Regulatory Activities in Support of SMRs and Advanced Reactor Systems
Ms. Paula Calle-Vives, IAEA, Austria
Mr. Tarek Tabikh, CNSC, Canada
Dr. Greg Oberson, NRC, USA

Berta Oates
Welcome everyone to the NEXT Gen IV International Forum webinar presentation. We have a panel discussion this morning on the regulatory activities in support of SMRs in advanced reactors systems. Our moderators today are Patricia Paviet and Vladimir. Patricia is the National Technical Director of the Molten Salt Reactor Program for the US Department of Energy within the Office of Nuclear Energy, managing research and development to support molten salt reactor systems across six US national laboratories. In addition, she is the Chair of the Gen IV International Forum Education and Training Working Group, which she has managed since November of 2015.

The efforts of this group focus on the GIF webinar series, the 'Pitch your Gen IV Research' competition, as well as knowledge management and knowledge preservation of advanced reactor systems. She has 30 years of experience on the nuclear fuel cycle, actinide chemistry and repository sciences. She earned her B.S. and M.S. in chemistry from the University of Sophia Antipolis in Nice, France, and a Ph.D. in Radiochemistry from the University of Paris, France. Patricia.

Patricia Paviet
Thank you so much Berta. Good morning. Good evening. Good afternoon, everyone. I don't see you, but I am sure you are happy to see me. For those who follow us every month, it's unusual that you see my face. It's early in the morning, like 6:30 a.m. Mountain Time in the United States. So, it's a pleasure really to have this panel session and I am very honored and privileged to have with me Vladimir Kriventsev from the IAEA, who is my co-organizer and co-moderator of this panel session.

We also have three distinguished speakers today. Ms. Paula Calle-Vives from the IAEA, Mr. Tarek Tabikh from the Canadian Nuclear Safety Commission, and Mr. Greg Oberson from the US Nuclear Regulatory Commissions.

So, as I said, it's my pleasure to introduce first, Dr. Vladimir Kriventsev. He is the team leader of the Fast Reactor Technology development team in the International Atomic Energy Agency and serves as the Scientific Secretary for the IAEA activities on fast

reactors such Coordinated Research Projects, Education and Training Workshops, International Conferences and so on and so forth.

He has 40 years of experience in the nuclear engineering and fast reactor technology at different institutions. He earned his Ph.D. from Obninsk Institute for Nuclear Engineering in 1994, and he has a Doctor Engineering from the Tokyo Institute of Technology in 1999.

Vladimir, thank you very much for your help and your support. And I give you the floor.

Vladimir Kriventsev
Thank you. Thank you, Patricia. Thank you, Berta, for inviting here to organize this webinar and inviting me to conduct this as a moderator also. Now I'd like to introduce the first participant, Ms. Paula Calle-Vives, who is the Technical Lead for New Technologies at the IAEA Regulatory Activities Section, which is a part of Nuclear Safety and Security department.

Paula manages activities on SMR safety and regulation, fusion and the regulatory track of the IAEA's Nuclear Harmonization and Standardization Initiative, for short, NHSI.

Paula also led the review of applicability of the IAEA safety standards to SMRs and non-water-cooled reactors. She coordinated the Agency plans to consider SMRs in revised and new safety standards, also reviews technical publications and developing training materials. Previously, Paula was the Lead of Advanced Nuclear Technologies at the Office for Nuclear Regulation in ONR in the UK. She also undertook roles on regulation of new build and operating reactors. Before ONR, she worked on operating reactors safety in the UK and France.

And in addition, we conducted several activities together with Paula. We are from different departments. I am from Nuclear Energy department, she is from Nuclear Safety and Security. And it was really my pleasure and honor to do that work with her. So, we became not only colleagues, but also, she is also my good friend. Paula, the floor or screen is yours now. Please go ahead.

Paula Calle-Vives
Thank you. Thank you, Vladimir. A pleasure that you introduced me in this webinar, and it's really a pleasure to present to you all our activities on new technologies regulation.

