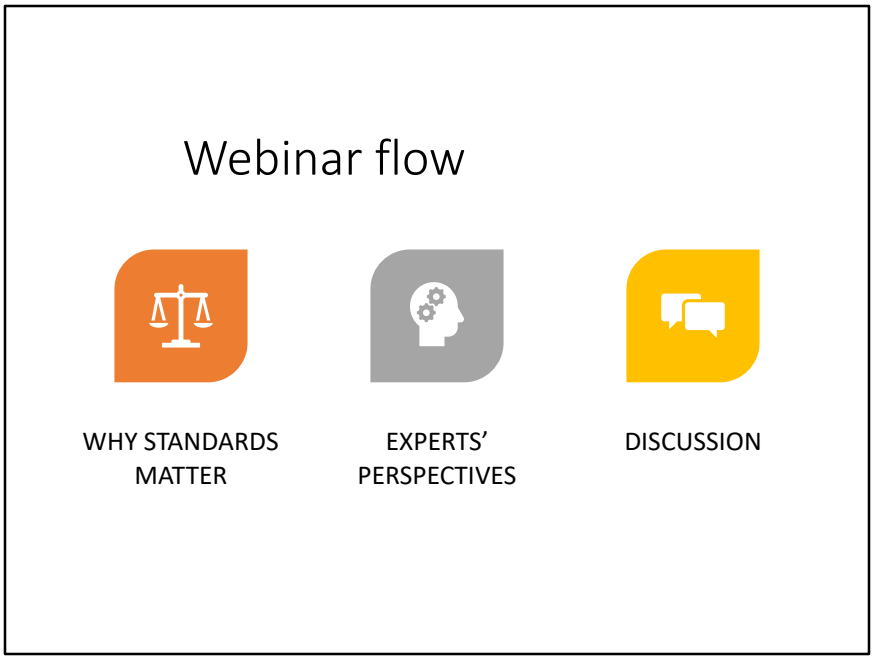
We have today three speakers---experts in various aspects of nanotechnology, representing both U.S. government and U.S. private sector perspectives, but certainly taking a very global view. They will share their experiences about how they are using standards, the value they see when they participate in standards development, and also the value they see in the standards that would result from activities in a range of different standards bodies.



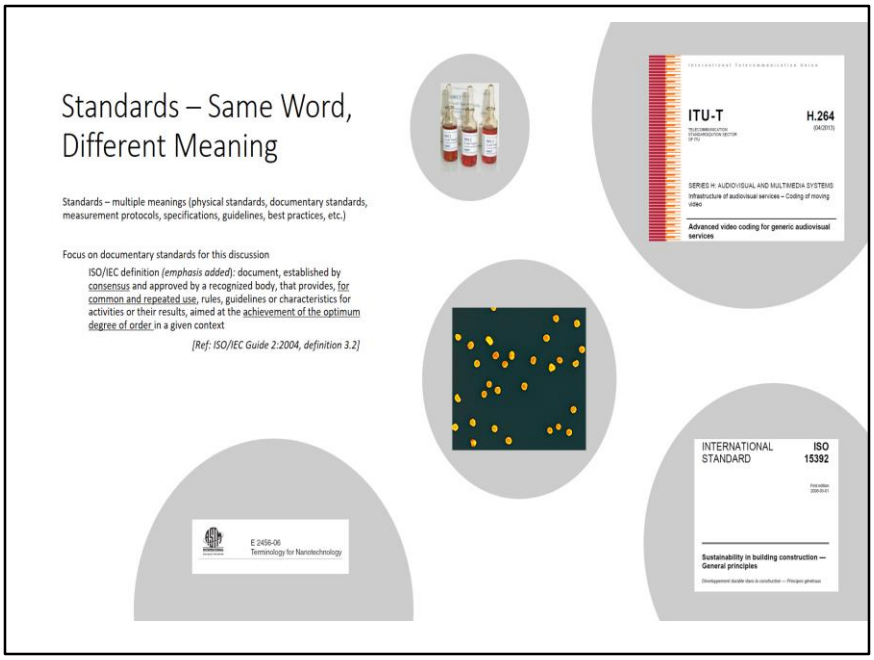
>> Ajit Jillavenkatesa: I want to just set the stage very briefly with a broad discussion about what's the value of standards and why is it that this is an area of significant interest for us.

Our three speakers today, and this is the order in which we'll hear from them, are Mark Ballentine from the U.S. Army Corps of Engineers, Scott Brown from The Chemours Company, and Katherine Tyner from the U.S. Food and Drug Administration. I will coordinate the conversation as it goes on today.

Our three experts represent multiple decades of experience in various aspects of nanotechnology and also many years of experience in standards development activities in a range of bodies. I think this diversity and depth of expertise and perspectives is really valuable in understanding the global dynamics around why standards are such an important tool for us.



>> Ajit Jillavenkatesa: For the webinar today, there are three primary areas that we'll focus on. We will start off with a very quick discussion as a baseline-setting exercise about what are standards and why they matter; then we will have the three presentations from our experts, sharing their perspectives; and then we have set aside some time for a discussion.



>> Ajit Jillavenkatesa: One of the important things to understand is that when we say standards, we're often referencing different things but using the same word, and this can often result in a lot of confusion around what exactly are we talking about. This webinar and the discussion today will primarily be around documentary standards.

We also use the word standards to refer to physical standards like reference materials that an organization like NIST, the National Institute of Standards and Technology or a third-party organization like Fisher Scientific might develop and make available.

Sometimes it also refers to physical measurement capabilities.

All these three different types of products often are very closely interrelated and will manifest themselves and be referenced in one form or another, so there's a very close tie. But it's often important for us to clarify what exactly we are talking about.

Courtesy: www.boeingcapital.com

Why Standards Matter

- *Lingua franca*
- Tools to enable protection of health, safety and environment
- Reflect state of technology and consensus in approaches
- Foundations for technological innovation
- Enable economies of scale, facilitate trade and commerce

>> Ajit Jillavenkatesa: The reason why standards matter---and it doesn't matter whether we're talking about documentary standards or physical standards or reference materials---is their very foundational nature. In the case of documentary standards, they provide a common language, a *lingua franca*, which brings clarity and efficiency in communication. It helps contribute towards certainty in what's to be expected in an outcome and how things are to be done.

These standards, when they're broadly adopted, when they are broadly used, are essentially tools that enable the protection of health, of safety, and of environmental aspects. Because these are developed in a consensus manner in an open and transparent organization which has very predictable processes, that have due process; they both reflect the state of technology---which the experts bring through their expertise and participation---and they also represent broad consensus about agreed-upon processes. So they form the foundation for technological innovation, because once those standards are in place, companies, organizations, and innovators choose to build upon them. (*Continued...*)

Courtesy: www.boeingcapital.com

Why Standards Matter

- *Lingua franca*
- Tools to enable protection of health, safety and environment
- Reflect state of technology and consensus in approaches
- Foundations for technological innovation
- Enable economies of scale, facilitate trade and commerce

>> Ajit Jillavenkatesa: The global impact of this is it enables the realization of economies of scale. When standards are referenced in trade documents, they actually create new markets, they open markets, they facilitate trade and commerce.

>> Ajit Jillavenkatesa: The great thing about participation in standards development and about having a diversity of standards to meet different needs is that we have a very wide and varied standards development landscape.

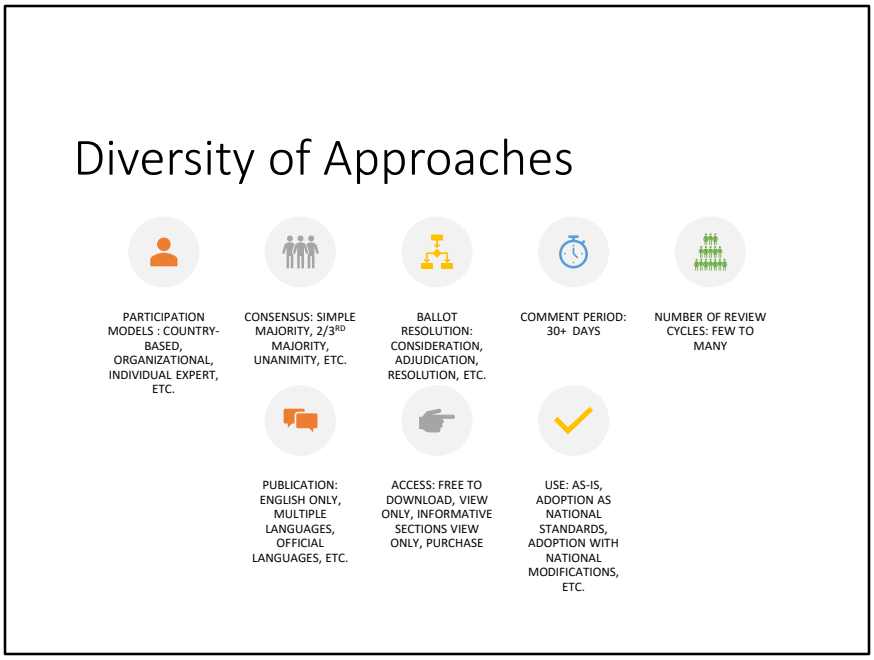
There are different standards organizations that follow different participation models, have slightly different processes, and as a result, the decision-making processes are also slightly different. But generally speaking, the main characteristic across this is these are all consensus-based approaches. And consensus-based approaches is general agreement, it does not necessarily mean that it has to be unanimous.

And also, in the standards landscape where we have diverse organizations bringing different expertise, one of the advantages we see is, while some organizations focus on a very specific technological area, other organizations are very broad in their scope and in their expertise, and they provide a welcoming environment in which experts can come and participate and bring their expertise. (*Continued...*)

>> Ajit Jillavenkatesa: The benefit of having this diverse and varied standards development landscape with multiple standards bodies, is it provides users choices about where they can take their particular efforts and their work. It actually also ensures that the resulting standards are fit-for-purpose and are robust. In particular, for technologies that evolve and develop in a very rapid pace, this process ensures the standards are available in a timely manner---the right standards at the right time.

But it also creates some challenges. These are challenges that are certainly surmountable, but it does require work. And what these challenges relate to is, the greater the number of organizations where work is happening, the greater the effort that needs to go into tracking and seeing what is going on where. (*Continued...*)

>> Ajit Jillavenkatesa: When these efforts work very well, we have a very efficient process, but sometimes they can potentially lead to confusion when there are either similar-sounding standards or when there are efforts where standards look very similar but are slightly different. For a nonexpert user, that can lead to some questions around potential duplication or overlap. There is also an interest where sometimes there has to be a sensitivity to where SDOs (meaning standards development organizations) might actually see a certain area where they want to go, and balancing that need with where the members want to go and where they want to see their efforts having results. But this dynamic---of the benefits, of the challenges, and the varied landscape---actually leads to a very dynamic and a very effective standardization system.

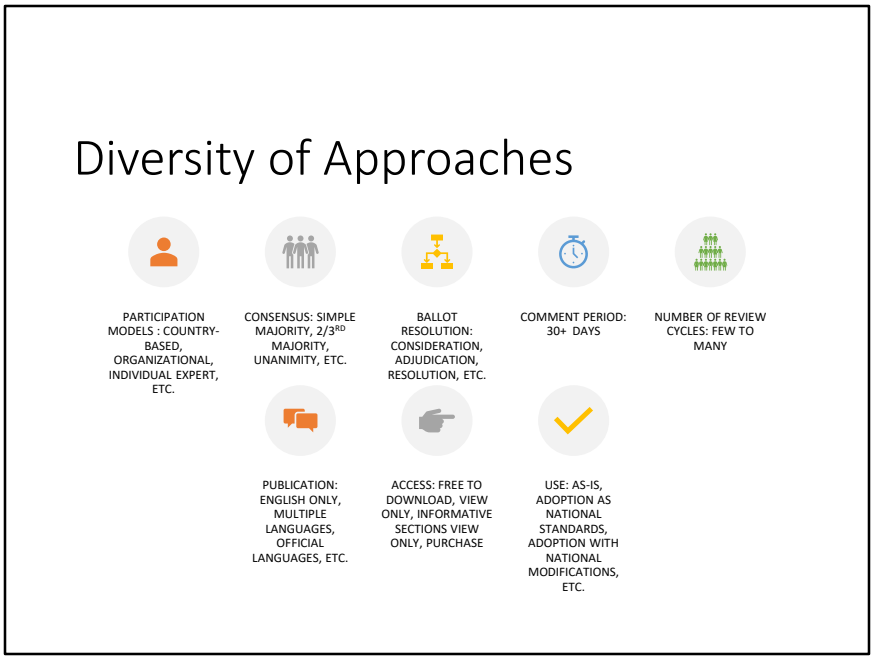


>> Ajit Jillavenkatesa: In this varied landscape with its different types of approaches to standards development, we have organizations which have very different participatory models. Some of them are country-based, some of them are regional, some of them are individual-expert-based. In these bodies, consensus and decision-making are also very different. In some cases, a simple majority may suffice, whereas in other cases, a defined majority in the form of a two-thirds positive vote can be defined as consensus.

Similarly, these organizations have slightly different approaches to ballot resolution, to how negative comments are adjudicated and addressed.

In many organizations, the amount of time that's made available to experts to review a document and provide comments can vary from a few weeks to sometimes as many as 60 days; it all depends upon that particular organization's unique needs.

