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TECHNICAL SESSION - T6

EXACTING THE SCIENCE OF EMERGENCY PREPAREDNESS

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TUESDAY,

MARCH 8, 2022

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The Technical Session met via Video-Teleconference, at 3:00 p.m. EST, Todd Smith, NSIR, presiding.

PRESENT:

TODD SMITH, Senior Level Advisor for Emergency Preparedness, Division of Preparedness and Response, NSIR/NRC

TOMOHIKO MAKINO, Director for International Cooperation, Japan Cabinet Office

GREG LAMARRE, Head, Radiological Protection and Human Aspects of Nuclear Safety, OECD Nuclear Energy Agency

TRISTAN BARR, Section Head of Planning, Outreach, Exercises and Training, Nuclear Emergency Response and Preparation, Health Canada

P R O C E E D I N G S

(3:00 p.m.)

DR. SMITH: Good afternoon, good morning and good evening. I'm Todd Smith, Senior Level Advisor for Emergency Preparedness and Incident Response in the office of Nuclear Security and Incident Response at the NRC.

And welcome to this session on exacting the science of emergency preparedness. In radiological emergency preparedness, preparing for tomorrow is our constant work. It's what we do. And whether we're learning it from the past or looking to the future, emergency preparedness is constantly evolving. And as you'll learn in this session, it's an international effort.

With me today is a distinguished panel of colleagues from around the globe. I'm joined by Dr. Tomohiko Makino, Director for International Cooperation at the Cabinet Office for the government of Japan.

Dr. Makino's contributions include extensive experience in the fields of emergency preparedness, resilient health systems, disaster response, global health diplomacy and biosecurity.

Mr. Greg Lamarre, head of the Division of Radiological Protection and Human Aspects of Nuclear Safety at the Nuclear Energy Agency.

Mr. Lamarre has over 30 years of experience as a systems engineer and providing world-class technical expertise as a leader in military government and international organizations.

Mr. Tristan Barr, head of the Planning, Outreach, Exercises and Training Section within the Radiation Protection Bureau of Health Canada.

Mr. Barr has expertise in radiation detection, characterization, dosimetry, radioactive waste management and emergency response.

Rounding out this panel will be myself. Starting my ninth year here at the NRC. All of which time I've had the pleasure working on emergency preparedness regulation, oversight and research.

And I'll add that this group of panelists holds a combined total of 12 graduate and undergraduate degrees spanning the fields of medicine, chemical and nuclear engineering, biology, health, physics and business. This is a very knowledgeable panel and we will have time for your questions at the end.

So as you listen to today's presentations, please submit your questions.

In this session, we're going to take a closer look at how the science of emergency preparedness has evolved to prepare us for tomorrow. To set the stage for this discussion, we need to start with a look at the challenges that have faced us yesterday and still face us today.

So it's appropriate that we lead off with a discussion on the impact that the Fukushima Daiichi accident has had on emergency preparedness in Japan. I'll now turn it over to Dr. Makino. Tomo.

DR. MAKINO: Thank you, thank you very much for that introduction. And it's my great, great pleasure to be here NRC and have a chance to introduce what Japan has experienced through the Fukushima Daiichi accident.

So they have done a lot to diverse our policies but there are also some things they haven't done well. So this session, we'll introduce some of the issues and the concerns they caused in front of you. So next slide, please.

At the first slide and the last location is a picture. So they, here on the right side, this shows how long this process and how many time the people travel, migrating.

So the village, entire village moves one place to the other and then they, they are actually contaminated. Then they are have to travel out of that place.

So over about 100 kilometers travel that may also make the committee (inaudible). Next slide, please.

This shows the, some of the areas are still restricted and the people cannot come back. And the figure on the left, right, below, shows the people who returned back to their original places.

The blue column are the people who traveled out, inside the prefecture and who came back who are stay away our area for years. But the orange column, those who traveled beyond the prefecture border are less likely to come back. That means their repatriation is another issue. Next one, please.

That describes the stable element distribution. At that time, the government stockpiled but not distribute the stable iodines. Then the decision of the local governments to urgently distribute are . And then they, after some of those areas where the people received the stable iodine urgently and were advised to take.

But the people didn't take because of their concern about the side effect or the concern about the next big emergency may happen. So just take it with them.

But education or good communication (inaudible) of the urgent distribution of the iodines. These are the, some of the problems but the big challenge was a long application of process of the hospitalized people. So next slide please. Next slide, please.

So the picture on that right is a queue of the people, senior citizens, who get on a bus. Then these senior citizens who travel so long way that is shown in the right lower picture.

And I show you because of the missing information or missing communication from the government, the bus travels to north to west and then eventually far south. That is several hundred kilometers travel journey which caused about 40 patients' death within a month. That was a very big tragedy of that long, evacuation, urgent evacuation procedure.

But the quick lesson is that evacuation is risky but please proceed to the next slide, Slide 6.

This picture here also shows that staying is also risky. Sheltering, the shelter in place order was also issued leaving a 30-kilometer radius from Fukushima Daiichi. So there are many hospitals who are advised for shelter in place orders.

But the staff members could not stay because of the disrupted social function. Like school closure or no groceries in the community. So the right figure shows that the number of the healthcare staff members decreased after early fate of the emergency.