Next slide please. I will start my presentation with a brief introduction of what are these new nuclear technologies, what do we

mean by that, and why it's so important that the IAEA is working on the safety and regulation aspects of these technologies. Then I will give you a very high-level overview of all the activities that the IAEA is doing on safety and regulation of these technologies. I have some slides on the important work of the SMR Regulators Forum that has been now working for ten years and producing a lot of very interesting work to help us with these technologies.

And finally, I will touch on the nuclear standardization and harmonization initiative that we recently launched to address some of the issues that the regulation of these technologies is bringing.

Next slide, please. So, first, the Agency, as you may know, is increasing the work on new nuclear technologies over the last year. And this is because we are seeing that our member states are more and more interested in these technologies and also because these technologies are bringing new approaches that are very important to consider from the point of view of safety and from the point of view of regulation. For example, these technologies are bringing new approaches to deploy these reactors. There may be some new potential ownership models that are very different from the current ones, and there may also be an expectation to be able to deploy these technologies as a standard design globally. They also, of course, bring design features that are different in some cases from the ones from the current operating fleet of reactors. There may be new fuels, non-water coolants. They may be a small size which facilitates the extensive reliance on passive safety. And also, there is use of first-of-a-kind features.

And finally, some of the key activities that before were taking place in a very specific manner on site, they are now potentially done in a very different manner, such as construction, commissioning, refueling or decommissioning. For example, for some designs, the construction and the refueling may be done in a factory. For other designs, the decommissioning may be carried out offsite in a centralized location. As you may know, one of the key publications from the IAEA are the safety standards. And these safety standards provide fundamental principles, requirements and recommendations to ensure nuclear safety, and overall provide a global preference for safety.

Given the differences of these technologies with the current operating fleet of reactors, and given that the safety standards reflect the approaches that we are used to in the current fleet of reactors, it was very important for the IAEA to take a major project to review whether the current safety standards are still applicable to these new technologies or whether there are any gaps. And this work was

finalized quite recently. And summarizing a safety report 123 that you have in the screen.

Next slide please. The applicability review of the safety standard considered water cooled SMRs. We also look at high temperature gas cooled reactors, sodium cooled fast reactors, lead cooled fast reactors and molten salt reactors. We also consider partially transportable NPPs, and we first identify in a systematic way what is different between these technologies and the current operating fleet of reactors. That summarized quite well on the safety report. And then we looked at these differences and whether given these differences the safety standard may still apply or there may be some gaps. In this report, we also consider the interface between safety, security, and safeguards.

Next slide please. This slide is giving you a visual representation of the outcomes of the review, and I really encourage you to look at the safety report because it has much more information than this. This is just a qualitative estimation of what we found. You see, there is a color code from the different safety standards and the different technical areas that we consider. We looked at the full spectrum from sighting to design to the commissioning, etcetera.

And as you can see, most of the safety standards here are dark green or light green, which means that are applicable if it is fully applicable, if it is dark green. Or there are very small number of applicability issues if it is light green. So, for the majority of the safety standards, the approaches are the same and there is very little gaps. There were some instances in light orange and dark orange where we found more issues. And these areas are related to the design, to the safety assessment, to some aspects of the waste management and the transportation. And the issues we found were in relation to non-water-cooled technologies because they bring new approaches and new design characteristics that are not necessarily covered in the current safety standards. And also, in the case of transportable NPPs, what we currently have on the regulations of transportation may not really apply to these designs.

Next slide. So based on this work, the IAEA structure, the work on safety and regulation on four main projects. You can see in the slide the new technology types that we are considering for all these activities. The first activity is the revision of the safety standards. So, what we are trying to do is to take advantage of the natural revision of the safety standards to address the issues that we found in the applicability of the safety standards. We are also developing new publications to support member states considering the safety and regulation of these technologies. And this is because not all the

issues can be addressed at the level of the safety standards. The safety standards are quite high level. And also because in some cases even if we found that the safety standard requirement still applies, there is a lack of experience on how to do that. So, we are developing a number of publications, I will show you, to address this lack of experience. And also, we are trying to build what we call a repository of knowledge by gathering good practices on the design or the safety analysis of some technologies, and also by developing a number of training webinars, etcetera.