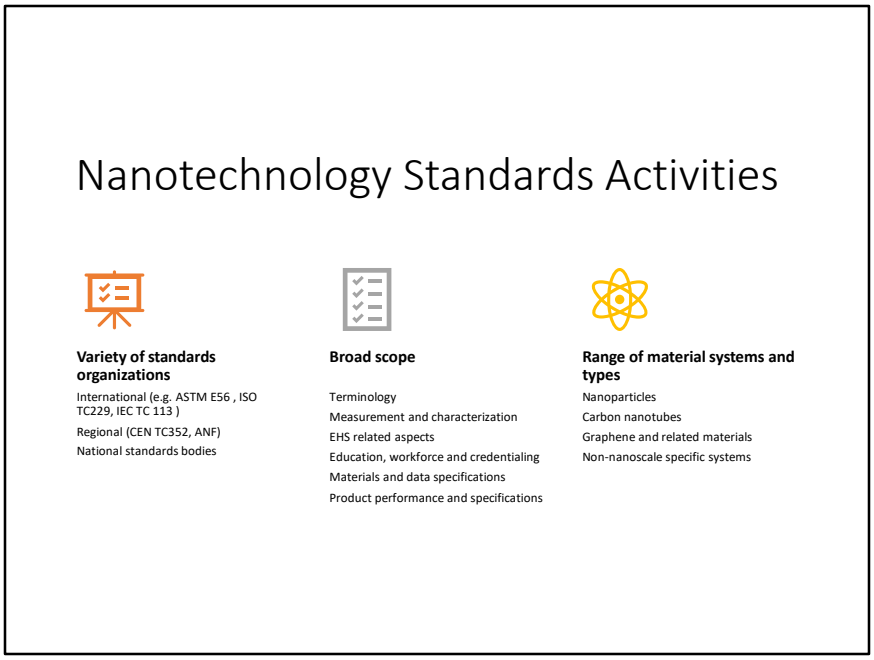
Similarly, the number of cycles of review before which a document is finally adopted varies. (*Continued...*)



>> Ajit Jillavenkatesa: The use of the standards also varies depending upon the organization that develops the standards. For certain organizations, the standard is translated into multiple languages and then made available. In those instances, sometimes standards are also made available for national adoption with some changes---or otherwise.

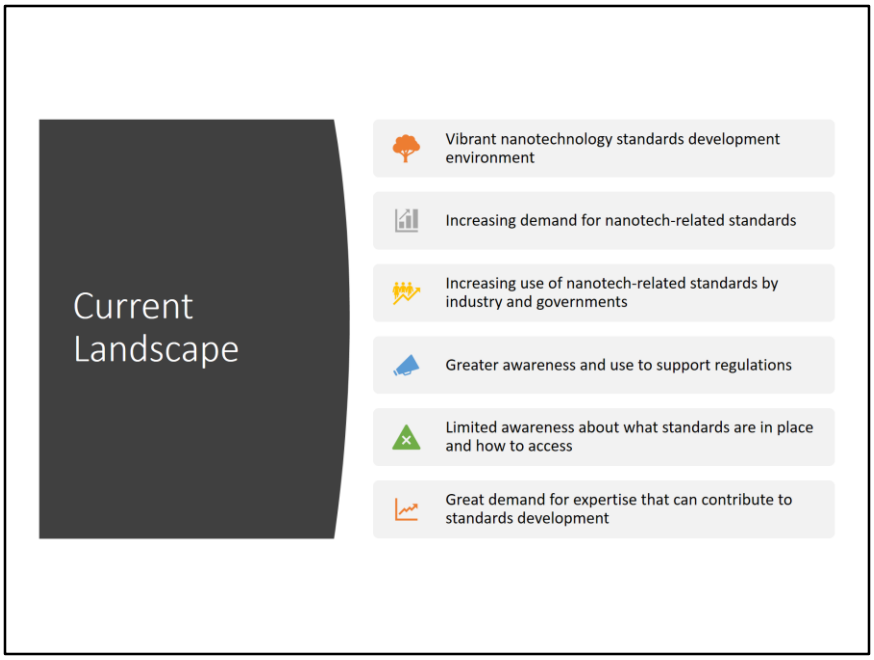
Some standards organizations make access to their standards available for a relatively low fee; some charge for them.

What this really represents is a variety of approaches where each organization's business model, standards development model, represents a combination of it’s members interests, of its technology space in which it's developing standards, and how those standards are used.



>> Ajit Jillavenkatesa: Specifically, nanotechnology standardization, which has now been underway for a little bit more than 15 years, has reached a very good space where there's a robust body of work underway in a number of standards organizations, which represent this variety of approaches. Some of the standards organizations are listed on the slide that you see. They include ASTM E56, ISO (International Standards Organization) Technical Committee (TC) 229; the IEC (International Electrochemical Commission) Technical Committee 113. There are also some regional efforts such as within the European Committee for Standardization TC 352, and certainly some national standards efforts in a range of different countries.

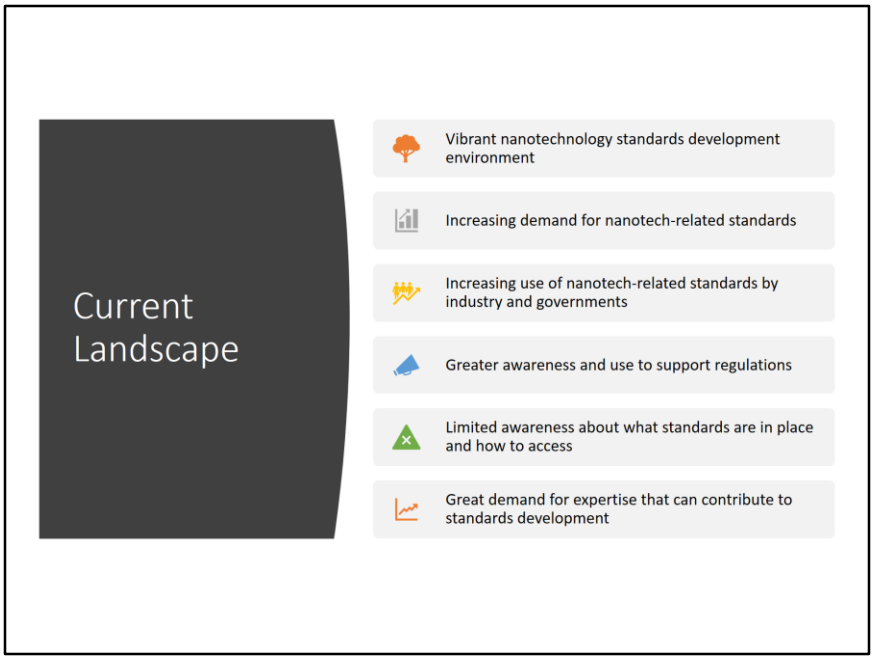
The work here represents a broad set of issues, including terminology, measurement and characterization, standards addressing EHS-unique aspects, relating to workforce education, credentialing, material data specifications. And similarly, a range of materials and system types.



>> Ajit Jillavenkatesa: What we have right now is a very vibrant nanotechnology standards development environment, and as most standards are being developed, we are also seeing an increasing demand for more standards addressing more material systems. This is reflective of the maturity of the standardization processes, but it's also very much representative of the fact that we're seeing more and more nano-systems and nano-related materials finding their way into commerce.

Another trend that we're seeing is, as more governments and Federal agencies, state agencies get involved in using nanotechnology-related systems or in regulating them, there is increasing use for standards by both industry and by government. And this is also leading to a greater awareness in recognition of the important role that standards play.

However, while these are all positive trends, one of the areas which we see as an area that still requires some effort is raising awareness about what are the standards that are available and how those standards can be used, and how can they be accessed. (*Continued...*)



>> Ajit Jillavenkatesa: From a standards development perspective, one of the greatest challenges that we have is the increasing demand for expertise that can actually enable standards development activities; this is directly proportional to and correlates to the increasing pace of standards development work.

One of the things I would hope that we will have resulting from this webinar is added interest amongst many of our webinar participants in either contributing to or participating in the development of nanotechnology standards.

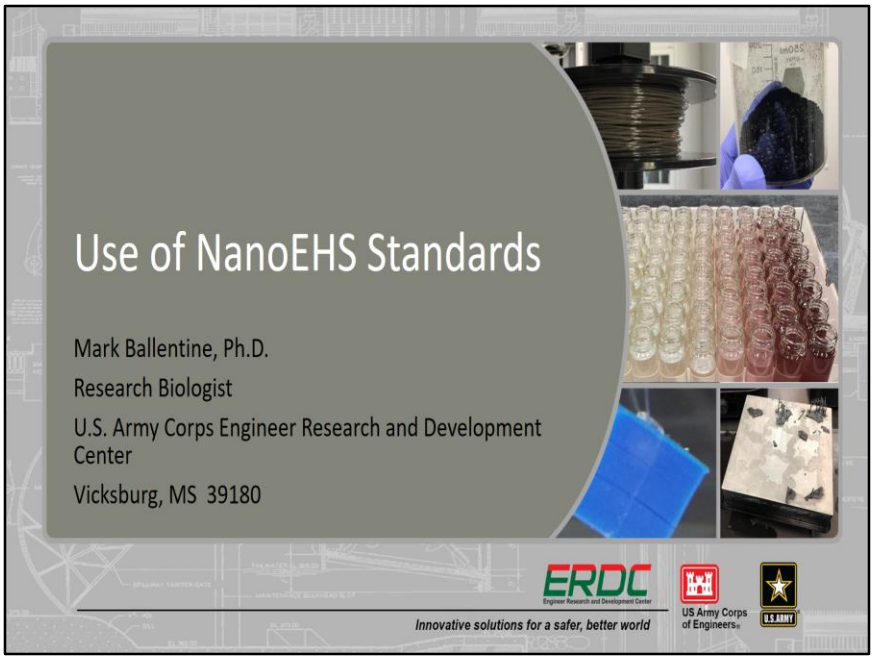
Experts’ Perspectives

>> Ajit Jillavenkatesa: With this, what I'll do is to transition to our experts’ perspectives. Our first speaker is Mark Ballentine, from the U.S. Army Corps of Engineers. Mark, over to you, sir.

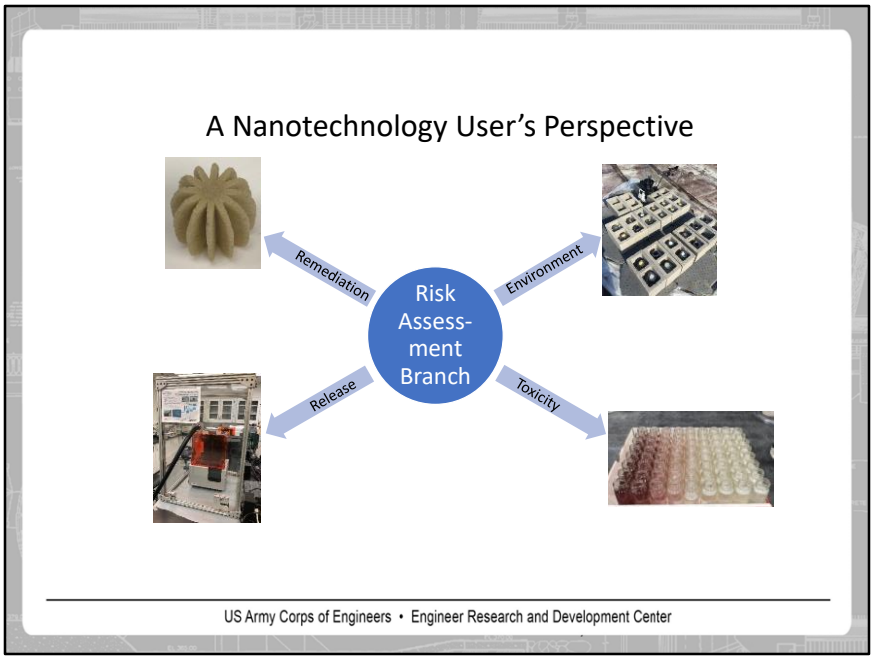
QUESTIONS?

Ajit Jillavenkatesa
ajit.jilla@nist.gov

>> Ajit Jillavenkatesa: Contact information -- ajit.jilla@nist.gov



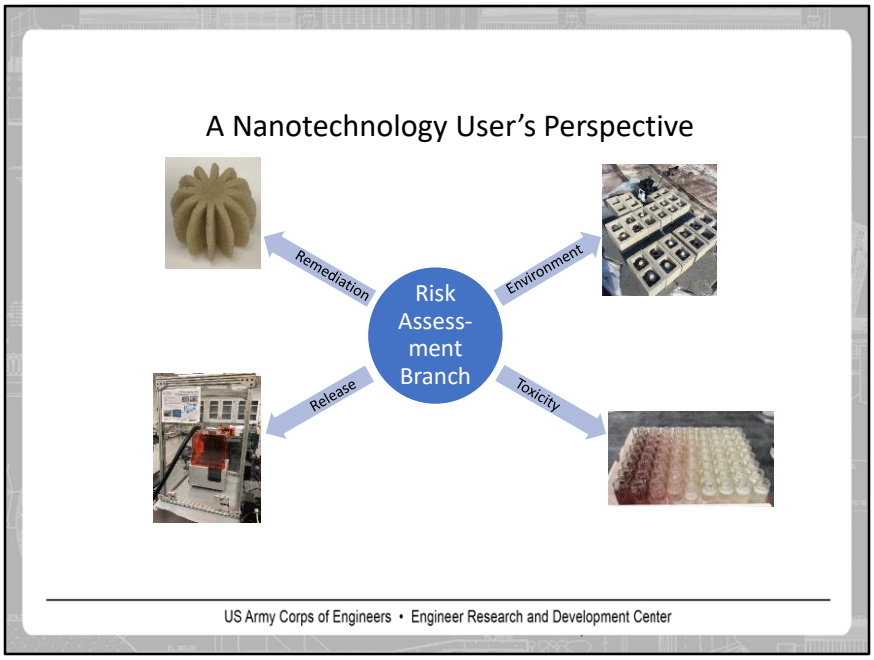
>> Mark Ballentine: Thank you, Ajit, for kind of kicking everything off, and thank you to all the participants for joining to listen in. As Ajit, said, my name is Mark Ballentine. I'm a research biologist with the U.S. Army Corps of Engineers Research and Development Center (ERDC). I work in the Environmental Lab here. My point of view is as a user, as an end-user for these standards. I will talk briefly today about how we go about using them and why---why is it important for users at a Federal institution to use the standards?



