

**Risk and Effects of Radiation**  
**Transcript of the National Press Club Event Conducted**  
**in Washington, DC, on 1 March 2012**

**HOWARD DICKSON:** Let me introduce myself. I'm Howard Dickson and I'm going to be the moderator today. As far as I know, this is a first for the Health Physics Society. Certainly not a first for you folks; you do this all the time; it's your living. We're going to do a brief introduction of the Health Physics Society for those of you who might not be familiar with us. The Society was formed in 1956 and it's a scientific organization of professionals that specializes in radiation safety.

The primary mission of the Health Physics Society is to support its members in their endeavors. We have approximately 5,000 members, so it's a rather modest-sized professional organization, and they represent a lot of different disciplines. Even though physics is in our title, we have people representing all of the basic science disciplines, medicine, and other related topics as well.

Our people work in all kinds of endeavors that involve radiation, whether it's academia or industry or medicine or consulting—many different applications. So you'll find health is in a lot of different positions within those kinds of organizations.

Our society is chartered as an independent nonprofit science organization so we have no affiliation with any government, industry, or private entity. Now, we do have affiliations with other scientific organizations like the NCRP, which John represents, but not with the government or private or industrial organizations.

We do a number of things in addition to supporting our members. We do have a lot of information exchange available through a website, through a newsletter, through various

publications. We're actively involved in the creation and publication of standards associated with radiation and radiation activities.

The Health Physics Society, of course, missed an opportunity about a year ago because none of us expected what happened in Japan. In this particular case, on the anniversary, we do have an opportunity to communicate much better and so we wanted to exercise our opportunity to do this. And it actually addresses one of our strategic goals, and that's to provide reliable and useful information to the media. It's a stated strategic goal of ours. So what a wonderful opportunity to do that in advance of the actual anniversary. Because we know that you need to communicate with folks and it's a very normal activity to respond at the anniversary of an event.

We're proud to provide you an exemplary group of experts to address your questions today. Several of the people on the panel here are members of the Health Physics Society, but they're not speaking formally or officially for the Health Physics Society. Only the president of the Society has that right, and she is not here today. [laughter] The Health Physics Society has not encumbered anybody on the panel with what they're to say or how they're to say it. We're independent scientists and, as such, we will give you our untarnished opinion with regard to the subject matter and respond to your questions in that fashion.

Well, I want to be sure that we have quiet in the room, so if you haven't already turned off your cell phones, I'd appreciate it if you'd take this opportunity to do that. I know I was annoying some folks earlier today with some videotaping with my cell phone so I've got mine turned off.

At this time, I'd like the panelists to introduce themselves. I'm going to start by giving you a little bit of my background and why I'm here. I'm a past president of the Health Physics Society. I'm currently Web Operations editor in chief. My responsibility is with our newsletter and our website, so I'm in constant communication with our membership and the public. I'm a physicist by education. I'm certified in the practice of health physics and the practice of safety and industrial hygiene. I really regard myself as a safety professional, and my whole career over 40

years has been dedicated to looking out for the safety of people. That's been my highest and loftiest goal, to make sure that people that I'm responsible for are adequately protected.

I've done that at a number of facilities where I've been responsible for significant groups of people, as many as 5,000 in one particular organization. And so, that's the kind of background I bring to you. I did play a role in the TMI-2 recovery. I was actually deputy director of technical planning for that. So, if there are any residual questions associated with a previous event like TMI, I'd be happy to address those.

I've asked all the panelists to keep their introduction brief, so I'm honoring that myself. I'll turn to my right here and ask Dr. Gale to introduce himself.

**ROBERT GALE:** Good morning, everyone. I'm Robert Gale. I'm a visiting professor of hematology at the Imperial College in London. And I'm an MD PhD and I treat people with cancer, so my background in entering this is really fundamentally giving-- I'm involved very much in transplants, bone marrow transplants. As you may know, we use extraordinarily high doses of radiation to prepare people for transplants. That very much simulates the situation that could occur, or did occur, at Chernobyl and other radiation accidents.

So my colleagues and I are the people who actually have hands-on experience treating high-dose radiation victims. You know, as I'm sure as many of you know, I've spoken to many of you previously, that I was involved, or am involved still, in the Chernobyl accident and treating the victims of that. Large radiation accidents in Brazil, in previous accidents in Japan, and I've spent, I guess, about half of the last year in Japan dealing with the Japanese government, dealing with the workers, dealing with the public on issues of radiation safety and contamination of the food supply, things of that nature. So I'm delighted to be here and I'm very happy to save most of my time to handle questions that you might have.

**HOWARD DICKSON:** John?

**JOHN BOICE:** My name's John Boice. I'm professor of medicine at Vanderbilt University and also the president-elect of the National Council on Radiation Protection and Measurements. And I'm a radiation epidemiologist. My entire career, I've studied populations all over the world exposed to ionizing radiation, including Chernobyl cleanup workers, medical populations, workers, underground miners.

I'm one of the delegates to the United Nations Scientific Committee on the Effects of Atomic Radiation and we're reviewing the Fukushima situation now. I'm also on the main commission of the International Commission on Radiological Protection, where we have a task force where we're also trying to evaluate the lessons learned from the Fukushima circumstances. I'm also on the Veterans Advisory Board for Dose Reconstruction, which also is involved in providing some oversights, some thoughts, on our U.S. military that were around Fukushima and helped with the recovery.

In March of last year, the week before the tsunami hit and the earthquake, I was in Hiroshima on the Science Council for the Radiation Effects Research Foundation, and this is where the joint governments, the United States and Japan, we continue to study the atomic bomb survivors from Hiroshima and Nagasaki. It's been ongoing for over 60 years.

A week later, I had left Tokyo and then the horrific natural disaster occurred. I then went back to Fukushima in September as part of an expert panel in Fukushima city, where scientists from all over the world were providing advice to the Japanese authorities and the Japanese government with regard to circumstances of what could be done in this aftermath, and my focus at that time was on health effects.

**HOWARD DICKSON:** Bob?

**BOB EMERY:** Good morning, my name is Bob Emery. I'm from the University of Texas Health Science Center at Houston and my doctorate is in public health and I'm board certified in

health physics as well. My area of interest is not only disaster response, preparedness and response, but also how the public can understand some of this highly technical information. How do you communicate some of this information to the public in a way that they can both understand it and make reasonable decisions based around that? So that's my area of interest. Appreciate the opportunity to be here.

**HOWARD DICKSON:** Very nice. Kathy?

**KATHRYN HIGLEY:** My name's Kathryn Higley, and I'm a professor and head of the Department of Nuclear Engineering and Radiation Health Physics at Oregon State University. And I've been in the radiation and nuclear field for 30-plus years, having received a license to run a reactor when I was still in my late teens at Reed College. And at Oregon State, we do research on next-generation reactors, fuel cycle. And my area of research is environmental transport of radionuclides and effect on the environment. And in fact, I'm a member of ICRP's Committee Five, Protection of the Environment, where we look at developing tools to assess radiation risks to nonhuman biota.

And I've been actively involved in cleanup efforts at sites such as Rocky Flats plant and also helping the Defense Threat Reduction Agency determine appropriate disposition for one of its former weapons sites, Johnston Atoll out in the Pacific.

**RICHARD VETTER:** Good morning, my name is Richard Vetter. I have a PhD in health physics and am board certified by the American Board of Health Physics and American Board of Medical Physics. I spent most of my career at Mayo Clinic as the radiation safety officer and professor of biophysics. Retired nearly two years ago and currently I'm acting as the government liaison for the Health Physics Society. Also a past member-- I'm emeritus member on the National Council on Radiation Protection and Measurements and currently a member of the National Academies Nuclear and Radiation Studies Board.

**HOWARD DICKSON:** Thank you. I think you all recognize that we have assembled an excellent panel for you, representing a broad spectrum of expertise and experience in the area of radiation safety. So we want you to take advantage of the fact that we have such an expert panel.