Some hospitals retained the staff members but some couldn't get a sufficient number of the staff members. Then as is shown in left figure of Slide 6, the survival of the patient inside the hospital where shelter in place order was issued also decreased. So the staying inside the area of a natural disaster is also risky. That's all on this slide. So please proceed to the next slide. Slide 7, please.

Fukushima after a decade. This is my personal addition from listening to the local people and my observation. So they ask about learnings. One, that the urgent evacuation is very risky and led to the 40 deaths of its evacuees.

But shelter in place is also challenging. That this can disrupt the social function and then the people cannot stay there for long time. Maybe one will be maximum.

The third bullet, the certified disaster-related deaths, that means this is not due to the immediate earthquake or tsunami, but those residents who requested that the area to the accident are pretty much bigger in Fukushima compared to other prefectures where the incidents are much bigger.

That means the long-term effects is severe for such a large-scale evacuation otherwise. The fourth bullet. Community was disrupted because of the prolonged evacuation and then the people went back to the community and who traveled inside that area for work or just migrated. There are very different types of the people were there.

So getting a good consensus to reveal the community has become a big issue over there. And then people are from different positions so even the radiological decay, but mental barrier may stay there to split the community. These are the station in Fukushima. Next slide, please. Slide 8, please.

In terms of the emergency response and management, there are really many lessons. Such as unexpected situation or unplanned stations or staff are not skilled.

In order to overcome these three big challenges, government took actions. Next slide, please. Slide 9, please.

Before Fukushima, user and safety authorities somewhat mixed in the left figure. So after Fukushima, governments, they restructured the authorities between two. And it's safety and community.

And the other on the right is the user or promoter of the nuclear energy. So as to divide these two or three pieces. Next slide, please.

National legal framework for the nuclear emergency was actually built in 1999, pre-event. But it didn't assume such a combined existence but the nuclear existence was triggered by the mass existence.

So that special arrangement for nuclear emergency was revised and then that establishment of the Nuclear Regulatory Authority and also the Nuclear Regulatory Authority requested to build the EPR Guide. Next slide, please. Slide 11, please.

So the nuclear, based upon the new EPR Guide, each local governments are requested to build their device or renewed emergency response plan. So each site has a combined local government responding time which is called as Regional Emergency Responses.

These needs to get approval by the committee led by the prime minister. So far, these little regions have EPR plans are approved. And there are four sites operating right now. Next slide, please.

Let me introduce three examples of the newly introduced protective actions on the sheltering facilities. One is the site number 12 sheltering facilities with radiological protections.

So after the emergency event, some buildings, including the responding office buildings to the emergency didn't work well. Stuff like windows are broken by the earthquake and then the radiological plumes came inside. Then that building couldn't be used for response.

People were up and moved to their special prefecture government 60 kilometers away. So after Fukushima, key buildings such as responding buildings and the safety for patients to be sheltered inside are equipped with these possibilities.

Like airtight and the pressurization and the filtration to make the air clean to be placed inside the buildings. This is a pressurization facility. These facilities are subsidized by the national government. Next slide, please. That's 13.

So the stable iodine blocking methodology. So the confusion is that the people will not be clear about whether to take the iodine or not. And those are in need of pre-distribution.

So after Fukushima, local governments started to pre-distribute the stable iodine to the government out to the local residents. But that process did not just mail or send. But the government needs to hold town hall meetings to provide information to the residents.

What is the right timing to take and what is the effectiveness of the stable iodine? And communication of these outlets. These are the changes after Fukushima.

Now, let me introduce some drill and training programs. Responding staff members of the government are more, just public office are rotating from different ministries and governments.

So the different drills and the training programs are mainly targeted for these responding officers of the operation centers. The various training programs, like lectures, seminars and this special sessions and the drills that test the actual procedures to go on.

The key drill is at the head of the drill box. And that's NEDPD. So let me go over that drill. Next slide, please. Slide 15, please. Thank you.

For the NEDPD, a Nuclear Energy Disaster Prevention Drill is an annual, large-scale drill lead by the national government. The feature of this drill is to invite the prime minister and the political leaders as well as the local residents. About 1,000 people joining.

The scenario is open so it is not that much for testing the decision making but good for checking the procedure to implement the protective actions.

(inaudible) the commitment.

So the next slide, Slide 21, is the medical drill that the healthcare staff members with the PPE and are ready to see the contaminated patients. These are the pictures of our national drill.

So the last section of my presentation is about our lessons and the responses to the COVID-19 pandemic. And now we are on Slide 22.

Thank you, thank you. I'm very sorry for the sessions. After seeing the COVID-19, some of the challenging station. How to balance the two risks. From November of 2020, we issued a kind of guide to the local governments to think about how to balance the two risks. Especially in the station of counting, evacuation counts or in doing transportation.

The question was whether to ventilate or not. So to stay on the principle to ventilate but try to ventilate during the time that the radioactivity is not there. Next slide, please. Slide 23, please.

And as a side, the COVID-19 response was that they told us what we should do during this situation. Especially the good lesson from the COVID-19 was what are the essential number of the people to respond.

(inaudible) but also the questions are that nobody was (inaudible) and it's not easy to say whether that is good between stay or move. Stay and shelter in place or evacuate. So after all, we are all still on a long wait to keep improving our emergency responses. Thank you very much.