>> Mark Ballentine: To give you a little bit of background as far as what nanotechnologies we use here in the Environmental Lab---and more specifically, the Risk Assessment Branch, which is where I sit in the Environmental Lab---there are four main areas that we use nanotechnology and nanomaterials where standards play a roll.

The first one is the *environmental* space. While this could deal with release and other places in the environment, what we're looking at now is what the environment does to the material itself. We often use a nanotechnology and nanomaterials, and we put them into a matrix, but we want to see, when a soldier is using it in the field, does the material break down? Is the use of it going to be limited because of the environment that it's in?

We also look at the *toxicity* of the materials themselves. We do baseline testing with different nanomaterials. (The picture, for whatever reason, is upside down there---I apologize for that). That's a nanogold ink test, which is a base material on some sensors that we use in some of our nanotechnology work here. So we want to test toxicity. Is it going to be an issue if it does get out of the matrix or out of the material, and what are the baseline toxicity values for that? (*Continued...*)



>> Mark Ballentine: One of the big pushes for the military, and the Army specifically, is use of 3D printers in fields and in installations where you are going to have not just scientists use them, but soldiers, and use different types of 3D printers---a metal bed printer or an FDM (fused deposition modeling) printer or an SLA (stereolithography) printer as pictured here. We are doing *release* studies where we're studying the nanoparticles that are being released from the different types of printing, and standards play a big role in that, in kind of aligning method development, which I will talk about.

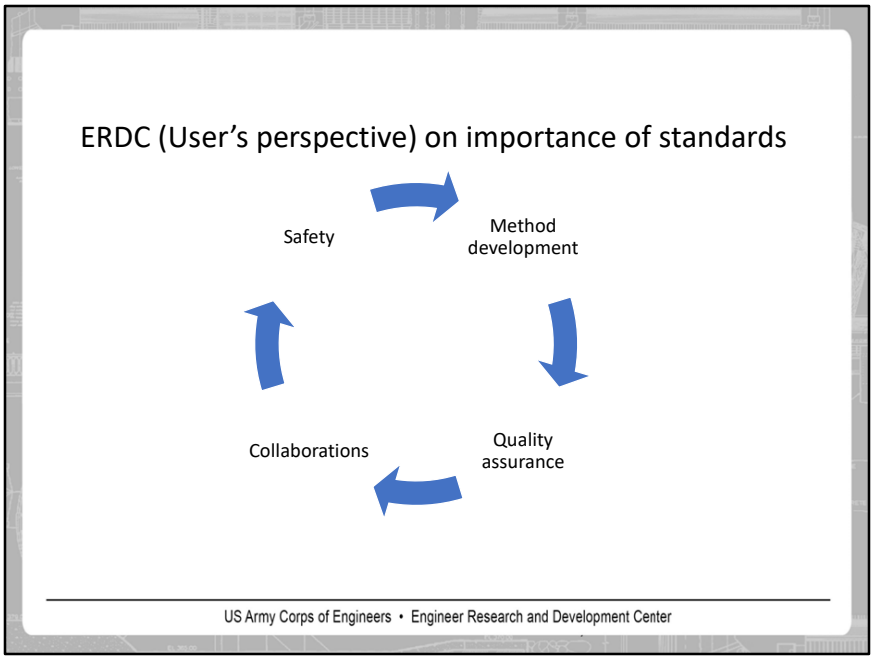
The last space we focus for nanotechnology here in the Risk Assessment Branch is the use of the nanotechnology in *remediation* of other chemicals. It can be as simple as what's pictured there, which is a little model that's been designed with material that's added in at the nano-level to remediate ammonia from different systems that we're testing.

From this point, what I am going to do, everything I am going to talk about, kind of plays into all these different experiments and fields of space that we use here at ERDC, and specifically, the Environmental Lab.

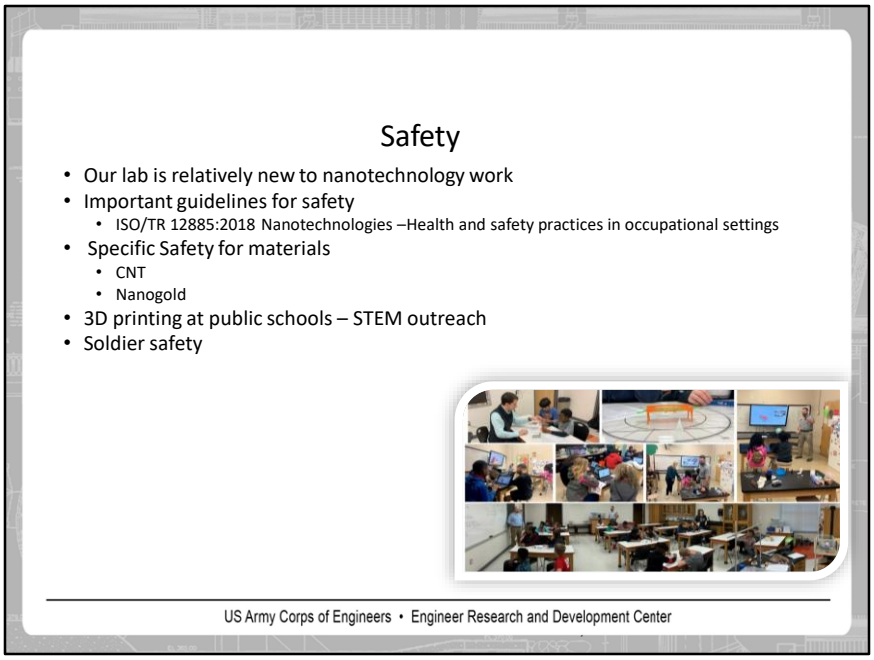
>> Mark Ballentine: As I talk about the standards, it's really important to first talk about participation in the actual development of standards. As a user, it has become very important to become part of the process and not just take what is available. As a representative for ERDC and the Environmental Lab, getting to the meetings to help contribute to the new ISO standards is important, because we can help guide the process and guide the standards that are needed for not just our experiments but for the decision-makers and non-science decision-makers above us who will be looking at these standards as a baseline to help them make informed decisions.

Personally, as a user, a scientist and a researcher, the ISO meetings and standards calls are a great way to network for new scientists, as I am myself. It also opens the doors for potential collaborations; you can make contact with scientists across the world who have the same interest or potential work in the nanomaterial realm.

The big thing is, you have direct communications with other experts; that's a huge benefit to the Army and our lab, where we get a chance to talk to nanomaterial scientists in the Netherlands, for example. On a personal note, it's nice to travel to get to other places, because the meetings do happen all across the globe.

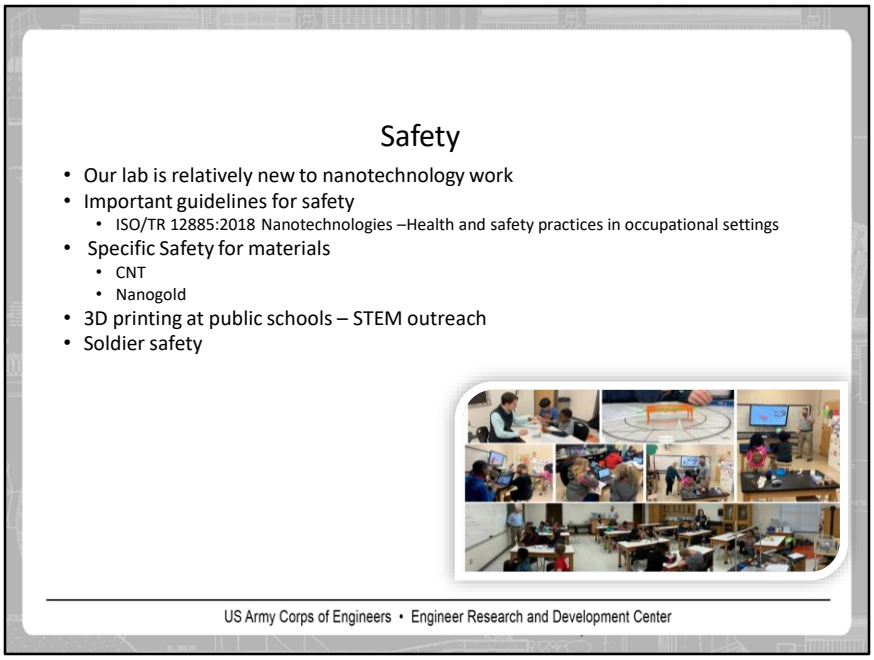


>> Mark Ballentine: So as far as the mission space that we have here at ERDC, with the environment, the release, there are mainly four things that we use the standards for. It starts and ends with safety, as our lab techs, and ourselves, and the people here at ERDC are definitely the bread and butter of everything that goes on.

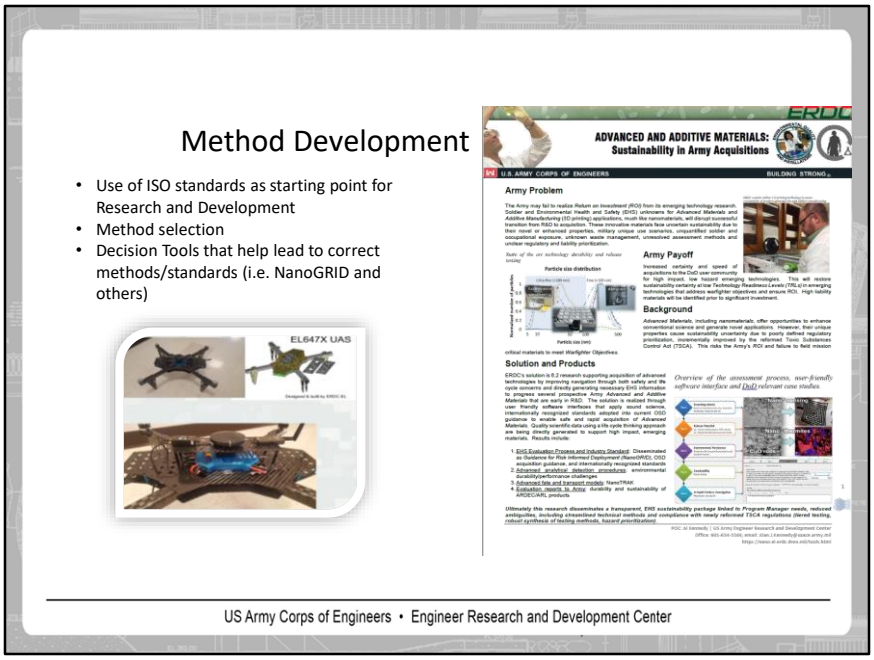


>> Mark Ballentine: So, safety, here: Ours is a relatively new lab in the nanotechnology world. We've been doing it for five or six years, pretty steadily since then. Standards have really helped guide us in the process of what's the baseline safety that we need to have in place, whether that's just handling the material, getting it, storing it, all the different processes that have to go on that may not be on the forefront of your mind as you're developing a research program. But you definitely want to keep your lab personnel safe. There are general overview safeties, and then there also are standards for specific materials---carbon nanotubes and nanogold are some examples of those.

Another reason that safety is really important to us, and myself in particular as a user, (is) we have outreach programs where we take our 3D printing and materials that we've developed into schools, for example; that's the pictures that you see down there. We need to make sure, when we're talking to the administrators or other people, that they understand that we've taken precautions; we use the standards for that. (*Continued…)*



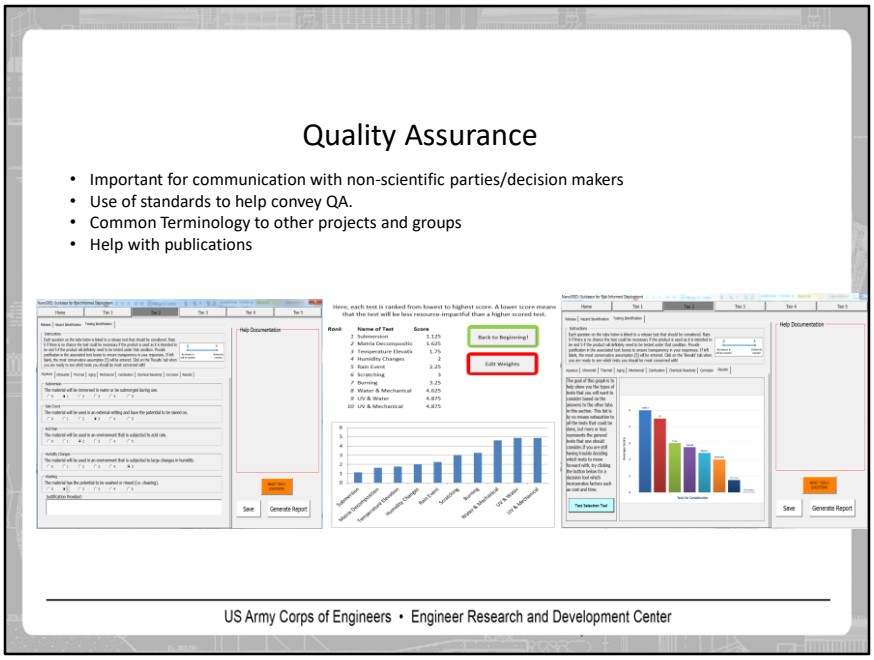
>> Mark Ballentine: And soldier safety: everything stems from that. If soldiers are taking these materials into the environment and they're interacting with them every day, we need to make sure that they're safe in what they're doing.