What I'd like to do is just cue it up a bit and then I'm going to turn it over to a few of my colleagues to make some brief statements prior to opening the floor for questions from you. It's really important that we take advantage of opportunities when we have accidents. It's very unfortunate when we have incidents or accidents. But in every case, there's information that can be gleaned from that and learned from that. We need to take this opportunity to learn everything we possibly can from the Fukushima event and be able to translate that into a language that makes sense for people, that makes sense for decision makers, and scientifically inform those kinds of decision makers.

We're not in politics and we're not going to be able to control a lot of decisions that are made, but we may be able to influence those by providing the proper science background for individuals.

And that's what we're about, informing people with the facts, the scientific background. Public policy needs to reflect scientific facts and findings and it's very important that we do that. And we are in the process of reviewing everything that we possibly can with regard to Fukushima. Some of our panelists have been there and will be able to convey that information to you in a very personal and real fashion because they've had boots on the ground. And I think that's very important.

In many cases, as you might imagine in this business, there are real risks and then there are perceived risks. And we try to sort these things out. There is an inherent fear of radiation on the part of a great many people and there's some basis for that, as we know. A lot of radiation can be very dangerous. The question is, Is a little bit of radiation so dangerous?—or how do we put that into perspective? How do we make important decisions with regard to evacuation? There are real

risks associated with evacuation, and there may be perceived risks associated with the evacuation as well.

Those are the kinds of things that we are prepared to deal with. So we have convened this panel with the kind of expertise that they've just described. We have medical expertise, environmental expertise, epidemiological expertise, communication expertise on this panel. And you can take advantage of that through your questions.

As I mentioned to you, we have folks that have been on the ground and Dr. Gale is one of those. So I'm going to ask him to discuss things from that perspective to introduce the topic to you.

**ROBERT GALE:** Thank you. So good morning again, and as I said, I'd like to be brief and spend most of my allotted time for questions. But I usually get pulled into these accidents almost instantaneously because the problems that I am most knowledgeable about are acute radiation accident victims. And so I was very quickly in Japan and, fortunately, there were no radiation accident victims requiring the kind of big-league things that we do at Chernobyl or in Tokaimura, but I did spend a substantial part of the first month in the prime minister's office dealing with the issues that we've just heard about, about populations at risk, evacuations, the relationship between the benefits and risks of evacuation. I mean, why we don't just evacuate everybody from huge areas. What are the real costs of evacuating people—discontinuations from medical care and things like that that cause deaths versus what might happen in the future with [00:16:32] of uncertainty.

So I just put a few PowerPoint slides together, I think just six of them, that would-- so I think there you see the death toll so far. We have 20,000 deaths from the tsunami and earthquake, we have zero from Fukushima. But the fact that everyone is here today shows that what is the public's focus is really on Fukushima. We heard very few things about the earthquake, the tsunami. Why is that? Why are we so heavily focused?

So, in order to-- since we don't have acute injuries, our focus really, and there are other experts who will address this, especially John Boice on my right, but can we use Chernobyl as a benchmark for predicting what might happen after Fukushima? I think that's what people are interested in, the Japanese public, but all of us.

So, I mean, one of the variables we have to consider is how much radiation is released in one of these accidents. You can look at some numbers there. This is a work in progress and I think the only thing you should look at from this slide for the two radionuclides that are of greatest public health concern, iodine-131 and cesium, is that Fukushima is about 10 times less. And without getting lost in how many petabecquerels were released. But, we've got to translate that information to its effect on human beings. These are just numbers, becquerel.

So the next PowerPoint shows you data that you may or may not have seen. I suspect most of you haven't seen it. These are data from the first 10,000 people in the Fukushima area that are thought to have received the highest doses. These are, again, incomplete data. They're external doses, they're not-- but these are 10,000 people. You can see that almost 6,000 got less than a millisievert—we'll come back to what that means in a second—and another 4,000 got between 1 and 10 millisieverts. You know, bearing in mind that the doses that all of us get from radiation, either from natural sources or manmade sources--

**AUDIENCE:** (George Lobsenz, *Energy Daily*) Does that exclude workers or does that include workers?

**ROBERT GALE:** This is not the workers. We can talk about the workers. These are 10,000 inhabitants who were thought to have received the highest doses. And then you can see there are only 71 of those 10,000 that got doses of less than 20 millisieverts, and then two people who got around 20 millisieverts.

So what does this mean? So I say we have to really translate these doses to the population effects. Again, this is a work in progress so I really suggest you just look at the ratio of these numbers. Look at person sieverts, then you can see there's roughly a quarter of a million person sieverts. Talking about Fukushima, we're down in the thousands, we're talking about 100 folks less, or even less than that.

So the next slide, you know, Casey Stengel, who Mr. Wold will remember, some of you may be too old or not from New York, but Casey Stengel said it's dangerous to make predictions, especially about the future. [laughter] I published a paper in the *Bulletin of Atomic Scientists* about two weeks before the Fukushima accidents with my Russian colleagues from the Institute of Biophysics saying that we no longer are really worried about reactor accidents; we're worried about improvised nuclear devices. So I feel bad about that. And you may want to take any comments I make in the context of my ability to predict things. But I'm not as bad as Marshal Foch, who said that airplanes are interesting toys but of no military value. [laughter]

With that caveat, just some estimates, and John Boice will talk about these, I'm sure, in greater detail. But if you take all the data that I presented and the fact that for a 50-year-old male living in Japan, his chance of getting cancer in the rest of his lifetime absent the Fukushima accident, it's almost 50 percent. So, what kind of an increase in both cancer incidents and cancer deaths would we expect from these kind of doses if they prove to be correct? You can see that these are incredibly small doses if they're proved to be correct. You can see that these are incredibly small increases that would never be detectable, especially in light of a very steeply increasing incidence in cancer deaths in Japan over the last 60 years. And I think John will address whether epidemiological studies are even appropriate.

And then the final point that I just want to touch on is where we can, I think, do a lot better, and that is in the sphere of expressing risk to the population. And you'll hear about that shortly. But the truth is that telling people their dose in millisieverts or telling them the concentration of cesium in becquerels per liter of water is not helpful because people really want to know what

they think is a simple question, which is, What is my risk? They're not interested in millisieverts or becquerels. They wonder, What's the risk?

Now, that question, what is my risk, is not simple because what is my risk compared to what? Am I three years old or am I 80 years old? Am I a smoker or am I not a smoker? And those doses which do not take into consideration these incredibly important variables, they don't help the person.

So my colleague, Owen Hoffman in Oakridge, and I've written several pieces on this, but he's really the expert. He's not here today, so I'm just speaking on his behalf. And we found that a much better way to get this information to people is to have thermometers, risk thermometers like this where the top of the thermometer is something that's 100 percent certain and the bottom of the thermometer is something that's quite rare, like one in a million.

And then you can plug into that thermometer various things like cancer risk, for example. I said that for a Japanese or American male at the age of 50, about one in two, 50 percent, is your lifetime cancer risk. Which is somewhat discouraging, I think. Several people have said to me on hearing that, "If I have to get cancer, I hope I get a good one. I hope I get prostate cancer and not lung cancer." But you can make that worse by being a smoker, as you can see from that thermometer. But there's some other things. What do we consider negligible, where does the CT probably fit in?

And then the final slide, we'll just show you where on that thermometer does something like Fukushima lie. Now, you'll hear a lot of detailed scientific discussions of our uncertainties, that we shouldn't really be talking about point estimates, we should be talking about ranges. But I think what people want to know, what the public wants to know, what I have to deal with and when I'm in Tokyo and people ask me, or the workers ask me, "What is my risk from getting millisieverts?" they want to know, really-- I'm sorry [00:24:45], "Where am I on that thermometer?" They don't care if it's two in ten thousand or four in ten thousand, which is a

huge scientific difference. But just where am I on that thermometer? And I think these kinds of expressions give a better sense to the public and it's certainly an area where we can improve.