The other two activities that I would like to share with you today is the SMR regulators forum that is producing very important publications to help regulators to consider SMRs, and also the recently launched Nuclear Harmonization and Standardization initiative.

Next slide. In terms of the safety standards in the screen you can see the safety standards that are currently under review. The reason why safety standards are under review is because of a number of issues that raised by our member states, but we are taking advantage of their vision to consider the gaps or the issues identified Safety Report-123. So, you can see that we have publications safety standards that will be considering the new technologies on commissioning and operations, safety assessment, emergency preparedness and response, regulatory framework, and waste. There will be more safety standards that will follow beyond 2024.

Next slide please. We are also developing new publications mainly in the area of siting, design, safety and safety analysis, emergency preparedness and response, and the commissioning and waste. And I would like to draw your attention to the design new publications, because this is the area where we found more issues, and this is the area where we thought that there was not sufficient knowledge to start updating safety standards for non-water-cooled reactors at this stage. So instead of that, we are developing a publication for the different types of non-water-cooled reactors, including high temperature, molten source reactors, liquid metal cooled reactors, and we are also developing something on transport on floating NPPs. There are many other publications you can see here. But the idea of these reports will be to provide good practices and approaches for the safety assessment and the design of these technologies.

Next slide. Now, let me touch a little bit on the SMR Regulators Forum. The SMR Regulators Forum is a regulator-to-regulator forum that was established in 2014. So now this year is the ten-year anniversary. And this is a really important...

Sorry, can you go to the previous slide? Yeah, this one.

This is a very important collaborative platform and an example of how experienced regulators are working together to help offer the benefit regulators worldwide. The forum has twelve member states that you can see in the screen. We have three permanent observers, and the IAEA provides scientific secretariat.

Next slide, please. So, the idea of the forum is to have a platform for regulators to share experiences that will facilitate the members of the forum and others to take efficient, robust, and thorough regulatory decisions. Also generally to encourage enhanced nuclear safety and security for these new technologies, and generally to facilitate international cooperation among the members of the forum. The forum is publishing a lot of reports when they finalize a phase of their work, and these reports are increasingly referred by our member states internationally and they also can be used by the IAEA or other international organizations to identify areas that are important for future work. In fact, these reports provide recommendations for this type of work.

The reports can be very useful for the regulatory forum members, but also external regulators or other stakeholders because they provide information that regulators can use to enhance the regulatory framework and activities when considering SMRs. They are also providing a good description of the challenges that regulators are facing and how to solve them. They put forward common positions on key regulatory issues in relation with SMRs and they provide recommendations to international organizations such as the IAEA and others.

Next slide, please. Since they started, the forum has already completed three phases of work. Initially, the pilot study produced three reports on graded approach, defense-in-depth, and emergency planning zones. And since then, the SMR forum was structured in three major working groups. The licensing issues working group that considers issues when applying licensing process to SMRs. The design and safety analysis working group that is building on to the defense-in-depth work by considering specific design issues of SMRs and how to address them.

And finally, manufacturing, construction, commissioning, and operation is looking at the manufacturability, supply chain, commissioning and maintenance experience, etcetera. So, phase two published three reports with the topics you have in the screen covering some of the issues in relation to these three working groups. And then in 2021, until very recently, the end of last year, phase 3

continues with the work of these three working groups touching on additional issues that were covered in phase two. So, for the licensing issues they started to consider regulatory cooperation on the DSA. They started to look at 3S and also the confinement for SMRs and on water cooled technologies. And the MCCO started to look into the long lead items because SMRs are – we are expecting them to be more modular and therefore this is more important topic for these technologies as well as starting to look at differences in organizational capabilities that we are finding in the new vendors and the new stakeholders involved in SMR deployment.