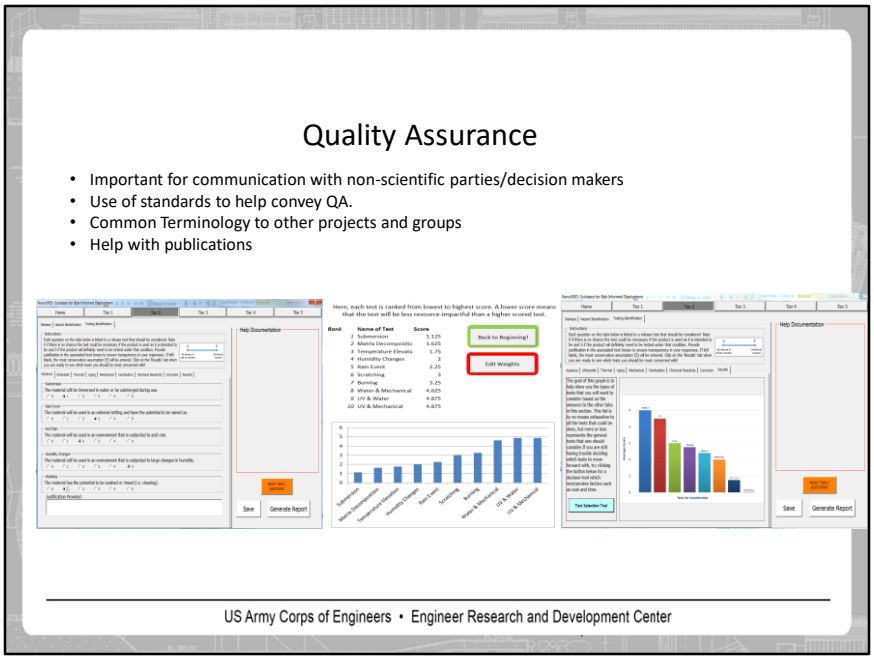
>> Mark Ballentine: Method development: As a research institution, we're always trying to be on the forefront of using these materials and using them for different applications.

The ISO standards, in particular, are definitely a jumping off point for a lot of our research and how we develop our experiments and our methods. There are tools out there (and) we have developed some: *NanoGRID* (Nanomaterials Guidance for Risk Informed Deployment) is a decision-based tool to help guide users through the process of determining what methods or what experiments they should be using---depending on the type of nanomaterial itself---for environmental health and safety. And as it goes through there, it leads to specific standards that you should be looking at.

NanoGRID is not the only decision tree out there, there are quite a few, several that have been developed in Europe, for example. They all kind of have the similar trait, where they try to lead you to the appropriate choice of standards or methods.

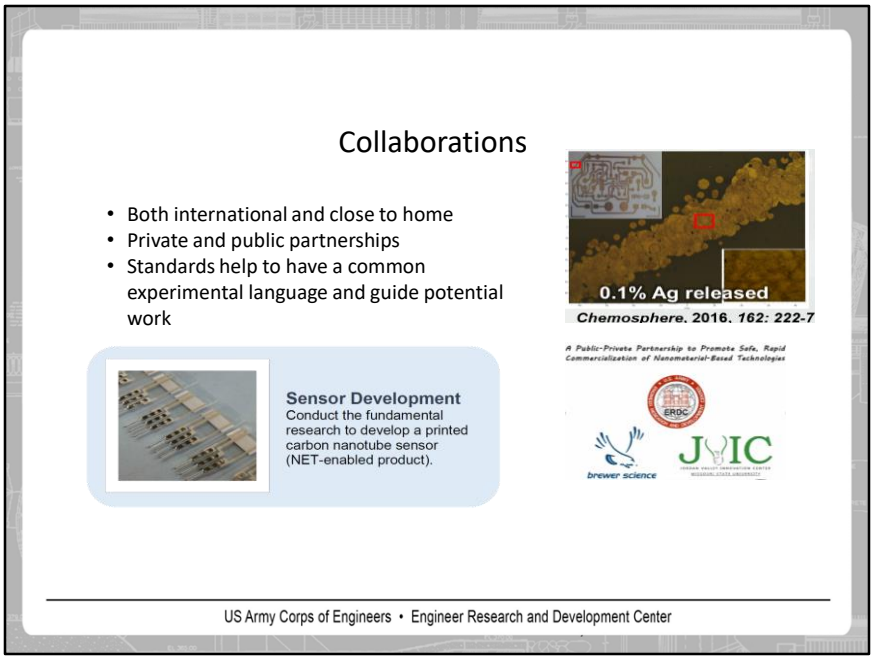


>> Mark Ballentine: This is tied to quality assurance, which is huge. Typically, working for the Army Corps of Engineers, when you do any kind of research, you know that lives will depend on it. You want to make sure the data you are putting out there---whether it's for a new nano-munition or new sensor, or whatever the case may be, the data will be quality and it's not going to come into question. And this comes to, it's really important for nonscientific parties and the decision-makers above the scientists, that they understand that a lot of our decisions are based off of standards that are used internationally, and that gives them confidence in some of the work that we've done. (*Continued...*)



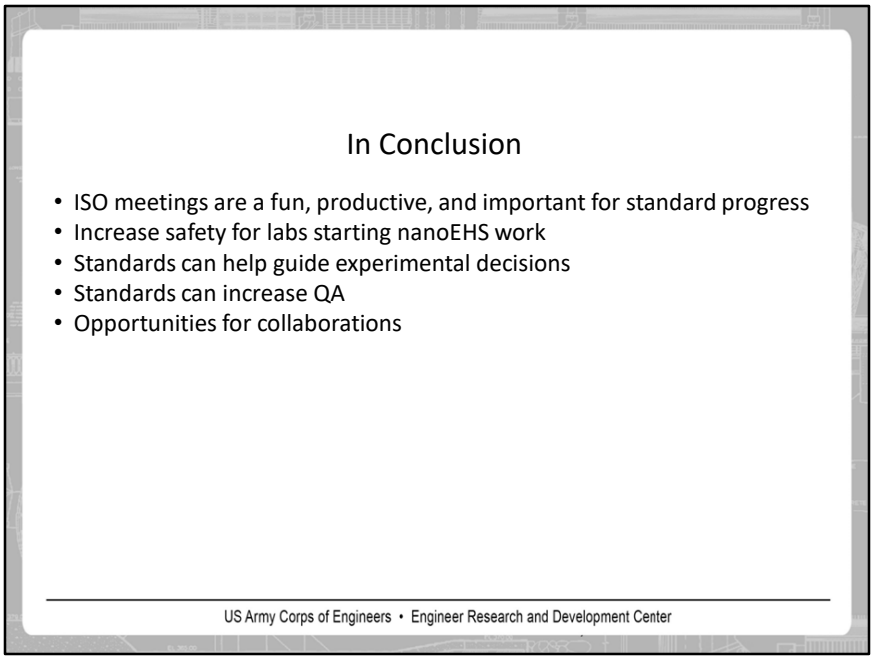
>> Mark Ballentine: The big thing is that common terminology comes out of standards, which is huge. Ajit touched on it in the very beginning; if you're using different terms but you mean the same thing, it can cause a lot of problems.

Along with that, the standards also help with publications---whether it be a tech report, a white paper, or just a typical journal article. The use of terminology and the use of standards will make sure that your methods, your quality assurance, and everything kind of lines up so that everything is appropriate and goes as it should.



>> Mark Ballentine: Lastly, specifically for myself and scientists in my group, the standards have really helped with collaborations. It's introduced us to people internationally and also close to home---people that we've met through some of the ASTM meetings that have facilitated some work. We've developed private and public partnerships with ERDC and others, such as Brewer Science and JVIC (Jordan Valley Innovation Center, Missouri).

The standards just give us a common language and give us a guide for potential work. Because as a user and as somebody who's involved in the meetings and the standards development, you kind of see where the needs are. That way, you can move forward with what you need to as far as new experiments based off of what the need is for the standards but also what we need here for the soldiers to be safe.



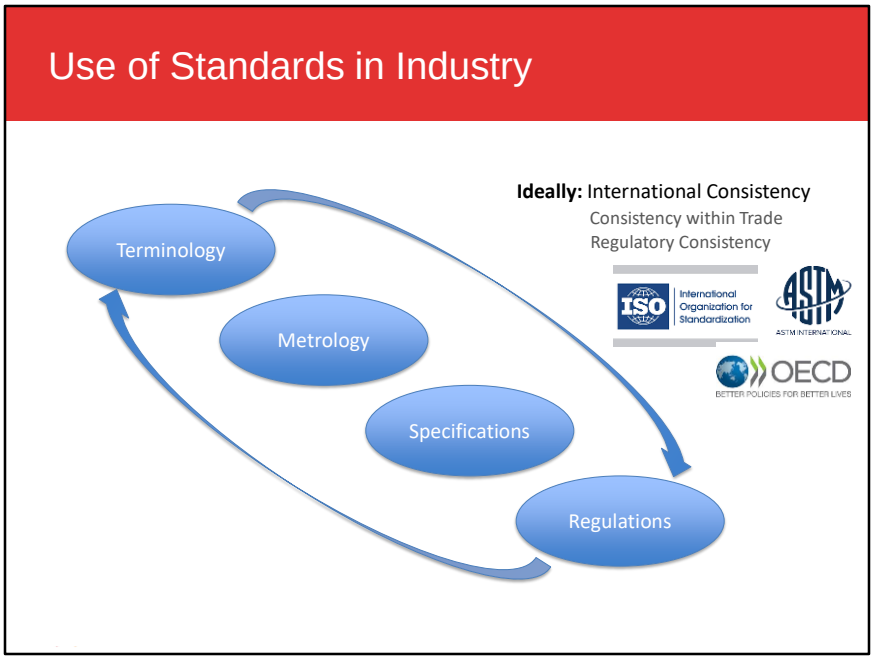
>> Mark Ballentine: Just to wrap up, before I hand it off, the ISO meetings are really important. Personally, they're very fun. I've never felt like they're a waste of time. They're very productive. I feel it's in-person peer review of standards and that process. You, as a user, it's important to get in, so that you have a say, to help guide the process as to what's important for people that are going to be on the ground using these particular standards.

They have definitely helped with increasing safety in our labs and getting it started with a lot of the nano work. It's helped guide experimental decisions and increase our quality assurance over time. And like I said, it's opened up a lot of doors and collaborations. That's where I will wrap up. I will hand off to Dr. Scott Brown.

>> Scott Brown: Thank you, Mark, and thank you, Ajit and Stacey, for the introduction and as well as the NNCO for the invitation, and all the participants on the phone.

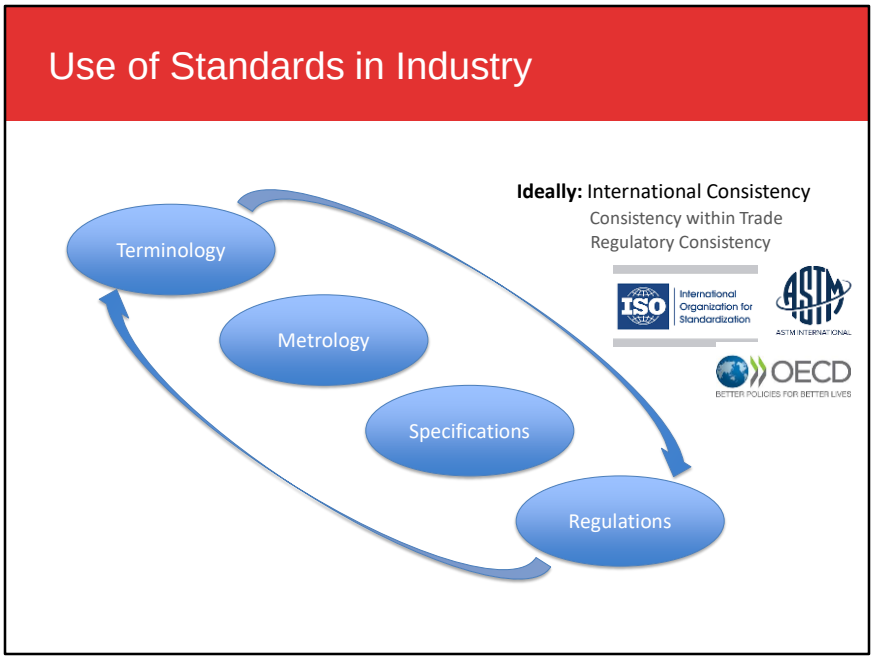
Good afternoon, my name is Scott Brown. I'm a principal scientist in The Chemours Company. We're a manufacturer of titanium dioxide as well as fluoropolymers and other chemical substances. My role within the company is as an R&D scientist as well as having other roles within our sustainability organization. I lead our internal nanotechnology regulatory group, and I've been participating in standards for nearly a decade.

I'm going to provide a perspective from the private sector. These are my personal views and do not necessarily represent those of The Chemours Company or the industry at large. But I believe many of us feel the same way.



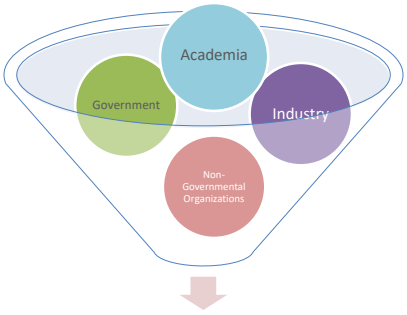
>> Scott Brown: Echoing what Ajit presented in the introduction. For industry, standards are in many regards essential. In order to sell and trade in goods and materials, you need to be able communicate what the materials are. You need to know how to handle the materials safely and ensure that you're in compliance with applicable regulations. So it's really essential that industry pays attention to standards, and standards are really important part of making this possible.

This ranges from common terminology and methods to, also, how you share the data. The way that specifications are provided for trade, the way that you provide information to regulators, these are all important aspects to business. And this is one of the key reasons why participation in standards and development of standard methodologies is so important. (*Continued...*)



>> Scott Brown: Many industrial firms are also international, so consistency across markets and across jurisdictions are really important aspects as well. You can imagine that if you could use a single standard that is accepted around the world, that has great value and saves a lot of money and cost. These are the reasons why industry is actively participating in international organizations dealing with standards, like ISO and the OECD (Organisation for Economic Co-operation and Development).