And I guess the final slide, I'm sorry, it wasn't the final slide, is just looking at comparable risks of death is another way of trying to express these things to the public. So, getting one millisievert of radiation, which is just on the bottom, is equivalent to smoking just 14 cigarettes, period. Not 14 cigarettes a day, but smoking 14 cigarettes. And you can see some other amusing things, like eating 25 cups of peanut butter. Peanut butter has a risk of containing aflatoxin, which can cause your death or can cause liver cancer. Driving 600 kilometers. So that really helps people quite a bit in understanding where they should place the risk of Fukushima. So I'll stop there and return it to you.

**HOWARD DICKSON:** Thank you very much. John, I think he's kind of cued you up, a natural expression, cancer epidemiology and risk, okay?

**JOHN BOICE:** Right. No, that was an excellent overview, and, of course, you should take away with it that the exposures to the populations are very, very low. And as such, there's no opportunity to conduct epidemiologic studies that have any chance of detecting excess risk. The doses are just too low. Nonetheless, the Japanese authorities are conducting large-scale health surveys of their population, over two million of the people in the Fukushima prefecture are being studied right now for the-- in parts of their health surveys. The Japanese authorities are saying that they're doing this to reduce anxiety and to provide assurance to the population as well as to provide medical care.

Also, what I'll mention in some of the slides is that there's a tremendous amount of activity on the international scene and nationally with regard to what can we learn from this circumstance. And as mentioned, this is an opportunity to learn more about radiation accidents, to learn perhaps more, initiate more types of radiation studies that will be useful for our society. And a number of opportunities that will come from this terrible event.

So, what I'm going to do is I'm just going to talk about health surveys and then just touch on what the international and national scenes are. And as Robert mentioned, the population exposures were exceptionally low. Even though there were releases, the winds blew primarily to the Pacific Ocean. So even those releases, the winds did not go to the Japanese except in a few instances where they had the hydrogen bubble explosions, and then the radiation did go to the northwest and there was deposition of levels that were of concern. So there's no question. But it wasn't as massive as Chernobyl, even in terms of the deposition of the radiation.

The reactors were different. You know, at Chernobyl there was no containment vessel. So for 10 days, the reactor burned and had to be quelled. At Fukushima, there was a containment, and even though there were releases, they have been explained to be more like puffs of radiation, large puffs, but going out into the environment, but not massive releases like Chernobyl.

Still, to go back on the previous slide, the Japanese also acted quickly in contrast to what the Soviets had done. The Japanese evacuated their people on the same day, March 11<sup>th</sup>, and then March 12<sup>th</sup> continued to evacuate their people to get away from the possibility of any radiation exposures. And this was extremely important, you know. There was a renaissance physician, Paracelsus, he said, "The poison is in the dose." Which means it's not the exposure that you get-- I mean, it's not that you got exposed, it's how much radiation you got. And so the Japanese population, as Robert mentioned, they got very little exposure.

And one of the things right afterwards, there was a concern about the kids and so they did examinations of the thyroids of the children, over 1,000 children, the Fukushima children, and they found essentially no detectable levels, no levels above where they'd be concerned. There were a few, and the highest was 50 millisieverts. The highest was 50 millisieverts. Okay, in contrast around Chernobyl in Belarus, the average was 1,000 millisieverts, epidemics of thyroid cancer occurred. Completely different magnitudes, as Robert had explained.

There were restrictions on the food. You know, when the Soviets, they could have stopped the thyroid epidemic by saying one thing. Don't drink the milk. The milk was contaminated. The Japanese acted very quickly in trying to measure the radioactivity levels in the foods and restrict the food supply. So that also reduced the population exposure. They evacuated up to 200,000 at the time. They made measurements of the radioactivity on these people. And so it was a very appropriate response. What the Japanese authorities failed to do was communicate effectively, and that still remains a problem, being transparent, on explaining what was being done in terms of radiation exposure.

Here's the workers. Now, the workers—there's been now 17,000 workers—have been involved in the reactor containment and the reactor cleanup. This includes the TEPCO workers as well as the contracting workers. Their average dose is 9 millisieverts. You know we get from natural sources, we get 3 millisieverts per year. This is their average. However, there are those workers that did get over 100 millisieverts. And you know, for a benchmark in terms of epidemiology, I always use 100 to 150 because below those levels, it's not possible for epidemiology to detect increased risks. So when you get to 100, 150 millisieverts, below that you really don't know and you have to use the models.

So here, on those that got whole-body external radiation, there were only 37 workers that got over 100 millisieverts. Now in terms when you add the internal dose—and this is when they breathed in the radioactive iodines and may have ingested some of the cesiums—that dose increases the level somewhat and there might be up to 100 people who got over 100 millisieverts, combining external and internal.

In terms of health effects, though, they'll be minimal because most of the internal, the ingested, radiation was radioactive iodine and it was radioactive iodine to the adult thyroid glands. If you and I get exposures to our thyroids, we're at minimal risk because the adult gland is relatively insensitive to the cancer-producing effects of radiation, in particular iodine-131. We have lots of

studies of adults exposed to iodine-131 where there's no effect. Children, though, have a very high effect.

So in terms, and Robert had mentioned it too, what's the lifetime risk even above the small number that got over 100 millisieverts? About one or two percent. In terms of a general population, 42 percent of men and women will develop cancer in their lifetime in the United States and Japan. And one in two men. So the guys, that's unfortunate, but half of us will, or already have developed cancer. In women, it's a little bit lower. But even getting the amount of radiation in the smaller number, that's increased their risk by about one percent in that small group.

Certainly, and these populations are going to be studied and they'll be studied for their lifetime, but they're not being studied-- and they'll be given medical examinations. The high-dose people will be looked at for cataracts, for the possibility of radiation exposure to the cataracts. But there's no anticipation that the levels were high enough to cause radiation effects.

In contrast, for Chernobyl, the Soviet Union sent in over 500,000 cleanup workers. Their average dose was 100 millisieverts. Some of the early guys did develop cataracts. These are the recovery workers, the ones that came in. Not the first responders, the first responders, as Robert mentioned, they received massive amounts of radiation, 28 of them died within just several months because the burns that they received on their skins were horrific, knocked out their bone marrow and couldn't produce blood cells or GI tract. So Chernobyl, Fukushima, completely different circumstances.

Oh, and this is just the United States. We were very humanitarian. We sent in 61,000 U.S. military to help with the recovery, to help clean up the harbors, to try to save people. And so our government has then-- we put monitors on all the military guys, there's 61,000. It's called Operation Tomodachi, and we did internal measurements of the workers, 8,000 in this slide. And the doses for our military were exceptionally low. But in the similar circumstances like what

we've done for our atomic veterans, we're going to be monitoring and following these military for their careers.

**AUDIENCE:** (Matt Wald, *New York Times*) I'm sorry, can you define the terms of the last slide?

**JOHN BOICE:** Sure, I'm sorry.

**AUDIENCE:** (Matt Wald, *New York Times*) MDA is what?

**JOHN BOICE:** Minimum detectable activity. That means of the 7,000 that got whole-body scans, you know, you stand in this machine and they measure the radioactivity coming out of your body, there were only 183 that could even have a detectable amount of radiation within their bodies. That means that 7,500, the measurements were zero, it was nothing, of our military.

Also, interesting, we have a background amount of radiation. If you and I went into one of these machines right now, we'd be giving off 7,000 becquerels. That's 7,000 DKs per second, just to give you an idea. And so if you want to reduce your radiation exposure, move away from your colleague because you're exposing each other like that. But that's because we have natural-- potassium-40 is-- we ingest radioactivity and bananas are one of the richest sources of radioactive potassium. We have carbon-14 in our bodies and we eat little amounts of uranium and thorium in our cereal. So our bodies are, in fact, radioactive in this low level.

So the population exposures are incredibly low. If you were going to do a study and write up a proposal to the National Institutes of Health, it would not pass peer review because there would be no statistical power by any means that it could provide useful scientific information. Nonetheless, the Japanese feel that it's a moral obligation to study their population. They've initiated studies. They feel that it's important to provide medical care for the population, and the

thought is mental health problems will be the most serious outcome, is the most serious outcome, from these events.