DR. SMITH: Thank you, Tomo. You made clear in your presentation that the challenges that you faced are multi-dimensional. And the reality of the situation goes beyond just radiological impacts.

Specifically, the social disruption and stigmatization reminds us there are human and societal dimensions to consider. It also indicates the need to integrate the social sciences into planning and response. And recognizing this, we'll now turn to Greg Lamarre to discuss how might we integrate non-radiological health impacts into the field of radiological protection. Greg?

MR. LAMARRE: Thanks very much, Todd.

And good evening, everyone, from Paris. I'm very happy to be here and thank you very much to the NRC for this opportunity for us to present some of the work of the Nuclear Energy Agency and some of our groups.

As it says, the title of the presentation is NEA progress to-date on those non-Radiological health impacts of protective actions from recognition to mitigation.

Hopefully I can build on some of what you've heard in Tomo's presentation as well. And also complement what I know Tristan is going to talk about.

I've got the pleasure of giving the presentation but I'd like to also call out my colleagues, Jatienne Garnier-Laplace, Jan-Hendrik Kruse. And also a couple very important people within our community. Matthias Zähringer who is the chair of our working party on nuclear emergency matters. And Thierry Schneider, the chair of CRPPH.

The work that I'm going to talk about over the next 15 to 20 minutes is largely based upon the work of two expert groups. The expert group on non-radiological public health aspects, EGNR, and the expert group on recovery management.

So maybe just to make a little bit of a plug here, EGRM has got a launch event later in May, 23rd of May, in order to launch its report.

And then there's also going to be an in-person workshop in October in Paris when we can start to hopefully meet face to face again. So please keep your eyes open for both of those events.

Next slide, please.

So just very quickly on the Nuclear Energy Agency for those of you that aren't familiar. We founded in 1958, 34 member countries plus a number of strategic partners, 8 high-level standing technical committees. You can see them along the right-hand side.

The work that I'm talking about is under, sort of the middle pilar there, CRPPH. And some of the expert groups that report up to that.

A real myriad of working parties, expert groups and the like. 24 international projects. In the organization approximately 110, 120 strong with supports across all of those different committees and working parties. Next slide, please.

So to get into the heart of the

presentation, I think we can all confirm that internationally, much has been learned from the tragic events at Fukushima Daiichi over the last ten plus years.

I think we can also probably all agree that a lot of the work in the early stages of that led to some very significant improvements in the engineering and design of the plants when we look at robustness, the defense against external events and the like.

What we've done now with the support and direction of our member states is really pivoted and turned our attention to some of the other aspects related to emergency preparedness and response.

And I'll talk to you now a little bit about where we're going on some of the psychosocial pieces. I think Tomo mentioned quite well in his presentation that when you look at the impacts of an accident like Fukushima, it goes much beyond the radiological consequences.

And I think we're also all very aware that although radiation induced illnesses, deaths are very, very minimal if not nil, that some of those psychosocial impacts due to evacuation and some of the other decisions that were made had a much more profound impact.

And it's with that in mind that we move forward to our expert groups in work in this area. We've also realized through our collective investigation that not only does work need to be done there but the decision makers are not yet sufficiently equipped to move from what has traditionally been a radiation protection-centric approach, i.e. trying to avert certain dose, perfect protective action levels that are dose centric to one that has a more comprehensive approach to the protection of health and wellbeing in the broader sense.

And it's with that in mind that the NEA has moved forward. Next slide. Slide 4.

So a little bit of background. As I mentioned, non-radiological consequences of nuclear or radiological accidents are complex. And they're multidimensional in nature with human and societal dimensions at its core.

That makes it all the more challenging. They are a combination of direct health consequences and indirect public health consequences of those protective strategies.

We've learned through the work of the expert group on non-radiological consequences and recovery management that management needs to reassess the risks of the protective actions to reflect a more holistic and inclusive approach throughout the entire cycle of an emergency.

Among many lessons, some have been well documented. For instance, there's a need to consider specific actions for vulnerable groups. Elderly, children and parents, pregnant women.

Clearly, one size cannot fit all. And a lot of those demographic specificities need to be considered in the strategy.

We need to proactively consider balancing the risk of immediate evacuation against the possible benefits of sheltering in place with continuous care. And what's required for continuous care also needs to be considered within your strategy.

And I'll talk further about this later on in the presentation. The need to further promote stakeholder engagement in a collaborative, inclusive manner from preparedness to recovery, all the way through in order to achieve the best possible outcomes. Next slide, please.

So how to proceed. Many of you may be aware, perhaps others are not. Last year we published a Fukushima Daiichi Ten Years On report. If you haven't had the opportunity to look at it, I strongly suggest that you do. It's available by a link on our NEA website.

It looked over the last ten years and the compendium of work that's gone on from the nuclear regulatory communities, the committee on safety of nuclear installations, CRPPH came up with nine recommendations on future areas for improvement and how the international community can help.

Some of those have to do with more advanced research. Some of them have to do, obviously, with fuels and physics and some of the science of engineering design.

The ones that I want to talk to you about a little bit here are Recommendation 6 and 7. Recommendation 6 involves stakeholder involvement and risk communication and the need to promote stakeholder involvement approaches to enhance community engagement and society resilience. And I think that has a lot to do with what we're talking about in this session.