Intangibles through Direct Participation



Varying Perspectives amongst Stakeholder Groups and Regions

- Opportunity to learn and share concerns
- Develop and grow common understanding
- Prioritize needs across sectors/stakeholder groups
- Identify & provide solutions

>> Scott Brown: This is especially important in the emerging science areas like nanotechnology where everything's not yet set in stone. So being in the room is really important, and hearing the perspectives amongst the different stakeholder groups and regions provides great value. Just understanding the different perspectives---from NGOs, different regulators, different government organizations, other members in industry, and even perspectives from those in academia---are really important to industry to understand where things are going and what are the key questions that need to be answered.

Collectively that helps standardization organizations prioritize what needs to be done. Being a part of that conversation and being in the room has enormous value to industry.

The Value of Consistency

Standards help establish common language and methods

- In general, help promote trade & commerce but also safety, education & research

Both over and under standardization can cause problems…

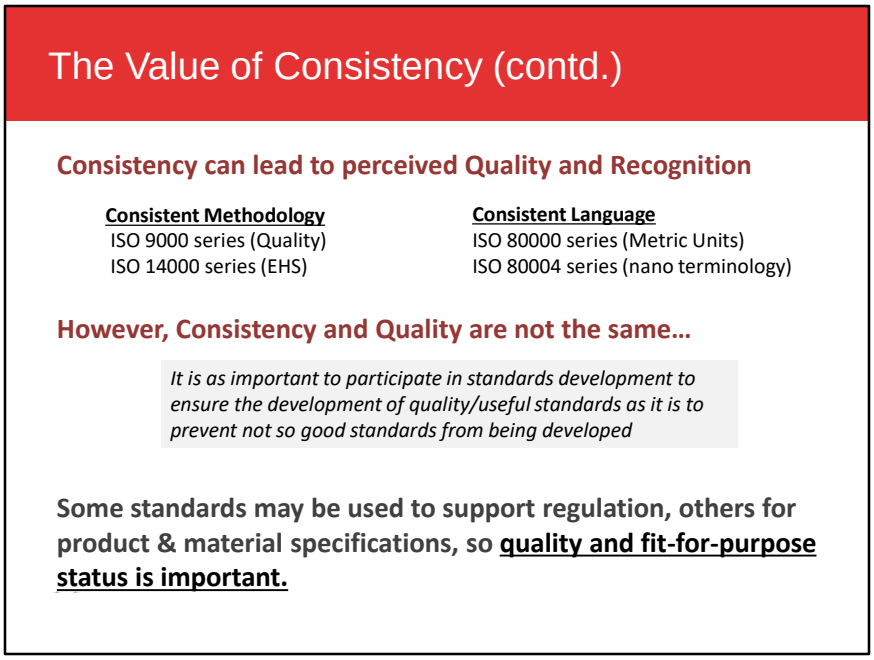
Striking the right balance is not easy.

Not everything should be standardized
… Standards need to be fit-for-purpose.

>> Scott Brown: Apart from generating the document, there's a lot of benefit from the active participation in standards development, away from just trade and commerce, but also in safety, education, and research.

Then we also must realize that you shouldn't standardize everything---not everything requires standardization. There has to be a balance between standardization, as well as providing some openness to competition and customization. Striking the right balance is not easy, and that's why being involved in the conversations is very important.

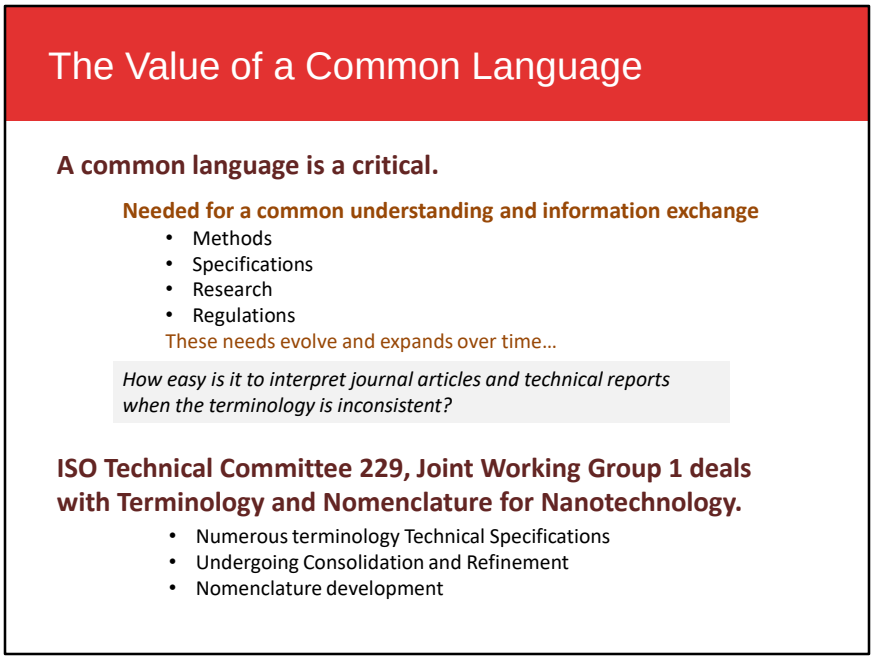
So standards must be needed, they must have their own value, as well as be fit-for-purpose. There are some examples where some efforts to standardize certain things have been mentioned, and of course, certain industries interjected. I think that's how the process is supposed to work, to a large extent. So it's important that industry has an active eye on the development of standards from that regard.



>> Scott Brown: When done well, the consistency from standards leads to recognition. You probably have noticed that many companies advertise conformance to ISO 9000 series or ISO 14,000 series for either quality or environmental management. The recognition of understood quality is a key value that results from the use of standards.

But also, another aspect that's important is that it’s essential to be involved in the conversation because sometimes standards are not always of quality for certain usages. This needs to be clear for the non-user. Mark and Ajit have conveyed that it's important to realize the purpose for the standards, so that quality can be addressed for that given purpose. If you were to measure particle size by one method that is not applicable to that material under those conditions, then that means something very, very different than if it's done correctly.

So understanding the relationship between following a standard and following a standard *for its intended purpose* is really important. And ensuring that the standards are also of good purpose and good value is really a key aspect of why industry is involved in these areas.



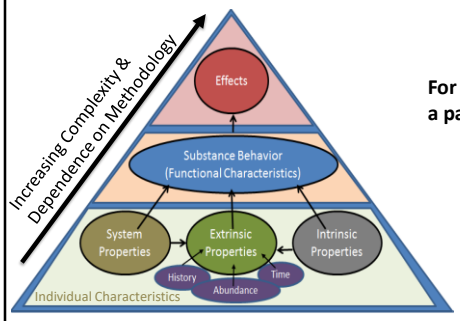
>> Scott Brown: One of the places where I participate strongly is in terminology and nomenclature development because of the reasons I mentioned earlier. This was also emphasized by Mark and Ajit: terminology is fundamental.

It's important to realize, in the development of terminology, that no area is an island, and that the community really develops around the area. Having perspectives come in from different angles during the process of developing terms and ensuring that there's consensus is really important, because these really set the foundation for specifications, research dialogue, as well as regulations. And these evolve and expand over time. Terminology sets the basis for growing the area; growing trade, as well as the science.

So terminology is key. One of the areas that's developing terminology for nanotechnologies is ISO TC 229 Joint Working Group 1. This has evolved over time from just basic terminology to, right now, undergoing a period of consolidation or refinement. In the future, the hope is to see some nomenclature development.

The Value of Common Methods

Common Methods promote comparable data with understood origins.



Physicochemical Property Hierarchy

For particulate systems, a single "method" for a parameter is often not enough…

- Need for clear demarcation of purpose and utility
- Need to take into account contributions from extrinsic/system property factors and history
- How do you do this without the proverbial "expert judgement"?

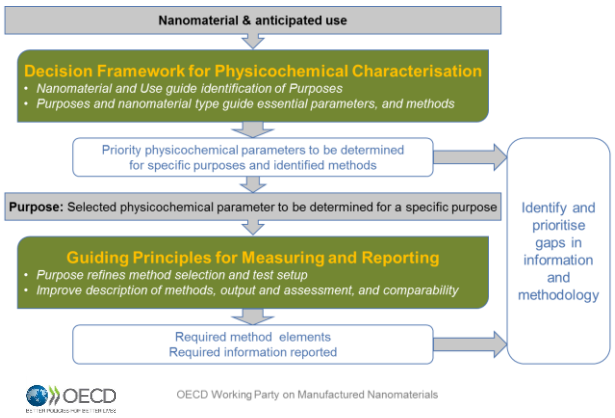
>> Scott Brown: Another area that I participate in is the development of methods for looking at the characteristics of nanomaterials. Developing common methods and promoting comparable data sets with understood origins is really important. This is becoming more important as more data is sought after to describe the potential behavior of nanomaterials in the environment, or to better understand the potential biological consequences or biological opportunities for these nanomaterials.

This is because of the influence of extrinsic factors that complicate the measurements and what you can get out of a single measurement. Instead of having one prescriptive standard protocol to follow, you may need to have a standard methodology for identifying the appropriate approach and then the means to tackle that approach.

This is an area that continues to evolve, and I expect it to evolve a lot over the future as regulatory requirements in Europe and elsewhere continue to grow. The use and diversity of nanomaterials has also evolved. When you think about it, if you look at the physicochemical property hierarchy, there could potentially be literally hundreds and thousands of different standards that may need to be created. But this, obviously, isn't practical.

The Value of Common Methods (contd.)

Physicochemical Characterization Process in the absences of universally fit-for-purpose methods:



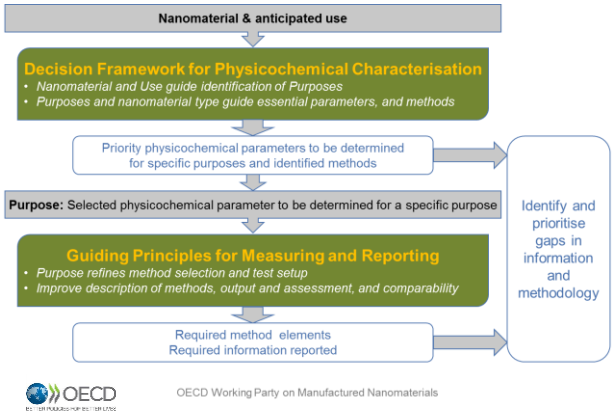
http://www.oecd.org/env/ehs/nanosafety/publications-series-safety-manufactured-nanomaterials.htm

>> Scott Brown: One of the developments within the OECD that was the result of collaboration between the U.S. Environmental Protection Agency, the Netherlands, and industry was to put together an efficient framework for physicochemical characterization of nanoparticles as well as guiding principles for their measurement and reporting. What these two items do, collectively, is provide guidance on methods, similar to the NanoGRID but in more of an open framework. These tools together are intended to develop and further promote communication between regulatory agencies and industry, and that's really important.

It's often something seen in industry that you're asked to provide information without good context with regards to why that information is being requested. Because of that, there are often feedback loops that go back and forth with a lot of testing that sometimes is unnecessary. Having this communication up front ideally would reduce the amount of testing and also lead to answers to questions. (*Continued…)*

The Value of Common Methods (contd.)

Physicochemical Characterization Process in the absences of universally fit-for-purpose methods:



http://www.oecd.org/env/ehs/nanosafety/publications-series-safety-manufactured-nanomaterials.htm

>> Scott Brown: These two documents are living documents and they're available on the OECD website; the link is shown there (http://www.oecd.org/env/ehs/nanosafety/publications-series-safety-manufactured-nanomaterials.htm, reports No. 90 and No. 91), and they're open for comments. We hope to evolve these in the future as guidelines and standards evolve, and we're looking forward to having participation on the evolution of these documents.

Ensuring Quality

Ensuring standards are meaningful, reproducible and fit-for-purpose are key reasons for active participation.

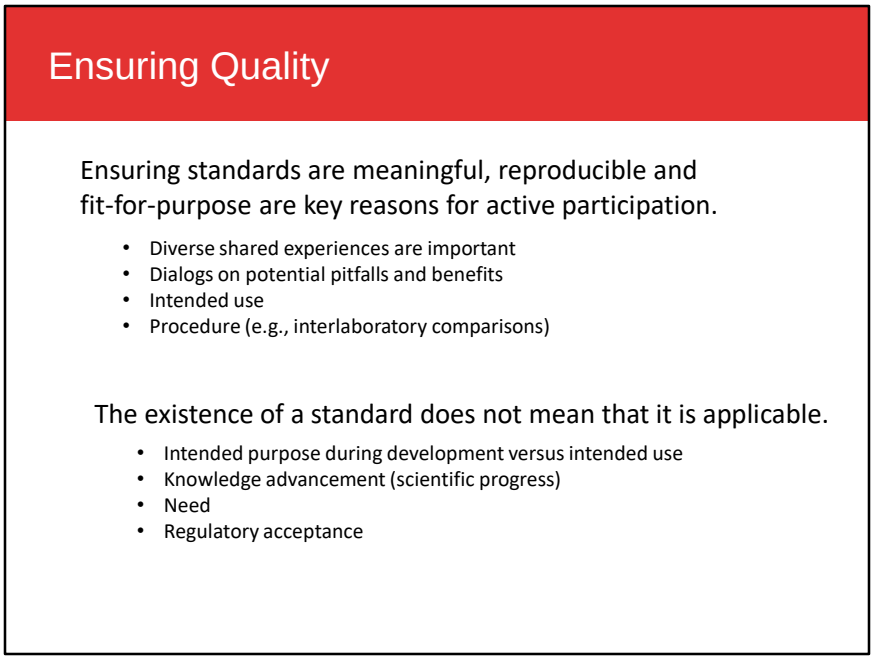
- Diverse shared experiences are important
- Dialogs on potential pitfalls and benefits
- Intended use
- Procedure (e.g., interlaboratory comparisons)

The existence of a standard does not mean that it is applicable.