So here's the basic study. This is what is ongoing right now. The Japanese government and the Fukushima prefecture have initiated a health study of everyone who lived in the prefecture, two million residents. They've sent them a 10-page questionnaire to try to get information about location, where they were, their dietary habits. It's a 30-year follow-up study; they've spent this year already 96 billion yen. I'm not sure on conversion, but I think that's a billion U.S. dollars, something like that, has already been spent. It's a huge expenditure that's going for these health surveys that's going on. And the purpose that they say, not to identify new understanding of low-dose radiation effects, but to eliminate or alleviate the anxiety.

One of the things you think, if you go through a machine and you're measured and your radiation activity is normal and low, supposedly the thought would be, "Well, that would be a little bit reassuring that you know that you were there but you don't have radioactive excess."

Oh, this is when we were there, one of the things the expert panel, we wanted to contribute to the population and we are, in this slide, saying please participate in the survey. So we were making a plea. The Japanese government, as many of us perhaps, are not that familiar with health surveys. So we were asking and working with the Japanese press to say please don't throw the questionnaire away. Please come in and help out. This will be good for you and good for the prefecture.

So here are the four studies. There's the basic general study studying the two million. The four specific studies that are ongoing right now. There's 360,000 kids under the age of 18 that are having their thyroid gland scanned, looking for thyroid abnormalities. And this will be done and followed up over the years. A health exam is going to be given to those people in the proximal area within the 20,000 kilometer evacuation zone. Blood samples will be taken, they'll be physically examined, and enhanced information obtained on questionnaires.

Mental health and counseling has already started, again, thinking that would be the concern. You know, they've lost their loved ones, 20,000 people have died in the tsunami. They've had to be evacuated from their homes. Some will not be able to return to their homes; some levels are just too high. And then there's the possibility of the stigma of being from Fukushima as well as not having occupational opportunities. Pregnant women and nursing mothers are also being studied. There are about 20,000 of those that have special surveys.

Oh, this was the last press conference I was in. Okay, this was in Fukushima City. There were over 100 and I thought I was going to get epilepsy because the flash of the cameras was going off. There was like three or four or five per second; it was really remarkable. But what it did, it showed the tremendous interest that the Japanese had in learning about what the possible effects might have been from this experience. Then I was able to go to the reactor itself and visit the damaged facilities, dressing up in hazmat suits and bringing radiation monitors with us.

And now, I'm just going to finish with the three slides just mentioning that there are international and national efforts. The International Commission on Radiological Protection has a task force—and this report should be out in about a year—where half of the members are Japanese, the other half international scientists, where we're trying to address what the lessons learned are and what were the interesting and important findings. What was really interesting, it was two, in terms of when we started the meetings, we asked the Japanese what their concerns were as opposed to telling them, "What I think your concerns would be." It was very interesting. And they were different from our preconceived notions. They had issues with regard to internal radiation, issues with regard to how to communicate to not only your public, but to your medical doctors, things that were very important to them, which we were then trying to address.

These were just a number of them. There's misuse of units and what are the units, what about these internal doses? What about the rescuers, the guys who come, what radiation protection should we have for them, the guys who come in to save lives?

And then protection of children was an important issue. Monitoring policies, and then this term is what is a safe radiation dose, people want-- you know, if you assume for protection that no exposure is safe, then how can you have a safe radiation dose? And so these issues there and then issues about when can you return to a contaminated area.

The United Nations also has an international-- a group that just met last month with the Japanese and international scientists addressing Fukushima and the assessment.

What we do at the United Nations, though, we do a lot of dose assessment and what are the doses and what are the data. And so there's data compilation. Radionuclides, what were they? You know, there were a number of them that were released. You know, there were iodines and cesium-134, but then there were cesium-137, 134; there was a little bit of plutonium, perhaps. And what's a proper assessment there? Then what's the dose and then what's the risk associated with that? And then what are the worker doses and the concerns? So this is all going on right now. And perhaps in a year's time, this information will be consolidated.

And here's finally our National Council on Radiation Protection and Measurements. If you are really interested in this, in just less than two weeks, we're having our annual meeting right here in Bethesda and we're going to have eight sessions on Fukushima. And they're going to be addressing the implications of the accidents for radiation protection. And there are several stellar lecturers—one is Fred Mettler whom many of you have probably spoken with because he's our U.S. delegate to [00:42:12] and one of the top radiation scientists and physicians in the world. He'll be talking about the effects on children and radiation exposure.

And then we have Dr. Sakai, who's going to talk about reference levels—he's from Japan—and about allowing people to come back to the contaminated areas. So that's just in a couple of weeks.

And then if you come back next year, so next year we're going to have another session. And in fact, the preliminary results from the health surveys, although they're only two years, they will be presented by Dr. Yamashita providing, you know, "Well, this is what we've actually done. These are the numbers we've scanned, these are the doses that we've received. This is the number of thyroid abnormalities we detected." So that's going to be coming.

And then lastly, we have a scientific committee that's headed by S.Y. Chen from Argonne National Laboratory, and this is dealing with issues about what happens after an event. In the United States, what happens in the United States? What if we have a nuclear reactor accident? But what if we have a dirty bomb? What if we have one of these improvised nuclear devices go off? It's not beyond the realm of possibility. And then what happens? What's guidance? When do we allow people to come in? What are the levels? These are just really important, practical issues. What about medical care? And so this committee is ongoing and will be addressing-- and we're emphasizing lessons learned from Fukushima with regard to contaminated radiation level areas. Thank you very much.

**HOWARD DICKSON:** Thank you, Dr. Boice. I'm always fascinated by the new information that you provide us continually. So thanks very much for that. One final brief presentation, Dr. Higley?

**KATHRYN HIGLEY:** Thank you very much. So one of the things I struggle with, and you've seen my colleagues struggle with as scientists, we have this really detailed understanding and trying to communicate the issue of risks and the like to people that aren't immersed in our discipline, is really a challenge. And we oftentimes, we trip up in doing it. And it's going to happen and I apologize in advance.

But one of the things I wanted to point out is that we've been dealing with radiation and radioactive materials for over 100 years. And you listen to Dr. Gale, you listen to Dr. Boice, and they have said that the expectation of impact is really very, very minor to the individuals. Now,

we're not minimizing the psychological impact, the fact that people have been moved out of their homes, and just the destructive nature of the earthquake and the tsunami and the like that's devastated that area.

But from a radiological perspective, the impact is going to be really-- we expect it to be really, really minor. And the reason for that is that we understand really pretty well how radionuclides move through the environment, how they disperse, and how people can be exposed. And because we understand that, we're able to make decisions to block that exposure. And so in Fukushima, they recognized as this plume was coming out of the reactors that one of the best things to do is something we call shelter in place. You let the plume go by.

We've known for 50 years about this iodine pathway where iodine can come out of a reactor. It moves through the environment and it can go from a cloud to grass to cows to milk to children. And so, we took those lessons and we said, "Don't drink the milk. Stay indoors while the plume passes. We'll take a look; we'll evacuate you as necessary." And because of those actions, because of knowledge that we had, we were able to very effectively-- not we, the Japanese government-- was able to effectively block a large component of exposure in this population, something that they weren't able to do in Chernobyl. So that's one of the advantages of understanding how this material moves through the environment.

Now, it's been a challenge for me looking at the impacts or the perceived impacts as this plume had moved towards the west coast and dealing with the public along the western seaboard who were absolutely terrified about the potential effects from Fukushima and trying to convey to people that the 4,500 miles of open ocean were going to be a very effective barrier to dilute and disperse and drop the exposure to a point where okay, maybe we can measure it. But simply because we could measure it, it doesn't pose any significant risk at all to the general public.

So it comes back to being able to convey what I know, what I've known in almost 40 years, which is kind of scary, researching in this field. That I as a scientist, as a radiation protection

specialist, as a parent, I was not concerned for my family at all from any of this material moving across the ocean to the United States. And I struggle, I still struggle, with how do I convey that so I don't seem condescending, so that I don't seem smug? But we really do understand how these materials move. And while we're looking at the lessons learned from Fukushima, and that is going to be folded back into radiation protection decisions here in the United States. They're going to look at do we need to change how we address exposures? Are the EPZ zones that we've set up, are those appropriate? Should we tweak those a little bit?