Just as an aside, the NEA also, in recognition of the risk communication part of that recommendation, is later on this year launching a first risk communication training course to be hosted on Slovakia in December.

Recommendation 7 looks at the recognition of mental health impacts. Important to note that both these recommendations promote an all-hazards approach aligned with UN Sendai Framework for disaster risk reduction. Next slide, please.

So a little bit more about the problem statement on mental health and psychosocial impacts. Mental health and psychosocial impacts need to be better considered in protection strategies for preparedness, response to and recovery from the events.

The work within the expert groups also drew largely on the World Health Organization framework for mental health and psychosocial support. Radiological and nuclear emergencies have provided some high-level guidance across these areas.

It is realized that more work is required to prepare decision makers to move from, once again, a radiation centric approach to a more holistic approach that looks at the overall health and well-being.

It's also very important to realize that one size does not fit all. As a stakeholder, needs and expectations are very circumstance, population, demographic dependent.

Optimization and decision-making for overall public well-being must integrate the social, cultural and other relevant factors. And I'll talk in the next few slides about how we're going to try to address that. Slide 7, please.

So Action 1, action-oriented solution. Stakeholder dialogue through the emergency cycle. Some of what we're looking to do is exploring possible options to improve decision-maker's responses to stakeholders' needs and concerns by involving stakeholders in the protection strategy.

By starting at the preparatory phase to develop mutual trust that is central to the success, drawing on existing frameworks such as the ICRP co-expertise approach that is highlighted at a high level on the right-hand side. That brings together people, experts, NGO's decision makers to facilitate radiological protection culture dissemination.

And the dialogue will provide people with the knowledge on health risks and radiation exposure. The am I safe, how safe is safe enough and methods to put into perspective potential deleterious effects of protective actions allowing informed protection decisions. The ability of the stakeholders to be involved in that risk benefit consequence decision making process. Next slide, please.

In order to support this, obviously member countries are also looking for us to assist in the development of tools and data to support these dialogues.

Such tools and data are necessary to balance the health risks of radiation exposures against the health risks from protective actions and their subsequent disruption of normal life as Tomo mentioned in his presentation.

Data on mental health and psychosocial consequences of actions such as evacuation, sheltering, relocation, societal disruption can be documented from other disasters and brought into the conversation.

And it's also, we're also promised, we're very heartened to see good progress being made in a number of NEA countries. I know Tristan's going to talk about that being done at Health Canada. We're also aware that our partners at the US NRC have moved very boldly forward in this area as well. Next slide, please.

So ongoing work and next steps. So NEA member counties are committed to bring forth practical, actionable guidance to advance preparedness, response and recovery using this multidimensional approach with human and societal dimensions at the core.

NEA expert groups that I've mentioned previously, continue to work on operationalizing the World Health Organization framework. First, by developing national-level guidance on how to better prepare for recovery with health and wellbeing being supported, being one objective of recovery.

And by preparing the translation of the framework into a series of operational action sheets on mental health and psychosocial support during preparedness, response and recovery.

Those action sheets are under development right now, action sheets on training of first-line respondents, how to distribute educational material to the communities on mental health and psychosocial support. And other supporting material like that. That work continues.

The ultimate goal is to evolve beyond the optimization of radiological protection to the optimization of well-being. Ultimately, testing and validating of these new approaches and tools using national and or international exercises will be key.

And I would also like to highlight that we're well advanced on planning of the INEX-6 exercise. That will happen in 2023, 2024. That we'll hopefully be able to put to action some of this new learning. Next slide, please.

Just a little bit more on ongoing and complimentary work. We're in the midst of planning our third stakeholder involvement workshop entitled, Optimization in Decision-making.

That we'll get to the key of this decision-maker paradigm and how to most effectively involve the stakeholders in the decision-making process.

It's been determined that a series of webinars will be held in 2022 starting in June and going through the fall. And then that the actual workshop itself will be held likely here in Paris the first part of 2023.

The program committee has been convened and is looking at the specific objectives listed at the bottom. Improving the common, practical understanding of what optimization decision making means. Increasing the consideration of inclusive stakeholder involvement to optimize the decision making. And ultimately, developing a foundation for generic multidimensional framework to support optimization for policy and regulatory decision makers.

I think with a successful outcome to this workshop, this could really be important pillar as well for us to build upon as we advance science of emergency preparedness and response.

And next slide, I think, is the last one. Yes, thank you very much for your attention and happy to answer any questions at the end. Over to you, Todd. Thank you.

DR. SMITH: Thank you for sharing that, Greg. I'm really glad to be part of the work the NEA's doing in the area of non-radiological health impacts along with Tristan.

For those of you who have joined us today, I do apologize if you missed anything in the slides. I will remind you that all the presentations will be available on the RIC website for your review after the session.

Greg, getting back to what you discussed, I appreciate that in your presentation you provided not only a concise problem statement but you also proposed action-oriented solutions. You spoke of the need to develop mutual trust and to be ready to dialog with people who want to know what are the risks and want to know am I safe.

You also spoke of the work that is required to prepare decision makers. And you proposed that we develop tools and data to help optimize protective action decision.

Fortunately, we have Tristan Barr with us. And he's been giving that a lot of thought. So he's going to share now with us some ideas, how we can use science to sharpen our tools. Tristan, the floor is yours.