- Intended purpose during development versus intended use
- Knowledge advancement (scientific progress)
- Need
- Regulatory acceptance

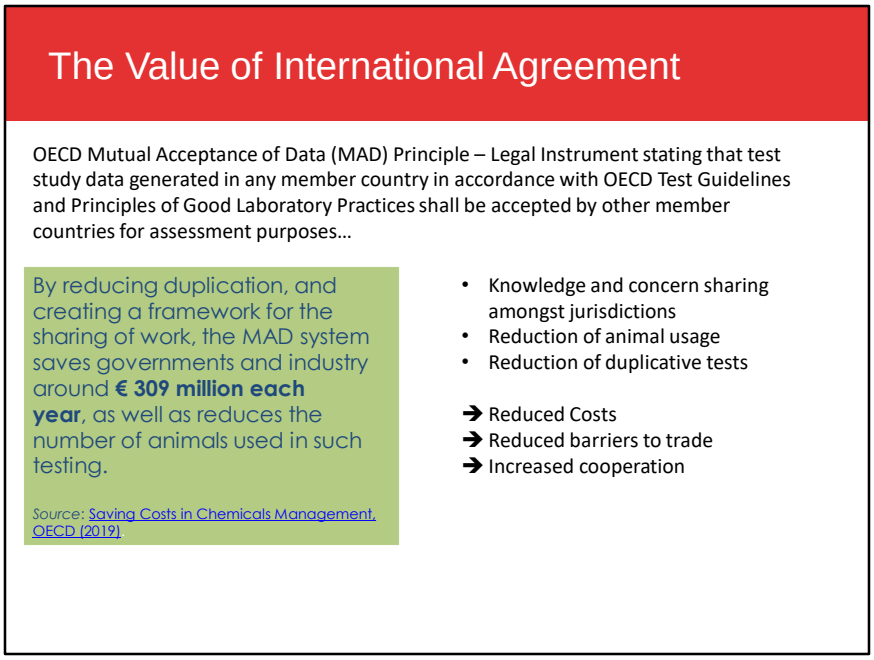
>> Scott Brown: As I have alluded to throughout this presentation, ensuring standards are meaningful, reproducible, and fit-for-purpose are key reasons for active participation. It's really hard to do this just through written comment; being in the room is almost essential for ensuring sound communication and ensuring that the comments are addressed and tended to appropriately.

For many of you who may not have participated in standards activities in the past or may have only provided comments, I encourage you very strongly to actively participate in some of these meetings, because this is where the feet hit the pavement and the real work gets done. (*Continued…*)



>> Scott Brown: Also, it's important to realize that the existence of a standard doesn't mean it's applicable. It's something we see often in industry, and it's a conversation that we continually have amongst a group of standards that have the same name but are for really different intended purposes. Making sure that the intended purposes for the development of those standards is very clear is really important. And as well, you are making sure that they're updated with the growth of knowledge in the various industries as well as that they're still needed. Sometimes, certain methods become outdated and the standard is no longer applicable.

Then again, there are often methods out there that are really good, and sometimes we want to promote those and draw attention to them to regulators or others for extending their use. So it's important that there's active participation not only for ensuring that standards are good but also for ensuring awareness of standards. So sometimes you will not be familiar with standards unless you show up to the meeting and hear about things you may not be an expert in, but they're relevant to your area.



>> Scott Brown: The value of international agreement is a very important aspect to industry participation in standards development, especially in the nanoEHS world, and the EHS world in general. An important example of this is the OECD Mutual Acceptance of Data principle. This is a legal instrument stating that test study data generated by member countries (there are ~40) in accordance with OECD test guidelines and principles of good laboratory practices will be accepted around the world. This is an enormous benefit to companies, because where you would have needed to have done testing, millions of dollars of testing, on a substance in different regions with different testing requirements—it now becomes consolidated to a group of internationally agreed upon tests.

If you follow these guidelines, you can not only reduce your testing costs and save animals as well as dollars and time, you can also get your materials to the market a little faster. You facilitate the communication between regulators, between the regions, on the substance being submitted. It really helps minimize uncertainty and duplicative tests and reduces barriers to trade that are very important. This amounts to about $350 million of savings each year, which is enormous.

Concluding Remarks

- **Standards are important for the trade and regulatory purposes.**
- **Participation in standards development is essential for ensuring that the language and methods are both useful and fit-for-purpose**
- **Standards development offers a unique cooperative multi-stake holder engagement opportunity to develop the tools to help grow and further refine technology spaces**
- **Purposes for standard development can be diverse and it is critical that these purpose are clear and front and center.**
- **Nanotechnology standards activities are evolving.**
  - From foundational to building more of a structure
  - Rapidly progressing needs (e.g., OECD activities)

Scott Brown: In conclusion, for industry and from my personal perspective, standards are obviously important for trade and regulatory purposes; they're also important for just developing product specifications and R&D.

Companies tend to have their own internal standards, as well as use standards that are developed in standards organizations, to communicate the properties of the materials. It's really essential.

It's one thing to use standards, but to participate in the development of standards expands on not only the utility of standards but also on understanding of the direction where things are going. It provides you the opportunity to provide input into the process and help identify needs and improvements. A really critical part of this process is that active participation.

The purposes of standards can be quite diverse, and there's currently a very wide range of activities in the standards development area, moving from foundational to rapidly progressing needs. In the nanoworld a lot of these are technology based, but many are regulatory-related.

Questions & Comments

Scott C. Brown
The Chemours Company

Principal Scientist
Titanium Technologies
Research & Development

976 Centre Rd
BLDG 709, RM 134D
Wilmington, DE 19805
USA

+1 302-683-8419
Scott.C.Brown@Chemours.com

>> Scott Brown: If there are any questions, this is my contact information. With that I hand off to Katherine. Thank you.

>> Katherine Tyner: Thank you, Scott; thank you, Mark and Ajit, and also the NNCO for their invitation. And thank you, everyone, for dialing in.

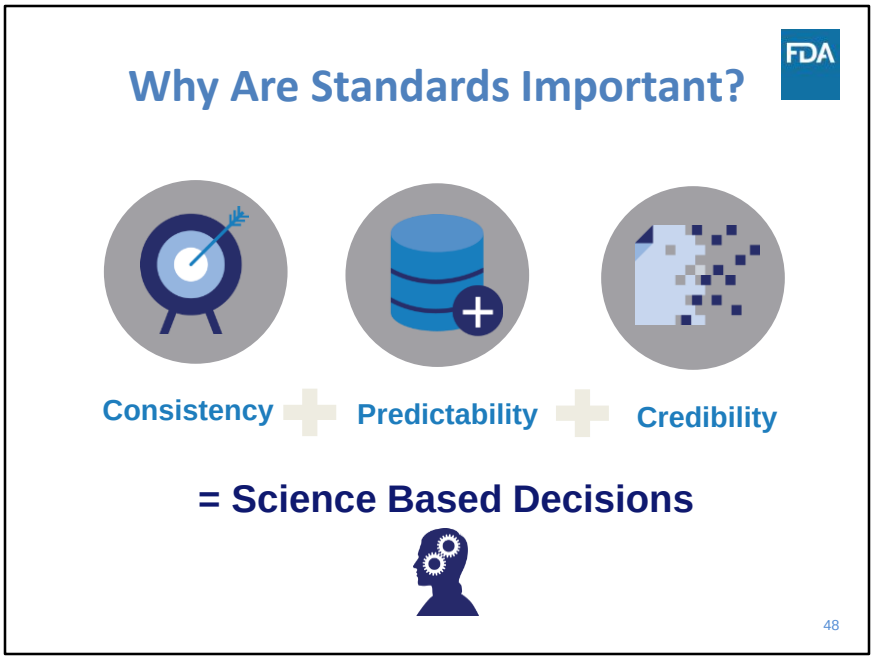
My name is Katherine Tyner. I'm from the Food and Drug Administration, and I get to present the regulatory perspective for standards. It's a fun thing to present from the FDA perspective, because we're always looking for nanomaterials, and the majority of the nanomaterials we see are intentionally in there, which is a little different when we're talking about EHS perspectives as well as standards.

Disclaimer

This talk reflects the views of the author and should not be construed to represent FDA's views or policies. The mention of commercial products, their sources, or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products by the Department of Health and Human Services.

47

>> Katherine Tyner: Because I'm regulatory, I have my disclaimer up, and we'll go through that.



>> Katherine Tyner: Why do we think standards are important at FDA? You get consistency, predictability, and credibility. All of the speakers so far have touched upon this. What this allows, for us on the review side, is that we have science-based decisions; that really is the bread and butter of the work we do from a science-led organization

What Standards Do We Use?

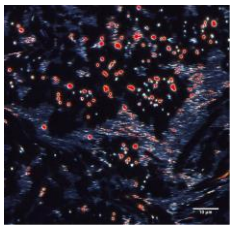
- Documentary Standards: Any document, established by consensus that provides rules, guidelines or characteristics for activities or their results.
  - A list of instructions or guidelines to follow
- Reference Standards: Highly characterized specimens—pure materials or mixtures of chemicals that have been tested in multiple laboratories—intended for quality control use in conducting assays and tests
  - Physical things used for validation of methods

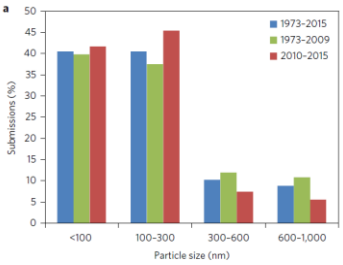
49

>. Katherine Tyner: Ajit mentioned this earlier: When we talk about standards, there are different types of standards. And from our perspective, the two types of standards that we use most often are *documentary standards*---this is really a list of instructions or guidelines to follow, typically for an analytical technique or method that's applied to a complex drug product---and then we also have *reference standards*---these are physical things that are used to validate the methods we just talked about.

Why Do We Need Standards?

- Specialized analytical methods are often needed to characterize drug products containing nanomaterials appropriately
  - May not be as familiar with the methods
- Analytical procedures used in testing should meet proper standards of accuracy, sensitivity, specificity, and reproducibility and demonstrate that they are suitable for their intended purpose
  - Validation





D'Mello S. et al. Nature Nanotechnology DOI: 10.1038/NNANO.2017.67; Fisher AC et al. Int. J. Pharm. 515 (2016) 390-402
Tyner KM et al. AAPS J. DOI: 10.1208/s12248-017-0084-6

50

>> Katherine Tyner: The reason why we're so interested in standards is because---especially when we're talking about nanotechnology, and since I'm on the drug side, we're talking about drug products containing nanomaterials---these tend to be complex drug products. The more complex the drug product, you are going to need specialized analytical methods to characterize these products appropriately. These methods may not be familiar to the industry or the developers, and they may not be that familiar to the regulators. And so, having some type of standardization really goes a long way in getting people onto the same page.

On the flip side, you have these complex analytical techniques---or you may even have simple analytical techniques---but in all cases, you need to demonstrate that that technique is fit-for-purpose for your particular product. That's where we get a lot of the standards discussion as well.

Why Do We Need Standards?

- Documentary standards provides a common ground and common starting place to characterize complex drug products
  - May reduce the number of questions from companies and reviewers
  - Speeds quality products onto market
- Reference materials allow for validation of methods
  - Need a material to demonstrate fit for purpose
  - Example: Size is often critical for the performance of drug products containing nanomaterials and needs to be controlled.
  - The technique used to measure a 10 nm particle will need to demonstrate through validation that it can reliably measure a 10 nm particle.

51

>> Katherine Tyner: To give more specific examples, in terms of documentary standards, this provides a common starting ground to characterize complex drug products. Why that's important is that it reduces the number of questions from companies and reviewers If you have the same standards, if you are talking the same language, you have the same vocabulary, you're starting a lot further down in the conversation for these questions that we have when we're reviewing drug products. Ultimately that speeds quality drug products on to the market.

On the flip side, if you have these analytical techniques, this is going to allow for validation of those methods. So you need to demonstrate that your technique is fit-for-purpose. (*Continued…*)

Why Do We Need Standards?

- Documentary standards provides a common ground and common starting place to characterize complex drug products
  - May reduce the number of questions from companies and reviewers
  - Speeds quality products onto market
- Reference materials allow for validation of methods
  - Need a material to demonstrate fit for purpose
  - Example: Size is often critical for the performance of drug products containing nanomaterials and needs to be controlled.
  - The technique used to measure a 10 nm particle will need to demonstrate through validation that it can reliably measure a 10 nm particle.

52

>> Katherine Tyner: As an example, size: for nanomaterials that's typically something we always talk about. It's often a critical quality attribute for the performance of the drug product, and it needs to be controlled and measured.

If you have a technique that measures, let's say, a 10-nanometer particle, and you are going to claim that it measures a 10-nanometer particle, you need to demonstrate through validation that it's measuring a 10-nanometer particle. For that, you typically need a 10-nanometer particle, and that's where the reference standard comes in, where you actually have physical materials that can help demonstrate that fit-for-purpose.

FDA Nanotechnology Standard Participation

- ASTM International
  - E56 Committee on Nanotechnology
- International Organization for Standardization
  - TC 229 Nanotechnologies
- Organisation for Economic Co-operation and Development
- United States Pharmacopeia (USP)
  - USP Joint Sub-committee on Nanotechnology

53

>> Katherine Tyner: In terms of participation, the FDA has been getting more involved in standardization for nanotechnology standards, specifically. One of the reasons is because we're reaching the stage where we really feel like we have a say and we can comment on the types of products we're seeing, and the types of methods and techniques we're seeing, and help drive that conversation.