We continue to look at lessons learned. But right now, we've done a pretty effective job in blocking exposures, as I said, in Japan and I don't have any personal concerns from how we're managing these risks in the United States today. Is that brief enough for you?

**HOWARD DICKSON:** That was very nice, thank you Dr. Higley. Now, I'm going to open it to questions for the panel here. But let's not forget that we have two additional panelists that haven't had an opportunity to speak to you. Dr. Vetter has a pedigree on the medical side. I know with Fukushima, we focused an awful lot on reactors and reactor accidents, but he has a great deal of expertise in anything associated with medical applications, and representing that area, I think, is extremely important. Don't forget, when you address questions on the broad scope of radiation risks and hazards, what he can offer.

Dr. Emery I regard as the epitome of the safety professional. He's credentialed in so many areas I can't even keep track of it. But he expands beyond just radiation. So his focus has been very strongly oriented towards all aspects of safety. So he can address some of those other kinds of safety issues that were associated with Fukushima and the communications aspect, I think. So don't forget as we proceed that that expertise is available to you.

Now, you're welcome to address your question to an individual or to the panel. If you address it to the panel, I'll try to make sure it gets to the right individual up here. So, with that, without further ado, here we are.

**AUDIENCE:** My name's Bill Freebairn, with *Nucleonics Week* and Platts. My question is regarding the deposition of cesium, because a lot of the iodine effectively blew out to sea. The cesium seems to be a component of concern. But I'm wondering if you have a thought about what can be done about it now that it's been deposited. There's talk about removing it. How dangerous is it and what are the risks and what are the suggestions you have?

**HOWARD DICKSON:** I'll turn to our environmental health physicist for a response.

**KATHRYN HIGLEY:** So again, lessons learned from Chernobyl about how this material moves in the environment. And there are a variety of things that have been done, that can be done, to deal with the cesium. So simple things, washing a roof, collecting the runoff, washing buildings or streets. And then very simple collecting of surface material is being considered. Also plowing if you're concerned about areas for agriculture. You can take a look at deep plowing. I mean, these seem very simple, but they're very, very effective.

And so there's a lot of different things that you can do that are not particularly high tech. The key is that you want to drop the exposure. You also don't want to generate massive amounts of waste in the process. So it has to be a thoughtful effort. But it's a variety of things that are being done to address it.

**JOHN BOICE:** Can I add to that?

**HOWARD DICKSON:** Yes, please.

**JOHN BOICE:** You know, cesium clearly is the concern on the deposition in the Japanese soil. And the Japanese government has designated three zones with regard to the radiation levels. And cesium is the concern, the 137, because its half-life is 30 years, so that means after 30 years, half of it's still around. So the radiation exposure is of concern, as it was around Chernobyl.

They have three areas. One area is the areas that would give individuals 20 millisieverts or below. And this is sort of the reference level where you would start and try to remediate and reduce the radiation contaminants. But the population would be allowed to go back into these areas with these levels. And they're focusing also on the schools and taking the topsoil away and trying to clean up the roofs and as much as they possibly can. And that's getting it down as low as possible and continuing with the remediation.

The next level of 20 millisieverts to 50 millisieverts—and that's sort of a restricted area right now, and there'll be remediation. But it's a little more difficult and they're trying to get it down to below the 20 millisievert levels.

The unfortunate area, they have areas-- this is like around Chernobyl and Prypiat and some of these areas where it's 50 millisieverts per year and more. Those areas, the population will not be able to return for many, many years. And the possibility for remediation is just incredibly difficult because it's so much and levels are so high.

Some of my colleagues, when we had visited the reactor sites from the former Soviet Union, were involved in the Chernobyl cleanup, they just said, "You know, when you get levels that high, you just can't decontaminate the forest." It's just the levels are too much. You just can't do it. And so it's going to be there for quite some time for these relatively high levels.

But for the other ones, they are having ongoing activities, focusing on the schools and the children and then also, as Kathy mentioned, the problem is what do you do with the radioactive debris afterwards? And just to mention them real quickly, you know when they kept cooling the reactor with the water and they produced over 100 tons of highly radioactive water. And that has to be reprocessed, and that's a real concern about how you do that. You have so much radioactivity in the water and in the debris and then processing that, that's going to be decades and decades.

**JOHN BOICE:** Just for emphasis, those doses were annual doses that you--

**AUDIENCE:** (Bill Freebairn with *Nucleonics Week* and Platts ) Annual doses per year?

**JOHN BOICE:** Just so everybody caught that.

**AUDIENCE:** (Bill Freebairn with *Nucleonics Week* and Platts ) You did mention that.

**JOHN BOICE:** I just wanted to emphasize that. That's right. Oh, and then the other thing I always mention, too, in each year the doses will be lower because there'll be decay. And then there's normal soil turnover. You know, it's just-- Nature tends to do it. Nature takes it-- it does. And so the population exposure-- so you have two things going for you in addition to the remediation. So you have three things going for you; the natural decay, the soil and the natural state of things, and the last will be the efforts where they're focusing on cleaning up the topsoil and the roofs and the local environments.

**HOWARD DICKSON:** Thank you. Gentleman here in the middle?

**AUDIENCE:** Thanks. Richard Harris at National Public Radio with a question for Dr. Gale, a couple of questions if I could. One of which is I know there are a couple of people who got occupational exposures that were high enough to cause redness or so on, that they were hospitalized, or at least examined. I wonder if you had a chance to get involved in those cases?

And the other question is what experience you had with people who-- you know, people have mentioned psychological effects and so on. Could you tell us a little bit about your experience with what those were like in Japan?

**ROBERT GALE:** So there were three workers, I think the ones you're referring to, that entered a reactor complex, one of the reactor complexes, where I think they stepped into some

radioactive water and it sort of went over the top of these working boots. They got skin exposures that were-- required surface decontamination, but they were discharged from-- they were hospitalized at the National Institute of Radiation Radiological Sciences. I've seen them after the fact and they're really fine and there are really no anticipated adverse consequences. You know, a lot of the workers know that I treated all the-- many of the Chernobyl victims. And so they've asked to speak to me. So it's a bit of a dicey situation because they're discouraged. I mean, discouraged would be a euphemism, from speaking to the press, from speaking to anyone. But as I wander around Iwaki [?] or Fukushima City, you know, the workers approach me or sometimes we have a meeting with them. And they want to know, what does it mean to get 50 millisieverts?

Most of the workers, John showed data on I think 18,000 or thereabouts. But, I mean, there will be more, of course, because their doses cut off at 50 millisieverts and therefore people will have to-- but it's not going to be half a million. So most of these workers, maybe more than 90 or 95 percent, are not nuclear workers. They are common workers that were upholstering couches in Osaka and now they get a-- now they're cleaning up a nuclear reactor.

So they get a crash course in radiobiology, you know, 72 hours-- they have 72 hours to learn what Kathy has spent 40 years learning.

**HOWARD DICKSON:** And we're still learning.

**ROBERT GALE:** Every day, they get a little chit, like a cash register receipt, that says, "You got so and so many millisieverts today." So they have a wallet full of these little chits. But, of course, what does that-- they want to know what does it mean. And sometimes they have very simple questions like they confuse external and internal exposures and so they want to know, well, when I go home, back to Osaka, is that safe for my children to-- usually when they're discussing these issues about what it means to get 50 millisieverts with me, they were in an izakaya, a sort of Japanese bar where they're smoking. And, you know, most of these-- these are

males that are living in dormitory conditions. They only work a few hours a day. They're bused to the site, they work three or four hours, they're bused back. They have a lot of spare time.

So there's a substantial amount of drinking and smoking going on. While they're discussing their concerns about radiation with me, they can go through a pack of cigarettes. And I try to put that in perspective and give them some idea of the relative risks to their health from getting 50 millisieverts and getting-- if you smoke a pack of cigarettes a day for a year, you're getting an internal radiation dose of about 30 millisieverts of the same kind of types of radiation that are emitted by cesium.