MR. BARR: Thanks Todd for that introduction. In fact, you took the words out of my mouth. I was taking notes and was going to refer back to what Greg said and Tomo. And that will save me some time in this presentation.

So I wanted to start, just with pointing out that, well, it says I'm the section head in planning, outreach, exercises and training. That is within the Nuclear Emergency Response and Preparedness Division at Health Canada's Radiation Protection Bureau.

So we're currently active so in the event that I get a call, I may have to drop but I hope that won't be the case for the next 20 minutes.

If you could, I'm sorry, before we go to the next slide. So I will be presenting on measuring the psychosocial impacts and the title of the presentation is A Case for a Non-radiological Sievert. Which I think speaks to what we've heard so far.

Namely, Tomo explained some of the risks associated with the protective actions that we would normally apply in the radiation or the nuclear event. And we heard from Greg regarding the things to consider. In particular the psychosocial and mental health impacts to be considered.

So if you go to the next slide, I reiterate that as the premise for the work that we are doing. And while this presentation will talk to the case that we made to develop a non-radiological sievert, it will also let you know that we failed to do so.

However, we did manage to develop a decision-making tool or rather a proof of concept for a decision-making tool for decision makers that would allow them, in concept of a protection strategy, to balance the potential impacts of the mental health and psychosocial impacts versus the radiological detriment in the event of an emergency while applying protective actions.

So the premises that Canada is improving and formalizing protection strategies for nuclear emergency response, it's a shared responsibility amongst the provinces that have nuclear power plants as well as the federal government.

We recognize that current nuclear energy response plans are well established and provide clear guidance on radiation dose thresholds for implementing protective actions to minimize those radiation doses.

And we heard much of the same from Tomo earlier on. However, we recognize that protective actions that minimize radiation doses may actually increase the psychosocial impacts to the affected population. In particular, the use of evacuation and or relocation.

In light of COVID-19 lessons, we also, we note that this highlights how protective actions for nuclear emergencies, although -- well, protective actions for nuclear emergencies could cause additional harm in the event of combined emergencies such as COVID.

So Tomo discussed this as well, but in Canada we recommended adjusting the reference levels in the event of a nuclear emergency for the public to a 150 millisieverts or 15 rem rather than a hundred millisieverts over seven days. In order to account for the potential increase from the spread of COVID where we communicate or evacuate people into reception sites.

So as a consequence, we asked the question, can we develop a unit of psychosocial detriment to compare to the unit of radiation detriment.

So effectively, is it possible to develop a non-radiological sievert and develop that balancing mechanism between the risks. Next slide, please.

To do this, we received funding and put together a team for a research project and for the development of a decision tool. And the objective of the research was to attempt to quantify psychosocial detriment and to develop a decision tool for emergency decision makers effectively, to balance radiological and psychosocial detriment.

To do this, we searched, we did a significant lit review and we searched available studies and data sets related to aftereffects of nuclear disasters. And then we looked to develop a common unit and decision-making tool to compare radiological effects to psychosocial health. Next slide, please.

And so we recognize that a current gap, the one that we're trying to fill, one of the ones that's been identified, is that challenge that decisionmakers have in the emergency response to include psychosocial factors in optimizing and justifying protective actions that form the protection strategy. Next slide, please.

So a summary of our research. And you'll see underlined that we identified no significant different. The objective here was we took data from Statistics Canada and used a model to evaluate the changes in outcomes measured by psychosocial impacts between a population that was affected by a disaster and one that was not.

Now, recognizing that there were significant cultural differences between the, well, the Japanese population, medium population. We looked to do that with Canadian data following evacuation events in Canada.

So we used the Canadian Community Health Survey information to evaluate psychosocial impacts that arise from an evacuation and we used the 2013 Alberta flood data that was available to us.

Specifically, we looked at variables such as life satisfaction, the time period, specifically the pre and post flood. We captured population data by postal code which is similar to a zip code in the United States, which captures the individual's proximity to the floods for those affected.

And then we applied control variables. So we used, these we used to control additional factors that we had identified as affecting life satisfaction such as socioeconomic controls, demographic controls and physical and mental disorders. Existing physical and mental disorders.

In the analysis, unfortunately, we actually found no difference in the data before and after the flood. Next slide.

So we had to get rid of that model. And we moved to again look at the literature review and identify the main factors or the main drivers for psychosocial impacts.

And from there, we identified that residence related factors were the key driver. But there were also significant contributions related to risk reception and socioeconomic changes.

And the idea that we had was that we could potentially propose a weighting factor for each of these key impacts on psychosocial health that would contribute to an overall psychosocial detriment. If you'll go to the next slide, please.

For those of you, and I think many of you are, who are knowledgeable in radiation protection and health physics, you'll notice that that concept would be somewhat similar to applying radiation weighting factors and tissue weighting factors that are used to generate the sievert which is that unit of overall detriment for radiation.

And the idea was to propose the unity of psychosocial detriment for decision makers that would allow them to compare radiation dose averted by protective actions against potential psychosocial impacts that could be exacerbated by those same actions. Next slide, please.

And the outcome was that we found that the data was not currently available to generate that non-radiological sievert. Notably, we noted mental health and psychosocial impacts from nuclear emergencies have been measured with general and summary indicators as opposed to indicators that speak to the particular impacts on psychosocial health.