So we participate in ASTM International, on the E56 Committee; we also participate in ISO TC 229, OECD; and we also sit on the United States Pharmacopeia Joint Committee on Nanotechnology.

FDA Nanotechnology Standards Sub-Committee Priorities

- Consolidate FDA comments for nanotechnology standards up for review.
- Prioritize nanotechnology standards based on Agency needs
- Assist in the development of standards

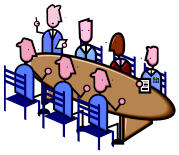
54

>> Katherine Tyner: One of the things that we have done throughout the agency is consolidate our nanotechnology standards efforts into an umbrella organization, which is the Nanotechnology Standards Subcommittee, of which I'm one of the co-chairs. This allows all of the centers with all the different product jurisdictions to comment on the various nanotechnology standards that are coming out, if they indeed impact their products.

The purpose of the subcommittee is to consolidate the FDA comments for nanotechnology standards that are up for review. This allows you guys, both the users and developers, to hear one FDA voice. Also, internally, we prioritize the nanotechnology standards that we would like to see developed and that we want to participate in, based on agency needs. We also assist in the development of standards through commenting, drafting, and some cases, even doing the interlaboratory studies to help validate those standards.

OMB Circular A-119

"6b. Does agency participation indicate endorsement of any decisions reached by standards bodies? Agency participation in standards bodies does not connote agency endorsement or agreement with decisions by such bodies."

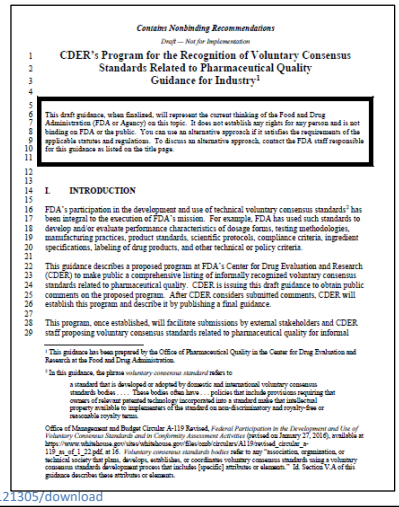


≠

55

>> Katherine Tyner: One of the questions we get asked, if we are at the table, Does that mean that we are endorsing that decision? Not necessarily, but we are bringing our FDA perspective to the table.

CDER's Program for the Recognition of Voluntary Consensus Standards Related to Pharmaceutical Quality



Contains Nonbinding Recommendations

Draft — Not for Implementation

CDER's Program for the Recognition of Voluntary Consensus Standards Related to Pharmaceutical Quality Guidance for Industry[1]

This draft guidance, when finalized, will represent the current thinking of the Food and Drug Administration (FDA or Agency) on this topic. It does not establish any rights for any person and is not binding on FDA or the public. You can use an alternative approach if it satisfies the requirements of the applicable statutes and regulations. To discuss an alternative approach, contact the FDA staff responsible for this guidance as listed on the title page.

I. INTRODUCTION

FDA's participation in the development and use of technical voluntary consensus standards[2] has been integral to the execution of FDA's mission. For example, FDA has used such standards to develop and/or evaluate performance characteristics of dosage forms, testing methodologies, manufacturing practices, product standards, scientific protocols, compliance criteria, ingredient specifications, labeling of drug products, and other technical or policy criteria.

This guidance describes a proposed program at FDA's Center for Drug Evaluation and Research (CDER) to make public a comprehensive listing of informally recognized voluntary consensus standards related to pharmaceutical quality. CDER is issuing this draft guidance to obtain public comments on the proposed program. After CDER considers submitted comments, CDER will establish this program and describe it by publishing a final guidance.

This program, once established, will facilitate submissions by external stakeholders and CDER staff proposing voluntary consensus standards related to pharmaceutical quality for informal

[1] This guidance has been prepared by the Office of Pharmaceutical Quality in the Center for Drug Evaluation and Research at the Food and Drug Administration.

[2] In this guidance, the phrase *voluntary consensus standard* refers to

> a standard that is developed or adopted by domestic and international voluntary consensus standards bodies . . . . These bodies often have . . . policies that include provisions requiring that owners of relevant patented technology incorporated into a standard make that intellectual property available to implementers of the standard on non-discriminatory and royalty-free or reasonable royalty terms.

Office of Management and Budget Circular A-119 Revised, *Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities* (revised on January 27, 2016), available at https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/circulars/A119/revised_circular_a-119_as_of_1_22.pdf, at 16. *Voluntary consensus standards bodies* refer to any "association, organization, or technical society that plans, develops, establishes, or coordinates voluntary consensus standards using a voluntary consensus standards development process that includes [specific] attributes or elements." Id. Section V.A of this guidance describes these attributes or elements.

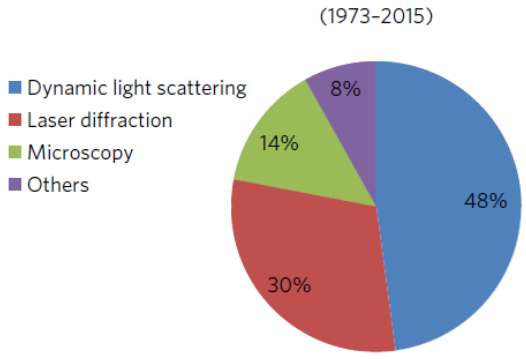
https://www.fda.gov/media/121305/download

56

>> Katherine Tyner: Another key aspect that we are bringing about is that, in the Office of Pharmaceutical Quality, we are standing up a program for the recognition of voluntary consensus standards that are related to pharmaceutical quality. I have the guidance up here; this is the hyperlink where you can find the guidance: https://www.fda.gov/media/121305/download. It talks about the structure and how we going to stand up this committee.

What this will allow us to do is to recognize standards that we feel are very useful for developers in different parts and aspects of pharmaceutical quality---nanotechnology standards being some of those. This will, again, allow that conversation to occur between the developers and the regulators, and again, have that common framework, that common vocabulary, so we can just start that discussion a bit further along. That speeds up the process.

Why Do We Participate in Standards?
Example: Submissions to the US FDA of Drug Products Containing Nanomaterials



Increase in dynamic light scattering and high resolution imaging

D'Mello S. et al. Nature Nanotechnology DOI: 10.1038/NNANO.2017.67

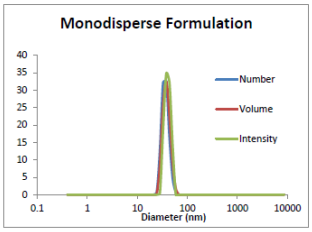
57

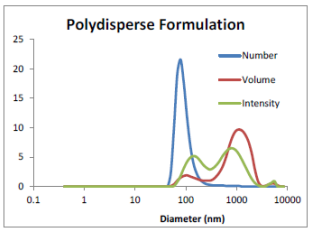
>> Katherine Tyner: So a quick case study of why we participate in standards and where our efforts are directed: This is a graph that shows the submissions of drug products containing nanomaterials and the types of analytical methods that are being applied to those products.

This was only going to 2015, and now we're at 2019. Greater than half of all submissions we see coming in use dynamic light scattering as one of the techniques. Now dynamic light scattering is a very old technique, but when it started to get applied to newer drugs, there were a lot of questions and issues, both on the regulators' side as well as the developers' side.

Why Do We Participate in Standards? Example: Dynamic Light Scattering

- What challenges has FDA has seen in drug submissions using dynamic light scattering?
  - Using instrument outside of instrument range
  - Validation performed differently than the sample measurements (e.g. volume weighting vs number weighted result)
  - Improper sample preparation
    - Dispersant, filtration, dilution
    - Data presented/analyzed incorrectly or insufficiently
  - Proposed size range is ~ 10 nm particle and validating the technique with a 100 nm particle
- CDER can focus on increasing the availability of documentary standards and reference materials
  - Same starting place speeds quality drugs onto market





58

>> Katherine Tyner: We saw a lot of questions or concerns or sometimes mismanagement of the method that could have been addressed with a standard. Some of those things would be like using the instrument outside of the instrument range, validation performed incorrectly, improper sample preparation and improper data analysis, and the fit-for-purpose and validation not being performed correctly.

And so having a standard---and now we actually do have a standard out---one through ISO (and there is also one being drafted through ASTM). Having those standards available takes care of all of those issues right off the bat, so we're just looking at the data and having that conversation rather than having questions about the methodology.

So those are the types of standards that we focus on, that when we see things that are coming in, we are seeing questions or concerns, we can focus our effort on those types of documentary standards and then the reference materials that would validate those methods.

Future Standards Needs

- Documentary standards that align with the technology that we are seeing being implemented
  - Corresponding to key quality attributes of the drug products
    - Not just size
- Standard Reference Materials
  - Range of size
  - Less reflective/nonmetallic material
  - Stability in biological material

59

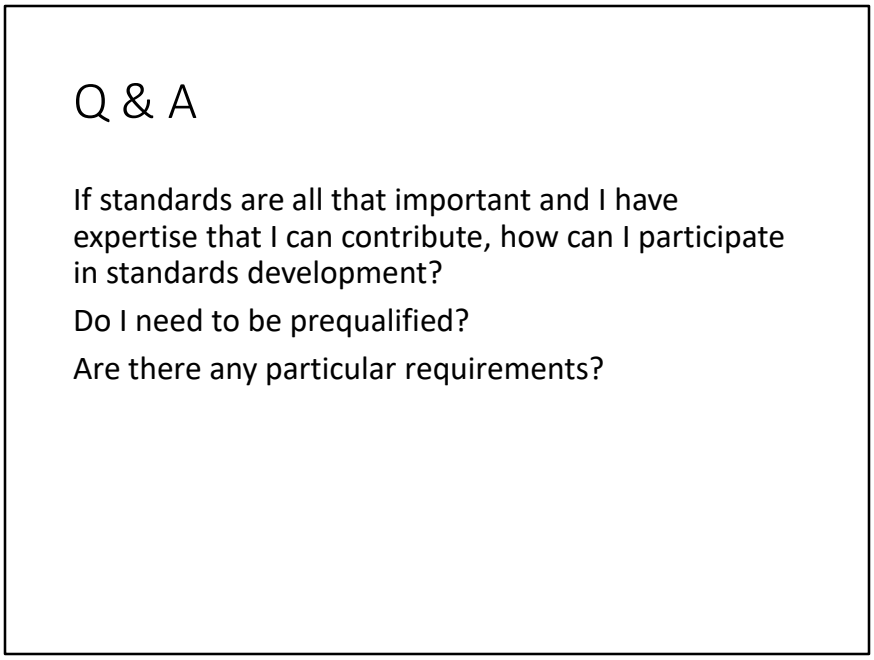
>> Katherine Tyner: In terms of where FDA is directing our resources recently, we're looking for documentary standards that align with the technologies that we're seeing being implemented in the submissions that are coming in. This would be not just the drug submissions but also the device submissions what we're seeing in the food area as well.

These correspond to the key quality attributes of the products, not just the drug products, and not necessarily just the size; it could also be morphology or some other attributes that are important for the performance of the product.

In terms of the standards materials and the reference materials, we're also looking at a range of sizes, different materials---a range of materials---different things that we're able to help validate those methods that we're using.

>> Katherine Tyner: With that I am finished, and I will turn the floor back to Ajit to begin the panel discussion.

>> Ajit Jillavenkatesa: Katherine, thank you very much. And thanks to all our speakers, Scott, Mark, for this range of perspectives. I think we have a few questions, which kind of span the differences in perspectives.



>> Ajit Jillavenkatesa: The first question I would like to pose for our speakers is perhaps a question that various people are thinking about, which is, "If standards are all that important and I have expertise that I can contribute, how can I participate in standards development? Do I need to be prequalified? Are there any particular requirements?" From your perspectives, do you have any recommendations you would like to share with anyone who's interested in participating in standards development? This is a question to any of our speakers. Scott, perhaps can you get the conversation going?

>> Scott Brown: *S*ure. Obviously, if you're developing a standard in a certain area, you need to have a stake in that area. Ideally, you would have some expertise in that field and be respected as an expert or colleague in that area. But sometimes, getting students involved in the standards processes is also a valid approach, and sometimes having those mixed perspectives is something that is of value. We often find that for new areas, no one's really always an expert, and so the diversity in perspectives is typically of value. (*Continued…*)

Q & A

If standards are all that important and I have expertise that I can contribute, how can I participate in standards development?

Do I need to be prequalified?

Are there any particular requirements?

>> Scott Brown: Sometimes, the evolution of a document, to make it a better document, comes from looking at the document from a nonexpert view and using the document. I think that if you're interested in a particular area, the expectation is that you're honest with the level of knowledge you have in that particular area, and don't be afraid to get actively involved; over time you will develop into an expert.

>> Ajit Jillavenkatesa: Go ahead, Mark.

>> Mark Ballentine: Just to kind of echo what Scott was saying and kind of how I got involved with it. We were using another expert who was developing a standard, and over time, kind of working through them as an intermediary, while we were doing research in the area, we were developing our skills. We got to a point that we felt like it would be better suited for us if we were more directly involved, and that's kind of what was on the table. (*Continued…*)

Q & A

If standards are all that important and I have expertise that I can contribute, how can I participate in standards development?

Do I need to be prequalified?

Are there any particular requirements?

>> Mark Ballentine: After we had developed a little bit of expertise, we had an interest in getting in there and really sitting at the table and having the discussion. So, you know, that's one path. Definitely, talking to your company or organization and then reaching out to the standards organization through them is another path, definitely a way that you could take.

>> Katherine Tyner: I'll just echo Mark as well. Definitely reach out. These groups are very friendly, very welcoming of different perspectives and different views. Being able to contribute as much or as little as you can, but having that different perspective, is always great at the table. (*Continued…*)

Q & A

If standards are all that important and I have expertise that I can contribute, how can I participate in standards development?