So it is a problem because it's not entirely clear that we have an informed workforce. It's probably impossible to have a truly informed workforce when you have numbers of people like this brought in acutely.

But so I try to alleviate their concerns. We have the same discussions, and you may have had, with the residents. Not the people who were evacuated, but people who live nearby. They also very much welcome the opportunity to sit down with people like John or myself and say, "Well, yeah, I've read all these things but is it safe for my child to play in the schoolyard?" or things like that. So I think we have to spend a lot of time with them. They have a fundamental mistrust of their own government, of course, and so it helps to have some outside people who don't have any particular affiliation chatting with them.

**AUDIENCE:** Thank you. Matt Wald, *New York Times*, I don't know who on the panel to address this to. In your opinion, is the evacuation zone now in place of the appropriate size? Is it too large or too small? Is there such a feeling about radiation that they are excluding people from places where, yes, they pick up dose, but the dose they pick up isn't as big a threat as being permanently turned out of your home?

**HOWARD DICKSON:** Matt, we all will have an opinion on that subject, but I'm going to ask Dr. Higley to address it first.

**KATHRYN HIGLEY:** So your question is in reference to Fukushima?

**AUDIENCE:** (Matt Wald, *New York Times* ) Yes. It's a year later. Should more people be going home or should they evacuate a wider area?

**KATHRYN HIGLEY:** Well, it's a balancing act. And I think that you balance the issue of radiation risk from exposure to the psychological trauma of being displaced from your residence. And you've heard Dr. Gale, you've heard Dr. Boice talk about the fact that the exposures we've seen to date we're not going to be able-- most likely not be able-- to even measure any increased risk to the population. So it's kind of a roundabout circuitous way to get back to your question—is that I expect they will continue to look at where they're excluding people, that the intent is to bring folks back expeditiously into those areas.

The challenge you're going to have is the perceived risk from the detectable radiation that's there versus people's desire to return to their homes. And I don't know if that's a really great answer for you.

**HOWARD DICKSON:** Just be patient. Dr. Emery hasn't really had an opportunity. I want to give you a chance to speak, sir.

**BOB EMERY:** I find this fascinating.

**HOWARD DICKSON:** I know everybody is wanting to jump in on this question.

**BOB EMERY:** I guess one of the things, I really enjoyed hearing all this information, because some if it's new to me, but I'd like to mention a little bit about the scale that you were

mentioning in communicating to the public. There was a scale that was developed by the IAEA called the International Nuclear Radiological Event Scale, the INES scale, and some of you have reported on whether the relative scale, TMI, Three Mile Island, was considered to be a five and Chernobyl was considered to be a seven. And then over time, this was considered to be a seven as well.

I think what I want to do is underscore that because we take exposures to radiation so seriously, and you can tell this is a very dedicated group here, that we want to focus on the lessons learned. And one of the important lessons learned I take away from this is that the INES scale is very powerful if you're talking about the event and was useful to communicate to the public. But where it falls short is articulating what are the conditions on the ground afterwards. And I think this gets to part of your question, how do we go about communicating to the public effectively in the future? We can't just use that scale because it doesn't speak to conditions on the ground near the event or perhaps in the U.S.

And so one of the lessons learned and one of the areas that I'm working on right now is how might we develop some companion scale that would speak to this exact issue, that this is a zone one and this is a zone two. And I'll tell you, I've been in the wrong place at the right time enough to know because I've been involved in some other events, that whatever scale is developed, needs to coincide and interdigitate with the INES scale. And my example is H1N1 where the WHO had different levels and everybody had their own level here. Well, you're a level 5, I'm a level 4, what's different? So it's really important that another lesson learned is we develop a new scale that will help talk about conditions on the ground, but that it effectively interdigitate with the INES scale.

**HOWARD DICKSON:** Okay. Dr. Gale?

**ROBERT GALE:** Well, being on the ground is-- I just wanted to-- this is a very important issue because it's one thing to talk about levels and so forth. It's another thing to be in the prime

minister's office when these decisions are made. As I said, in my little introduction you talked, we are going to incur a certain number of fatalities by just moving people. Not just people from ICUs, but elderly populations dislocated from their care providers, some elderly person with cardiac disease or diabetes, gets lost in the system and dies. So those-- in any event, you know, it's a very, very delicate balance and you have to accept the possibility to be wrong.

The other thing is, this is a military operation. You can't have soldiers out there with Geiger counters evacuating this home and not that home. You've got to just draw a radii and decide that's it. And that will invariably, because of the reasons that we discussed, of wind, meteorological conditions, those circular zones are going to include areas that should not be evacuated in retrospect. And I would say that applies to 75 percent of the evacuated area. There's a corridor to the northwest that clearly needs evacuation. And, of course, no matter what radius you draw that's reasonable, you will not necessarily catch-- so there are areas outside that John referred to that are beyond the 30 kilometer zone that are heavily contaminated. But the majority of the zone to the southwest and to the direct west are presently habitable.

And that brings me to one final point because I want to use my right time, a critical issue here is infrastructure. So it's not only whether people are willing to go back, many people don't want to go back because they've been relocated already. They've been moved in with their families in Tokyo so they're not interested in going back. There are a number of people who are afraid to go back. Sometimes appropriately, but often inappropriately.

But then there are a large number of people, and I speak to them quite often, who want to go home. They want to go home. But they can't go home because there are no schools, there are no - you need schools. You need hospitals. You need 7/11. And you need to be able to sustain your life. If you are growing crops and no one in Japan is willing to buy your crop because it comes from Fukushima, even though it's monitored; you can't have a viable life. So a government has to make a commitment to the restoration of infrastructure in order to allow rehabilitation. And that is a political hot potato. It depends on the stability of the government. The present government is

not sufficiently politically stable in terms of opposition criticism to, at this moment, invest in a major infrastructural reconstruction. And that is a rate limiting step. So, it's very complicated, I guess, is the bottom line.

**HOWARD DICKSON:** The prerogative of the chair, I'd like to also add to this. Just briefly, I think almost all the nuclear power plants are shut down. And so the Japanese people are doing without something like 20 percent of their power sources. So there are great sacrifices being made with regard to not having available power and scrimping and they're cold or they're hot or they're uncomfortable or the source of power simply isn't available to them. So the consequences of this, whether it be in the exclusion zone or not, it's countrywide that the pain is being felt. Another question?

**AUDIENCE:** Hi, I'm George Lobsenz with the *Energy Daily*. I was listening to some of the messages that you delivered here and I'm particularly thinking about public officials, regulators who might be encountering an accident like this. One of the things you said was the quick decision by the government to evacuate the area was key to keeping the dose low. But the other message you said was for the workers, that sheltering in place was the key thing to keep it low. And in a way, those are kind of contradictory messages. I think if I was a person trying to decide I'd say, "Well, do I tell people to shelter in place or do I get them out of there?"

So this is kind of a messy question, but I guess my question is, The message to the lesson learned here for regulators and officials trying to make this decision is what? Again, maybe it's just a balance but anybody on the panel who wants to address this.

**KATHRYN HIGLEY:** I'd like to address it because I'm probably the one that confused people in the audience. And it goes back to as a scientist, I know in my head what I'm saying and then when it comes out my mouth, it's something completely different. So, you have a choice in emergency response. And what you can do is, as the plume is coming out, you think of a plume of smoke coming and moving, one of the simplest things you do is you have people stay where

they are. Close their windows, stay in their house. That plume goes by, it's emitting radiation. And there's shielding provided by their home. You let the plume pass, and then at that point you say, "Okay, we're looking at what is the residual from the passage of the plume." Because some of the radioactive material is falling out, sticking on things. And you make a decision—should you leave or is it okay to stay?

So in Fukushima, it's a combination of sheltering in place while the active phase of this accident is taking place. And then you look at shortly thereafter—should they stay or should they move? And this played out over a series of days, and I think my colleagues could perhaps add to that statement.