Next slide please. So, all this work has been finalized and there are reports published on these topics and that you can find in the SMR forum website. And the forum has started recently phase IV in 2024 with the same organization. We still have three working groups. The licensing issue working group is collaborating with NHSI and we are producing work in the topic of regulatory cooperation. I will touch upon this a little bit later. The Design and Safety Analysis working group is continuing with the topic of 3S because this is still a lot of things to say and to explore on this topic. And they are also opening a new topic on mechanistic source term, which is really important for non-water-cooled technologies.

Finally, the manufacturing, construction, commissioning, and operation working group is looking at how to deal with potential deployment models from a regulatory perspective of a manufacturing and deployment when there is not an identified licensing available yet. And this is something that departs quite a lot from what is traditionally done for operating reactors. They are also considering construction oversight, given the construction may be done in a factory. And finally, how the regulator could consider organizational capability of a new licensee with no prior nuclear experience because this is again a model that the regulators are seeing in their countries.

Next slide please. If you are interested in the SMR Regulators forum work, please visit their website. All the reports are there. Also, you can subscribe to the SMR Regulators Forum newsletter if you are interested in news and events from this group. And check out our webinar series. This series of webinars are presenting the work from phase 3, and you can find the material and the videos available in the SMR Regulators Forum website. Our final webinar will be on the 18th of June where we will be discussing regulatory cooperation.

Next slide. I would like to close my presentation talking a little bit about the nuclear harmonization and standardization initiative. So, this initiative was launched by the IAEA in 2022. Again because of a response of growing interest of our member states in advanced

reactors, including SMRs, and also an acknowledgement that the deployment model of these reactors rely on being able to deploy and standardize design in multiple countries. And for this it was very important to make progress towards having a more harmonized regulatory approach and also a more standardized approach for the design of these technologies.

These two goals are very ambitious and are very difficult to meet, but the IAEA believed that it was possible to make progress towards achieving more harmonization, more standardization. And with this in mind, the initiative brought together developers, regulators, designers, operators, to try to make some progress towards achieving these goals.

The initiative had two tracks: the regulatory approaches track, the harmonization of regulatory approaches track, and the harmonization and standardization of industrial approaches track. In my presentation I will cover the regulatory track, and if you have questions on the other track, I will be happy to take them during the panel or the Q&A session.

Next slide. So, our overall goal of the regulatory track is kind of described in this slide. This slide has a lot of information that I will go slowly to cover as much as I can. You will see three layers of information in the slide. At the top is our very long- term aspiration of the track. What we want to achieve is progress towards the development of a global framework for the regulatory reviews of advanced reactors. We see this as something very important to allow for the standardization of designs, but also to save time and resources while maintaining high level of safety and security. And by the global framework, we mean to have similar regulatory requirements and approaches globally. Also, ideally having a single review team or the possibility to have a single review team composed by several regulators from different member states with one review outcome, and also having maximal use of reviews that have been already performed by other regulators. And this is a very ambitious objective. We know that it cannot be achieved in the short term, it may be achieved in the very long term, but there is progress that could be done towards this.

In the second layer, you can see what we think the experience in our member states is or may look like in the future. We are currently seeing regulators cooperating while they are undertaking national reviews against the national requirements. So, these types of initiatives are emerging and now we have quite a bit of experience on these types of initiatives.

The next natural step that we think the regulators may start to take, because it's a more efficient manner to achieve a more unified outcome, is performing limited scope joint reviews in which regulators will be looking at the design at the same time, if possible, against common requirements.

And then with the time, what we think may happen is that regulators may expand these joint reviews, the scope of these joint reviews, and be able to share resources because the limited scope joint reviews will have given them experience and understanding of what other regulators are doing. So, in view of that, at the bottom of the slide you can see what we are suggesting could be done to achieve our aspiration for the track and also meet the member states' expectations or way of traveling.