We reviewed a paper whose lead author, I believe, is Todd from the NRC from 2021, that quantified various non-radiological health effects from evacuations and relocations. But we noted that the paper specified that the impacts were not additive.

So we couldn't effectively make some

waiting factor out of those numbers to use to compare to the Sievert. So the overall the conclusion is that we cannot wait the psychosocial impacts and some of them to get a Sievert-like unit at this point.

And that in order to do so, we would need specific studies on the non-radiological health impacts that measure each health effect and their combined impact as well.

If you go to the next slide, we can get to the good news. We still have the objective of building a decision tool for emergency planners and emergency managers to balance the psychosocial impacts and the radiological impacts in an emergency and while applying protective actions.

So we noted that in the NRC paper, of the 14 psychosocial impacts that were assessed, depression had the greatest magnitude of impact on the populations. The prevalence and the impact of depression following a nuclear emergency with and without evacuation, relocation was used to model in the decision tool.

And we note that the prevalence of depression in a Canadian population following evacuation was estimated to be 19 percent. And here

I indicated 28.9 percent in the U.S. And this is actually an error. And I do apologize.

I think that was the upper bound of the impact of depression where 19 percent was from the United States and was the average prevalence. So we used this number and note that the impact from depression represents a lower bound of what would be combined psychosocial impacts.

So again, our model, and I'll present to you now, is based solely on the impact of depression following a nuclear emergency leading to a potential evacuation of location.

And again, this is why I note that this a proof of concept so as we develop further, we may look to model impacts into the model but at this point, we're basing it solely on the potential for depression.

We also had to use quality adjusted life years or QALYs to provide a metric for that impact. And we noted that various QALYs are proposed by application and may vary from $50,000 to $200,000 U.S. dollars.

And then we pulled radiological detriments estimated from the U.S. NRC 2014-dollar value per rem. So again, given that we were using QALYs as a metric for the impact of psychosocial impacts, we needed a dollar value to assign to radiological impacts and those were pulled form that 2012 NRC paper. Next slide, please.

So in building the decision tool, we had to establish a life satisfaction quotient which was pulled from a paper by Redhanz et al, 2015, which predicts lower life satisfaction with increasing proximity to a nuclear accident based on the Fukushima Daiichi evidence and studies.

We estimated costs to unit increases of life satisfaction that are relative to the starting socioeconomic conditions before the accident. So this is based on the liquid view but identifying that it's the relative change in the socioeconomic conditions that are one of the key drivers for life satisfaction.

We then broke down the population information as well as the socioeconomic levels of the population by postal code out of Statistics Canada data.

And we developed what we call a relative cost ratio. The formula for which you have here.

And we'll worry with the details. We can extrapolate it later if we have more time. But what I will show you is the results of this proof-of-concept model when applied to one particular scenario.

So if you run the model, you'll note that it produces actually postal code by postal code recommendations on whether to evacuate or not based on the cost ratio that was developed through our model.

And we have here a graphical representation of that same information. So you'll see relative sizes of the populations in each postal code that was modeled. And this was a total of 97 postal codes that are within the 57-kilometer radius of one of the nuclear power plants.

And you'll see that there is a line at one which is that relative cost ratio that we developed. And in this model, we have a kind of threshold at distance which turns out to be about 47 kilometers out. You can't really see on the graph.

But would suggest that there's a tipping point for that cost-ratio balance at 47 kilometers given the default parameters that we used. Now those default parameters for any particular evacuation, population, location can be changed.

But to specify in this particular case, the default parameters include that there is zero dose to evacuees whereas there is a hundred millisievert or 10-gram potential dose for non-evacuees.

We use a quality adjusted life year of $50,000 which is probably on the low end. And as you increase that, the curve, the slope would get steeper.

We used a life satisfaction quotient of minus 0.08 per 3 kilometers distance from the accident which can be adjusted as well. And we used the population statistics around the Darlington Nuclear Power Plant near Toronto, Canada and a depression prevalence of 19 percent.

So those are just the key parameters that can be adjusted. Recognizing again, this is a proof of concept and this is not to say that the distance at which the cost ratio changes is 47 kilometers.

But we're just starting to play with the outputs from the model in order to basically beta test it and come up with a useable decision. Next slide, please.

So at this point, we'll talk about the proposed usage of the tool. So I want to highlight, again, that this really is a proof of concept for a decision tool to balance radiological and psychosocial detriment. It's our first step.

What we hope is that this will have a significant contribution to evidence-based guidance on a justified and optimized protection strategy that would allow us to consider psychosocial impacts in both planning and decision making.

Additionally, recognizing that most people assume that nuclear and emergency response plans are based on radiological detriment. And they effectively are at the moment.

Proposing a tool that allows us to compare the psychosocial impacts or mental health impacts versus the radiological impacts, would be a key tool to explain to the population why you might evacuate or why you might not evacuate. And start a discussion to maybe better understand what radiological dose represents in terms of risk.

Because currently, I believe that radiological detriment is overvalued in terms of its potential risk in the event of a nuclear emergency and needs to be discussed with stakeholders before anything happens so that we can have more educated discussions going forward. Next slide, please.

So just quickly to point out the next steps, I would love to share the decision tool with you but it's not actually finalized and I cannot distribute it. But we do expect the research report to be ready for review in March.