**BOB EMERY:** If I could go to an analogy here would be Hurricane Katrina in 2005 and then, not long after that event, Houston was facing a Hurricane Rita and some of you saw how Houston attempted to evacuate where you had a city of perhaps four to five million people.

**AUDIENCE:** (George Lobsenz with *Energy Daily*) It didn't work.

**BOB EMERY:** Yeah, it just doesn't work. So, I'd like to underscore, I think probably the most prudent public health advice will be in these sorts of events in the future will be shelter in place until the source term is addressed and then characterize the area and make decisions afterwards. And that's a very effective intervention.

**HOWARD DICKSON:** You know, we talked about other kinds of incidents, a terrorist event, say, here in Washington, DC. You know how smoothly traffic flows in and out of the city—are we going to effectively evacuate Washington, DC, in the daytime? Probably not.

**ROBERT GALE:** A fascinating point is you'll hear in these discussions of can we get everybody out of Long Island quickly. But the worst possible thing that can happen, of course, is to have a bunch of people out in the open when you are not certain of the meteorological

conditions and the release conditions. And that's exactly how Fukushima played out. If you know that people are staying in their house, are going to get an unacceptable dose like in Prypiat next to Chernobyl, then you've got to move them out right away. We sent, I don't know, several hundred school buses down to get those people out. But for the rest of the people, you want an orderly, reasoned evacuation if necessary when the conditions are optimal and their exposure is reduced. I don't know if you want to—

**JOHN BOICE:** No, that's exactly right. And what they did around Fukushima, they immediately evacuated the people who were in close proximity to the reactor because of the concern of a major, major release. And they started off at two kilometers and they went out to larger and larger areas. And then eventually, they had the 20 kilometer no-entry zone. And then when they learned about going to the northwest and that long corridor that went way out 20, 30, 40, 50 kilometers, then there were areas of focused evacuation because the levels were known to be high. And then they did evacuate them.

But then during, this is really true, in the areas that might be radiation levels high or low, then it was stay in and be contained, don't go outside. So there was sort of-- the proximity to the source and how close you might be to getting increased levels of radioactivity.

You know, there's another thing, too, about the levels and the issue that people have been evacuated. And now the issue is, after a year, is how to get them back. And then these are very, very complex issues. And one is mentioned with the Japanese zone, the majority of the areas are below the 20 millisieverts per year. And that's the international recommendation of a starting point and then the people can come back home. Most of the population will be in that area. And so the people will be coming back if they want to. And, as already mentioned, why wouldn't they want to? They might be concerned about their children; they might be concerned about not having a job. They may not have an infrastructure there. And so there are these issues.

On the other hand, why would they want to come? If you can imagine, you've not been home for a year. You're living with your relatives. Or you're living in a gymnasium and you're cramped and your children want to go to school and you're off in some other area. And so you actually want to come back to your home, but you're concerned about all these other levels. So there's this dialogue that's going on.

If I can just mention a personal experience I had in September, I did visit the reactor accidents. And on the way there, we drove in our hazmat suits and everything through villages and towns. And it was a real spooky experience. We're driving through the towns and you look and there's the grocery store and there's the hardware store and there's lawnmowers outside. There are no cars in the parking lot. There are weeds growing up. You go by these wonderful looking homes, beautiful. Nobody is there. There are no animals, there are no cars. It looks like those old movies, "On the Beach"—or some of my other colleagues said it looked like the rapture and everyone was taken up and this is what was left.

One of the unfortunate things, or the spooky things, is many people will not be able to come back to these areas. I was allowed to take a radiation meter with me, you know, just a simple Geiger counter, and it had three scales. And so I'm there and we're getting closer and closer to the reactor and the meter goes up, it goes off scale. So I do it to the next scale. Meter goes off. So then I go to the final scale, you know, the rate meter, and it goes off scale just when we get there. And you could tell that some of these levels, some of the areas, will be so high that the people will not be able to return for several years. And some of them will be so high that decontamination will be very, very difficult, if not impossible and they'll have to be coridored (sic) off completely and people will not be able to return to those areas.

**HOWARD DICKSON:** We have about 15 minutes remaining, so those of you with burning questions, this is really an opportunity for you to get them addressed. Another question? Here you go.

**AUDIENCE:** (George Lobsenz with *Energy Daily*) In all the accidents, some of the issue has been the monitoring data that you have, and particularly the real-time monitoring data. And again, getting back to the sheltering in place, are there any lessons learned in terms of the monitoring devices? I seem to remember the operator driving around in cars on the plant site. Didn't seem to me like that was a terribly good way to go. And if there's any thought about, again, whether regulators ought to increase the monitoring requirements for plant operators and, again, whether or not the monitoring data in this accident was good enough for people to know what was being released?

**HOWARD DICKSON:** I'll let the panel decide who's going to address this, but I'll just make a brief comment. The Fukushima incident has been a boon to suppliers of instrumentation in our particular discipline area. Dosimeters and radiation measuring devices of all sorts, so I think everything under the sun has been applied in one fashion or another. Whether it's the most effective, efficient way to do it and collecting the best data, that's moot. So I think I heard you-- you were wanting to talk.

**KATHRYN HIGLEY:** Again, it really goes back to lessons learned, and with Fukushima, where you had the station blackout, loss of power, any automated systems that were collecting air samples, radiation monitoring systems, were suddenly rendered inaccessible, unavailable. And so that information is coming back into the U.S. market and people are taking a very hard look at how our own facilities are positioned to collect information in the event of natural disasters as well as other types of events and saying how do you expect to get your radiological information? How do you expect to do these plume models and collect data? So it is being looked at.

**HOWARD DICKSON:** I'm going to ask Dr. Vetter to talk briefly here. You haven't had an opportunity. I know you're an expert in dosimetry and measurements. So?

**RICHARD VETTER:** Well, the reason I haven't had an opportunity to talk is because there are no problems in the medical field. [laughter] Well, I would just say in response to the question that a very big issue is that we're dealing with-- when it comes to finally computing the dose, and then applying-- trying to turn that into a risk factor, it gets so complicated that it's very difficult to communicate those numbers to the public in a meaningful way.

And occasionally, you'll find situations where members of the public have these meters and they're waving them around and they don't know what it means. And just because, as Dr. Boice said, just because the needle went up all the way to the end of the scale, that doesn't really mean necessarily anything except the background, or your background radiation, is increasing. So you really need to understand what the meter is saying and I must give vendors a lot of credit. They're trying real hard to develop monitoring devices that will interpret for us that are more intelligent that will give us some pretty good answers. So, I hand them a compliment on the efforts that they're making.

**JOHN BOICE:** There's something, too, on the meter, just to mention, even though I spent all this time right next to the reactors, I received more radiation on my transcontinental flights from Tokyo to Washington than I did at the reactor site. So I try to use that in terms of, yeah, the meters went off scale but it's not that it was off scale, and I didn't stay there that long to even get a meaningful dose.

**HOWARD DICKSON:** I was very concerned, Dr. Boice, when you see that meter doing this number, I think I would turn and go the other way.

**ROBERT GALE:** I think so. I was in Akihabara, which is the-- Saturday, the electronics area. And I guess the equivalent of Radio Shack, had a sale of, you know, Geiger counters. You know, various models competing against one another. I don't know if some of you have been to Tokyo, but it is not uncommon for housewives to go to the supermarket and, in Tokyo, and with a

Geiger counter and actually measure the counts per minute of various rice and base their selection on what they perceive to be the radioactivity.

Now, we did some quick calculations. If you take contaminated rice, you know rice that has 500 becquerels per kilogram of cesium, what does that mean? Because it's very hard for the public to understand. This is another example of our problem. Well, you have to eat about half a kilo of rice a day for six months to get a millisievert of radiation. I mean, when you stick rice in water, that half kilo becomes a lot of rice. But you would have to eat that amount of rice to get that kind of a dose of radiation. That's about a third of what we all get naturally.