Do I need to be prequalified?

Are there any particular requirements?

>> Ajit Jillavenkatesa: Folks, two of the groups of particular note who are engaged in nanoEHS-related standards development are ISO TC 229 and ASTM E56. For anyone who's interested---this is a message to our webinar participants---please send a message to any of our experts, to me, or to the organizers of the webinar at the National Nanotechnology Coordination Office, and we can direct you to the right people either within ASTM, for participating in ASTM E56, or to ANSI, which is the pathway for U.S. participation into ISO TC 229 nanotechnologies-related standardization activities.

We have a number of experts who participate in both activities, and we have many experts who participate in one or the other. So it's a very flexible approach, a very flexible system. It's really about your interests and where you see the greatest value.

Q & A

Given the focus on the nanoEHS aspects, are there either particular standards or particular aspects of the nanoEHS standardization that you have found to be either particularly useful or that you are really interested in and that's the focus of your work?

>> Ajit Jillavenkatesa: The next question I'd like to pose for all of our panelists is, given the focus on the nanoEHS aspects, are there either particular standards or particular aspects of the nanoEHS standardization that you have found to be either particularly useful or that you are really interested in and that's the focus of your work? So, Katherine, perhaps can you get the responses to that question going in?

>> Katherine Tyner: Sure. For us, it's the characterization--the methods and the documentary standards that let us characterize the material. Because unless you understand what you've giving to an animal or human, you can't really understand what the toxicity is that is as a result of that. Those standards have been invaluable, the ones that come out both from ISO TC 229 and ASTM E56. (*Continued…*)

Q & A

Given the focus on the nanoEHS aspects, are there either particular standards or particular aspects of the nanoEHS standardization that you have found to be either particularly useful or that you are really interested in and that's the focus of your work?

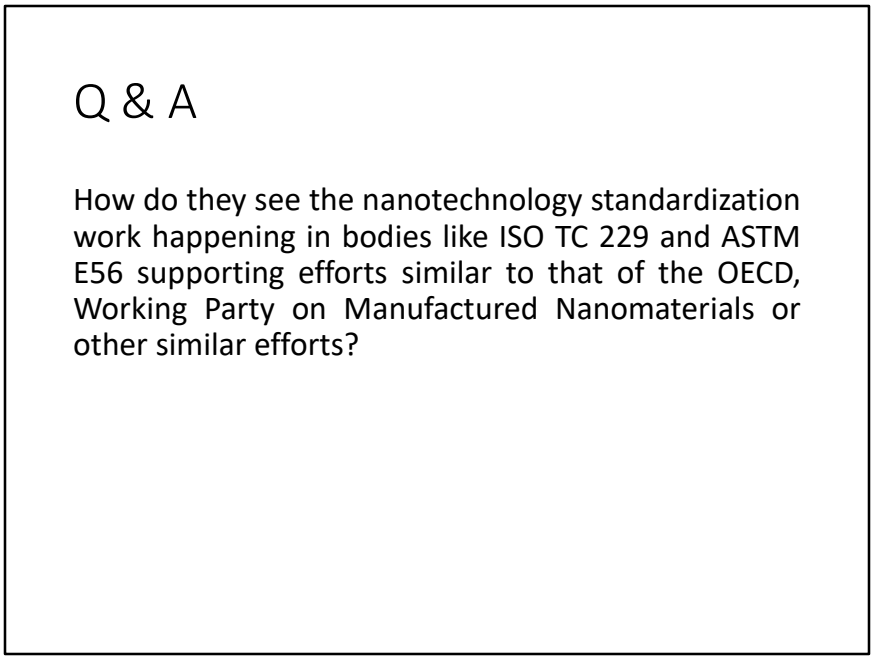
>> Ajit Jillavenkatesa: And, Mark, from your perspective?

>> Mark Ballentine: Characterization, definitely, and also release. Release is a big one, because a lot of our studies deal with release, even if it's secondary. If we are doing toxicity, we still need to know how the organisms are going to be exposed, or how the soldier could possibly be exposed to that. So a lot of that work coming out of TC 229 has been very helpful.

>> Ajit Jillavenkatesa: And, Scott, from your perspective?

>> Scott Brown: Characterization of course is a big one, especially given the complexity of systems and the extrinsic factors for many nanomaterials and many of the endpoints that regulators are asking for today. So having clarity there and a common set of media and approaches is really important.

>> Ajit Jillavenkatesa: Great, thank you.



>> Ajit Jillavenkatesa: Recognizing that we're almost at the top of the hour, I want to pose one last question before we wrap this up. The question is, the presentations touched on the OECD and the OECD-related work that's happening; perhaps our speakers can present a quick perspective about how do they see the nanotechnology standardization work happening in bodies like ISO TC 229 and ASTM E56 supporting efforts similar to that of the OECD, whether it's the OECD Working Party on Manufactured Nanomaterials or other similar efforts, which are often the combination of an intergovernmental with some private-sector-input-type effort?

>> Scott Brown: Ajit, I can hone in on that one first. The activities within the OECD actually look directly to the standards that are established and are out there, especially those from ISO TC 229 and some from ASTM E56, as well as other regional standards organizations. Those are usually the starting points. (*Continued…*)

Q & A

How do they see the nanotechnology standardization work happening in bodies like ISO TC 229 and ASTM E56 supporting efforts similar to that of the OECD, Working Party on Manufactured Nanomaterials or other similar efforts?

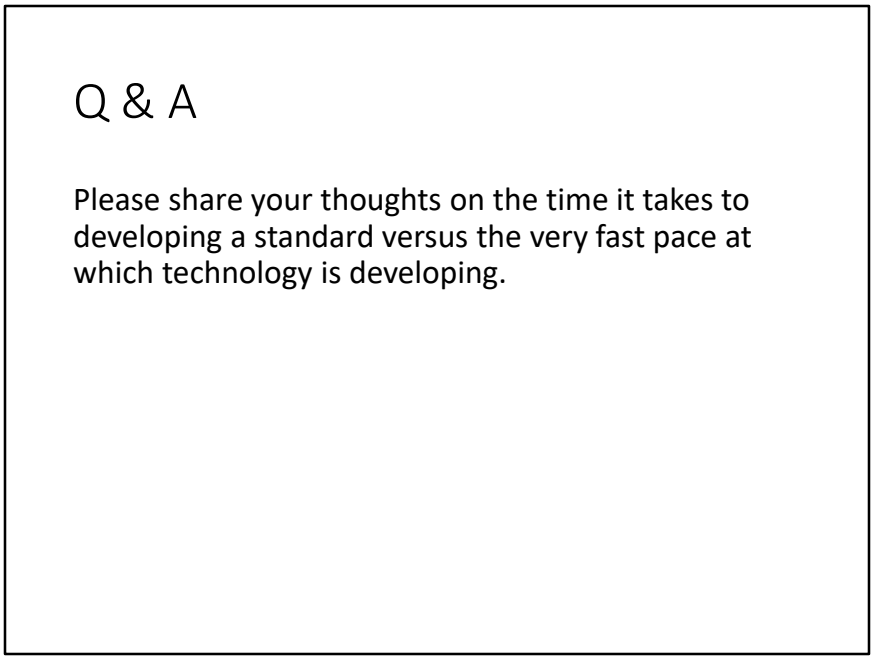
>> Scott Brown: Of course, when you have voluntary standards and then you have regulatory standards, sometimes the needs are a little different, so they have to go through a different process. Currently, there are a number of technical standards from ISO that are being incorporated into test guidelines that are being developed within the OECD WPMN (Working Party on Manufactured Nanomaterials) and WNT (Working Group of the National Coordinators of the Test Guidelines Program). Right now; those are in areas of particles size determination as well as surface area; there's continuing work in other areas also.

So these standards from ISO, ASTM E56, and these other organizations, are really the baseline for everything that gets developed within the OECD.

>>Ajit Jillavenkatesa: Katherine, Mark, anything from your perspectives?

>> Mark Ballentine: No, I really don't have anything to add; Scott covered it pretty well.

>> Katherine Tyner: Same with me.



>> Ajit Jillavenkatesa: We have, I guess, one last question. I will see whether I could sneak that in. But I am going to look to our hosts at the NNCO.

We have a question from the participants, which is, basically, requesting any of the experts or all the experts to share their thoughts on the time it takes to develop a standard versus the very fast pace at which technology is developing.

I think this is a very pertinent question, because even though it's framed in the context of nanotechnology, it applies to pretty much any technological area now. And it's also getting to one of the fundamental issues about the value, the timeliness, and the value proposition. So, any takers about the time length for developing standards versus the pace at which technology is developing? (*Continued…*)

Q & A

Please share your thoughts on the time it takes to developing a standard versus the very fast pace at which technology is developing.

>> Mark Ballentine: I'll just mention very quickly, it's definitely a concern. You know, standards can take years to finally get out. But the reason we want to be at the table for a lot of that, even though we're in the process of doing the research and developing new materials and new technologies, is that the standards help us with the baseline. So even if you're developing new technologies, the standard that may be lagging a little bit behind is still going to help support your new material, your new technology, when dealing or talking with other organizations or other decision-makers. So they are still interconnected, even though there's that delay time, I would say, with the standards.

>> Katherine Tyner: I would agree with that and say, absolutely, there's a sweet spot of when there's a technology that's ready to be standardized versus when it's too early, and kind of hitting that and trying to time out when the standard is actually going to hit, so that it's impactful. That's a discussion that you actually have at these standards meetings. (*Continued…*)

Q & A

Please share your thoughts on the time it takes to developing a standard versus the very fast pace at which technology is developing.

>> Katherine Tyner: Ultimately, from the FDA perspective, usually we're waiting until we see these techniques starting to emerge from the applicants before we start pushing those standards through. But ultimately, you know, whether or not it's a little bit earlier or little bit late, I agree it's very useful to have them.

>> Scott Brown: This is also one of the reasons why the phys-chem decision framework and guiding principles were developed, because one of the things that we realized was that the standards aren't quite available for all purposes at any given time. So, the framework provides a guideline to start to be able to address that, to allow for things to get developed faster with some recognition of just the basic process that needs to be taken for the characterization of materials---and clarity and the questions and the purposes. So that would help, ideally, genesis of specific documentary standards to be developed later on topical areas of greater importance. (*Continued…*)

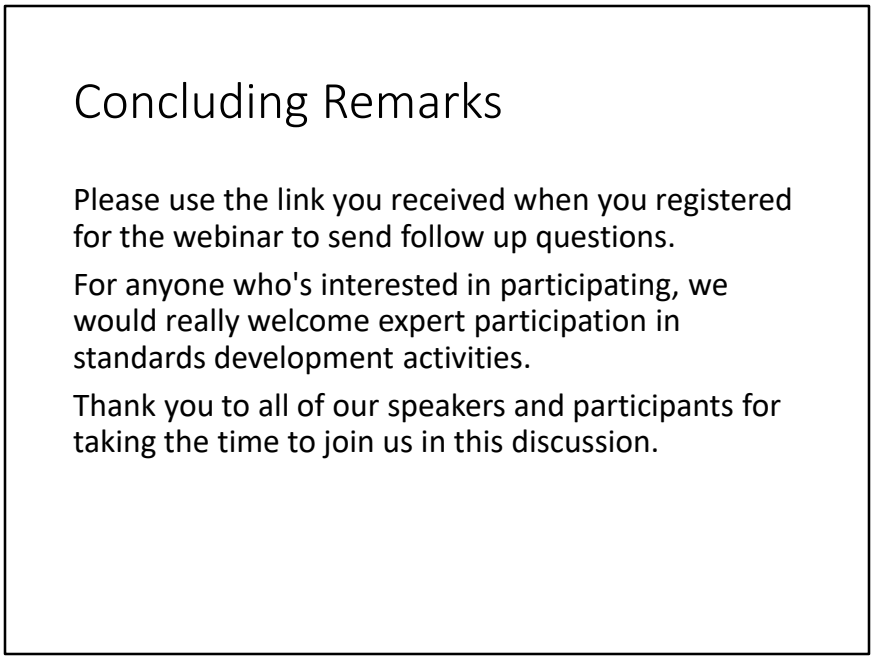
Q & A

Please share your thoughts on the time it takes to developing a standard versus the very fast pace at which technology is developing.

>> Ajit Jillavenkatesa: A couple of other perspectives that I would add into this one, especially if we are looking at standards after the fact, like safety-related issues. I think we want to make sure that we do take the time to ensure the rigor of the standard, just because of the associated risk that's present with not getting the standard right. So in many instances, that is actually a very fair trade, to make sure that we have the right product even though it might take a little longer.

But I think another important aspect to consider is that just because a standard takes some finite time to develop, it doesn't mean that as technology is evolving, that the evolution of the technology is not being reflected in that standard. A standard does not lock out a particular technological progress once the standard development process starts.

The development process takes a while because of the multiple rounds of reviews, of fine tuning. And as we learn more about the technology development, we make sure that that's reflected in that. So in many instances, we actually see the case of the base of technological development also actually informing the standards development, even if it does take a while.



>> Ajit Jillavenkatesa: Recognizing that, we're at five minutes after our scheduled closing time, and there are lots of questions. What I would like to suggest, if it's acceptable to our NNCO hosts, is that anyone who's interested in questions, please use the link that you received when you registered for the webinar to send any follow-up questions; between the speakers and myself as moderator, we will try to answer those questions and respond to you.

And for anyone who's interested in participating, we would really welcome expert participation and input in the standards development activity. There's way too much work to go around and not enough expertise for us to be able to do justice to the responsibility that comes with developing very sound standards.

With that, what I would also like to do is thank all of our speakers, and certainly our participants, for taking the time to join us in this discussion. And a big shout out and thanks to the National Nanotechnology Coordination Office.