I actually received it yesterday and because of our activation and response to the situation in the Ukraine, I have not had a chance to open that email. And then similarly, we expect the -- we have the tool which is currently in review as of yesterday.

Going forward, we expect to hold a Canadian workshop on recovery planning in the fall of 2022 in Ottawa, Ontario, where we would present a recently published paper which is another tool that actually addresses something Greg was mentioning.

Which was a guidance on planning for recovery following a nuclear radiological emergency. This is geared towards Canadian provinces that have a responsibility to generate recovery plans but may be of interest to this audience as well. It's available online.

And then to present our research on psychosocial detriments in the nuclear emergency in order to accompany that discussion on recovery. And then introduce the decision tool to balance radiological and psychosocial impacts for nuclear emergency response when applying protective actions.

On the last slide I just wanted to highlight the references that were mentioned throughout this presentation and thank you for your time.

DR. SMITH: Well, thank you for that presentation, Tristan. And again, I do apologize for those of you following along. There appears to be a delay in the slides updating. But we'll just keep moving forward with this discussion.

And please, visit the RIC website to download these presentations later.

Tristan, that's a very novel idea that you had and certainly I think an interesting tool that would seem to have much practical use. Specifically as you mentioned, in the development of evidence-based guidance.

I think that evidence-based policy is a

key component to building trust. If you listened to our Chairman's opening remarks this morning, you heard, him talk about a term called truth decay which is the diminishing role of facts and analysis in public life.

And how that can lead to a lost trust in government. And this is something we must pay attention to in emergency planning because we know that the foundations of trust have to be established long before any accident occurs.

Ultimately, that trust translates into confidence of decision makers and the public to make informed decisions based on the best available information.

How do we produce that information? And how do we get the evidence we need to inform protective actions. Let me now share how the NRC is using science to support emergency preparedness and public protection. Next slide, please.

Emergency preparedness ensures that protective actions can and will be taken in the event of a significant radiological release. Within emergency planning zones, predetermined prompt protective actions are in place to avoid a reduced dose from exposure to radioactive material.

The choice of protective action includes primarily evacuation and sheltering. NRC regulations require nuclear power plant operators to promptly notify offsite authorities and to provide a protective action recommendation if conditions warrant.

Offsite authorities consider the recommendations and will issue protective action decisions to the public. In the U.S., both the protective action recommendation and the protective action decision are informed by the U.S. Environmental Protection Agency, Protective Action Guide, or PAG.

PAGs are reference levels for action. But while PAGs can help decide when to act, it's not always clear which action to take. There are practical guidelines that describe how the protection principles of justification and optimization could be applied to aid in this decision.

Even so, it's said that selection of evacuation or sheltering is far from an exact science. But if that's the case, then we should be able to exact our science to help decision makers and the public make informed decisions. Next slide.

And the NRC is working to support protective action decisions with science. Just in the past few years, the NRC has published and continues to perform analysis to enhance our guidance and regulations and improve our state of practice.

These analyses are providing the scientific evidence needed to better inform protection from radiation in an emergency.

I'll now share a few of the insights from the studies listed here. Next slide.

Emergency response is broken up into phases. There is an emergency phase when immediate decisions are needed. An intermediate phase lasting weeks to months when releases have been brought under control and measurement data can be used as a basis for action.

And a late phase marking the beginning of recovery which can last for years. As we heard today, decisions to protect the public continue long after the emergency phase. To better understand this, the NRC performed a study of capabilities and practices in the intermediate phase of a radiological emergency response.

We gathered information from state response organizations and exercise reports and identified best practices for communicating to the public, developing partnerships and sharing resources for monitoring. How to base protection decisions on science. How to leverage technology to aid and response and carrying for vulnerable populations, including animals, throughout the event.

These insights have been gathered to promote a shared understanding among off-site response organizations and the public. These insights were also gathered to improve modeling assumptions and NRC consequence analysis which can be used to provide a technical basis for protective action guidance. Next slide.

In fact, the current basis for protective action strategies was informed by a detailed computational study into the benefits of protective actions known as the PAR study.

A conclusion of the PAR study is that evacuation should remain a major element of protective action strategies. Another conclusion is that the effectiveness of a protective action is sensitive to the timing of the release in relation to the timing of the action.

As such, the NRC requires the use of evacuation time estimates in the formulation of protective action strategies. To inform development of evacuation time estimates, the NRC developed state-of-the-art microscopic traffic simulation models of representative rural, coastal and urban communities, as you see here. And we used these models to examine a multitude of topics to enhance our understanding of evacuation dynamics.

The ETE study was then used to update NRC guidance for development of evacuation time estimates. The updated guidance reflects the state of the art in transportation modeling and provides measures of effectiveness useful for verifying the adequacy of ETEs.

Updates of the ETEs are periodically required. A task which all nuclear power plant licensees are currently performing as part of required 2020 decennial census updates. The updated ETEs will then be used to inform protective action strategies ensuring these strategies ensuring these strategies are based on the best available information.

As part of the ETE study, we also found ways to better protect our first responders. Some evacuation plans rely on traffic control officers to help direct traffic in an emergency. Our study demonstrated that effective evacuation does not always require police officers to control traffic at intersections and that normal means of traffic control can be just as effective.