Obviously, we have a problem when people are making selections based on Geiger counter readings. And it has a lot of implications because, as I said, this is a rice-growing area. People who grow rice there want to return home and grow the rice, are not able to sell it. If you go to the supermarket, again, you'll find that anything from Fukushima is about half the price of all the other products around it, for whatever it is, apples or rice or anything.

**KATHRYN HIGLEY:** You know, it's one of the challenges in our field that we have these radiation detectors that are so very, very sensitive. And Geiger counters, you know we've had Geiger counters for, I don't know, 80 years they've been around and they just say, hey, radiation is here. So his Geiger counter going off scale said there's a lot of radiation around, but it doesn't give you any information about the impact of that radiation. You need slightly different equipment.

We use those detectors to find contamination and then we have to bring in some other pieces of equipment to give us more nuanced information about is it really a risk or not. And that's the challenge. I mean, I could line up foodstuffs, just naturally occurring foodstuffs, and I could bring a Geiger counter and I could get it to go off with certain kinds of food just simply because of the enhanced levels of naturally occurring radioactivity in them.

So that's the challenge. We can see it because of our really good equipment that we've had available to us for a very long time. But it isn't necessarily a risk. And the issue is, How do I say that effectively to people? And I struggle with that all the time.

**AUDIENCE:** (Matt Wald, *New York Times*) What role should Fukushima play in determining whether we relicense nuclear plants in the United States or build new ones?

**HOWARD DICKSON:** You know, there's probably someone on the panel foolish enough to address that question. [laughter] But we are radiation safety professionals and licensing of nuclear power plants is really kind of out of our scope. However, as I said in the front, I'm not censoring anybody's opinion or statements. So if anybody would like to address that, have at it.

**KATHRYN HIGLEY:** I mean, there's a statement, a reactor accident anywhere is a reactor accident everywhere. And I'll be foolish enough.

**HOWARD DICKSON:** That's fine.

**KATHRYN HIGLEY:** Because, you know, I'm in a department of nuclear engineering and we focus on next-generation reactor design, looking at passive safety systems. And this event is being dissected for what are the ramifications for old designs, what can we learn in terms of seismic safety for new designs? And that is part of the discussion that's going on right now, and it should be. You should continue-- it's kind of hokey, the continuous improvement model, but you really do need to look at the knowledge that's coming out of this event and what is relevant to reactors here in the United States.

I mean, as soon as Fukushima happened, the NRC was communicating with all the licensees talking about look at your safety protocols, can you address prolonged power losses, and all of these issues. And that discussion continues. So, it's not going to be swept under the rug. I mean, it's an important part of going forward with nuclear power.

**ROBERT GALE:** You know, when an A380 goes down, we don't stop flying. You know, we analyze the accident and we try to take lessons from it.

**AUDIENCE:** Olga Belogolova from *National Journal*. I'm just in that same vein, I'm wondering, you know, are you concerned at all about-- and I don't know if anybody wants to answer this question-- about the pace at which any of the recommendations that are being given to the NRC are being implemented or not implemented because post-Fukushima recommendations to increase safety and these precautions?

**HOWARD DICKSON:** Bob, you might want to take this.

**BOB EMERY:** I would say that it would be very interesting to compare the recommendations that are coming forth now, particularly looking at station blackout and the like. But also, review those in comparison to recommendations that came out post 9/11. And I think you'll find that many of the recommendations and enhancements that were identified post 9/11 dovetail quite nicely with some of these things that are coming out now. I'm not a nuclear reactor expert, but I can tell you that the notion of being able to have a reactor that can withstand a station blackout for some period of time, to be able to address multiple events, which is essentially what happened here. So those issues are being closely examined post 9/11. And so, although I can't speak to the exact ones, it would be very interesting to do that comparison because I suspect many of the upgrades that are being carried out, or have been carried out post 9/11, will be addressing these issues that are identified now.

**JOHN BOICE:** And we know there were some immediate responses and those were-- the industry itself responded without being told by the regulatory agency they needed to do some things. So there was a lot of initiative on the part of the industry. You spoke the magic word when you said safety and that's why now it triggers something that we ought to address as safety experts.

**HOWARD DICKSON:** Another question? Wow, amazing. You answered all the questions.

**RICHARD VETTER:** One of the things about Fukushima that has been brought to the forefront is the need for education and for you guys to help. And we need education on radiation, understanding radiation risks, radiation communication; we need it in our schools. We need it among our scientists, too, and our doctors, just understanding what radiation is and what the levels might be for health concern. Radiation, you know, is a universal carcinogen. We all know that. Radiation causes cancer. But the poison's in the dose, and radiation actually is a very ineffective carcinogen because it kills cells and killed cells can't go on. That's when Dr. Gale does treatments and things like that, they're killing the cells. So there's this level of reality on what the risks might be.

An example, too, it's also in the medical community there's a need. When there were the evacuated populations around Fukushima, they had to receive their normal medical care by physicians in other areas. When we were having one of our meetings a few months later in Seoul, Korea, a physician from Kyoto came and met with us and she wore a kimono. And then she started talking about treating the people who were evacuated from the areas. And she had tears in her eyes because her colleagues would not treat the evacuees because they were concerned that they were radioactive. And the evacuees wanted to be treated for their diabetes, for their sore throats, for the normal things that you and I have. And it was very, very sad.

And then we enhanced, at least in the international community, about the need for really educating and understanding about the levels of radiation where there are concerns and what the potential health effects might be.

**KATHRYN HIGLEY:** I would like to build on that because in the United States, when Fukushima was unfolding, we had medical professionals saying, "Well, it's probably a good thing to take some potassium iodide." And you're thinking, "No, it's not. It really is not." In Fukushima, that makes a lot of sense because they're in the path. But for us, 4,500 miles away on

the west coast, it is not a good thing. And in fact, you're probably going to cause some effects by taking potassium iodide.

I mean, I had an individual call me who was an organic farmer in California that was so distressed about the potential impact to her livestock from this plume coming from Fukushima, she had her goats in her garage and her chickens in her house because she wanted to protect them from the dangers of radiation. And I'm more concerned about the health effects to her from having her chickens run around in her kitchen doing what chickens do.

So it's an issue, really, of communication and education of not only the public, but some of the other professionals to--

**ROBERT GALE:** It's a real problem because, you know, if you are-- this is a very educated audience. But if you're just-- you go to your doctor for advice, and you know if you think that doctors understand this better than you, forget it. Or better than the public, because we don't have as part of our normal educational plan the things we're discussing. And that is a real-- because each doctor is a multiplier of misinformation, you know. There were something on the order of 100,000 or more abortions performed after the Chernobyl accident and it's known, and John can speak to this in greater detail, that no one who was not at the nuclear power station, which was no pregnant woman, really had a fetus at risk. So if you want to talk about the loss of life, unnecessary loss of life, that is a good example of either people asking for abortions because of ignorance, or doctors recommending it, in many incidences, abortions.

**HOWARD DICKSON:** And let me just build on that and put in a plug for the organization that's sponsoring this—the Health Physics Society has an ask the experts service. If you haven't availed yourself of that service, I encourage you to do that. The website is HPS.org. Go to ask the experts. The dominant questions that we get are related to pregnancy and radiation and women seriously considering aborting because they've had a dental x ray or some trivial amount

of radiation exposure. So it's very, very tragic. Those events do happen. And it's simply a lack of information.

The Health Physics Society is a very modest-sized organization. We have difficulty communicating with the masses. You're an effective multiplier of that and that's one of the reasons that we're here. And we do thank you for your presence here. I truly appreciate it. And hopefully, you're able to reach a lot more people than we can reach in an effective manner and communicate these things that we've been discussing here this morning.

So I see it is the time, Mickey Mouse says that it's time to call a halt to this. But I certainly do appreciate what you're doing. Some of the members on this panel are working on a white paper that should be available sometime soon. We're all writing a chapter associated with that. We hope that that becomes a valuable resource to you. We provided you a lot of information in a package this morning and we encourage you to look at the material in there and to use the resources that the Health Physics Society can make available to you.

So thank you very much, thank you panel, and thank you, audience.

END