And this could provide two benefits. First, police officers can avoid exposure to a radioactive plume and second, it frees up those law enforcement resources for other use in an emergency and where they're most needed. Next slide.

And while evacuations are a common protective action response to many hazards and are typically safe and effective, as we've heard, there are other issues brought on by long displacement. That is, after the evacuation event, there are additional stressors unrelated to the hazard that can lead to negative health outcomes.

While many individual health effects from a specific evacuation event have been widely studied and reported in the literature, holistic view of the risk of prolonged displacement was lacking.

To bridge this gap, the NRC published a meta-analysis of the health consequences from evacuation and relocation across all types of emergencies. The meta-analysis identified 14 different health effects common to a response to a variety of events including natural, technological and manmade hazards.

What we found is that across emergency events, displaced populations were more likely to experience a negative health outcome than those who stayed or returned home.

And we gathered qualitative insights to look at which populations like children and the elderly might be more at risk from certain health effects. An important insight was that radiological emergencies did not result in outsized health effects.

Rather, the effect affect size seen in radiation events was generally similar to other hazards. This suggests these insights could be applied to all hazards planning. This also suggests that it was the disruption of the social ties and prolonged displacement from home communities that led to the effects.

More importantly, it begs the question, what can we do then to minimize the impacts of prolonged displacement? Is evacuation always the right response and what about the alternative of sheltering in place? Next slide.

Sheltering in place is another protective action common to many hazards including radiation. The U.S. EPA's Federal Protection Action Guide Manual was updated in 2017 with the latest information on shelter effectiveness for radiological emergencies.

But there's still many questions we can ask that are open to scientific inquiry. For example, how is the source term and the characteristics of the release change the effectiveness of shelters in providing protection.

Early shelter studies assume that radiological releases contain large amounts of radioactive iodine. Mostly in its elemental or gaseous form. Which was assumed to easily penetrate a shelter.

But as our knowledge of source terms has evolved, we know now that iodine is released in many chemical forms. Many of which are particulates. So how does the chemical form of a release impact shelter effectiveness?

And tomorrow's technology will continue to look different with accident powered fuels, small modular reactors, nonlight-water reactor technology. These advances in technology change our understanding of what could be released in what form, how much and when. Which can then change what actions we take.

And we can develop models to examine shelter effectiveness for tomorrow's technology and find better ways to implement sheltering in place.

For example, could we use filtered ventilation to our benefit? Many heating and cooling systems do not actually need to draw air in from the outside in order to function. And this suggests that rather than securing air conditioning systems, we could use them to help filter out airborne particulates and maintain livable conditions inside a shelter.

This could increase radiological protection and would also avoid shifting the health risk to environmental concerns like heat exhaustion or heat stroke on a hot day.

And what can we learn from other fields of study by looking at how shelters are already being used to protect from other hazards like chemical release, dust storms and other airborne contaminants.

There's lots of data already out there and the NRC's performing studies to gather this data, build better models and inform implementation strategies for sheltering. Next slide, please.

And masks, we've all developed the habit of wearing our mask for protection and masks are now a household item readily available for use. The current guidance suggests that wet towels and handkerchiefs can be useful to reduce dose. So does it make sense to wear a mask in a radiological emergency? If you wear a mask, what is the trade-off between internal and external dose buildup on the mask?

At the NRC we have the tools and the talent in place to answer these questions. We're using the tools from NRC's Radiation Protection Computer Code Analysis and Maintenance Program, or RAMP, to quantify the benefit of wearing a mask and to understand the tradeoffs.

And this will give the public confidence that protection habits they've already developed can be a simple means of protection against radiation.

Next slide.

And this is what the public wants to know. Our U.S. Centers for Disease Controls performed studies in which they've asked the public what is the information you want to hear. And the reply was just tell us what we need to know to be safe. And as you see illustrated here, we can provide clear, concise messages to decision makers and the public on simple measures they can take to be safe in a radiological emergency.

And, by maintaining consistency with the actions the public would use for other emergencies, we can build resilient communities ready to respond to and recover from all hazards including radiation. So whether it's a tornado, a chemical release, a pandemic or a radiological event, the simple message of go inside, stay inside, tune in and the decisions made for following action can be trusted because we'll inform these decision with solid evidence from science. Next slide.

So than you for listening. This concludes our panel presentations which I trust you found informative. I also hope you found it encouraging and you've come away with a better understanding of the tremendous efforts underway across the globe to prepare us for a safe tomorrow.

With that, I think we'll transition to question-and-answer period.

Okay. First question is a general question. How do NRC emergency preparedness programs compare with U.S. Department of Energy's?

That's a great question. I think there's a lot of similarity between the U.S. NRC and the DOE in terms of preparedness programs. That information is publicly available. A lot of it comes down into the use of hazard assessments to inform the planning and then it comes down to how we use those hazard assessments to inform the tools that inform the planning. Like the size of emergency planning zones around the hazards.

And it informs the development of the emergency planning functions that ensure that protective actions can and will be taken. And I think in both the DOE and NRC requirements, these functions are scaled commensurate to the risk of the facility. So risk-informed approach is used in both.

Question for Tomohiko. A major criticism about the Fukushima evacuation was the number of --

(Whereupon, the above-entitled matter went off the record at 4:11 p.m.)