In the NHSI phase I, the phase that we are completing now, we have been focusing on developing collaboration tools and processes, and this is something very important to enable regulators to cooperate better. Now, what we see will be the next natural step in phase two that we hope will start next year, is the implementation of these processes and also gathering of experience, capturing of experience on good practices through the implementation of this process, but also on how regulatory approaches may align or may diverge once they are put in practice by undertaking joint reviews and working together. We are also seeing that embarking countries are very interested in these new technologies, but they normally are not able, or because of resources, or also because of the timing in their countries to participate in these emerging joint cooperations. But they will, however, benefit a lot from learning from these cooperations. So, there is a need to focus on how we could support them better and how we could share the learning from these joint reviews with them.

And finally, this will, if this second stage is successful, this will lead us to a more medium to longer term step in which, by accumulating experiences on implementing joint reviews, there could be better understanding on what is common among regulatory approaches, what is different, and we could start to develop the pieces of this common review framework. As well there could be some work that is targeted to identify what are the differences and how to resolve them.

Next slide. So, with this in mind, the phase 1 has focused on developing processes to enable regulatory cooperation. And the types of cooperations that we have considered in our work are three types. We have found names for them to try to be organized in our work. We identify that regulators may collaborate in collaborative in

what we call collaborative reviews. That will be a case in which independent reviews against national requirements are performed by several regulators, with discussion with other regulatory bodies, but reaching independent decisions, then there may be a case of joint reviews. This will be when we have a team of regulatory police jointly reviewing the same design against common requirements and reaching a joint decision at the end.

And finally, maybe a case in which a regulator is reviewing a design against the national expectations and will use another regulatory body review. So, this is a leveraging regulatory reviews case. So, there are combinations of these three cases, and I am sure there may be other cases we didn't consider, but this is the focus of what we have done in phase one. So, with this focus the phase one regulatory track has been divided in three working groups with different membership. Mostly regulatory bodies, but in working group 1 we also had members of industry. And for each one of these working groups we have been nevertheless cooperating with industry closely. Working group 1 has been focusing on the first step to enable any type of cooperation, which is establishing a framework for information sharing. The group has identified what type of information is needed to be shared, what are the impediments and what are the agreements that need to be put in place to share information that is controlled. It also provides advice on creating or maximizing the use of publicly available information among regulators by creating repositories and also overarching aspirational agreements. Then we have working group 2 and working group 3 that have been working on developing approaches for cooperation. So, working group 3 has been focusing on the leveraging existing regulatory review processes and also the collaborative reviews. And these two processes that they develop are building on the current initiatives because we have some experience on doing this and we have brought all the lessons learned from the different approaches and created processes that we think are very useful and at work.

And then we have working group 2 that is going one step further and providing a first of a kind process that will be the natural next step towards achieving that harmonization or standardization, a multinational pre-licensing review process. Here we want to have a single team of regulators working together with some efficiencies in resources to review the same design, and ideally with a single review outcome or at least a review outcome that is summarized in the same way. The idea will be to work on identification of showstoppers early, at a very early stage of the pre-licensing, and then that could lead into further, of course, national work with some commitment to avoid the same review, say, duplication, avoid the same review again nationally. So, we expect to finalize the work in phase 1 this year,

and that this work will be made available to everybody through publications in IAEA documents.

Next slide. And I would like to finalize my presentation with some thoughts about what we think for the next phase of NESI. These are thoughts that we are still considering and where we are asking feedback to our member states. And I would be really very interested in your thoughts and questions on what we are thinking the next phase is. And this is aligned with what I was telling you at the beginning. Phase 1 focus on developing processes. Phase 2 is to focus on implementation of the processes. So, we are suggesting an activity on implementation of pilot review projects. Of course, this will mean that we need to have a request from industry to do this. But the idea will be to have one or two multinational licensing reviews during this period. The multinational review process will be open to industry in 2025. Then we want to capture the experience from these pilot projects, but also from other regulatory corporations that we are seeing and emerging. We want to do this in a repository jointly produced by regulators at industry that will have feedback on cooperation, supplier importer countries and joint regulatory reviews. Also, we want to use this repository to capture areas of commonality and differences in regulatory approaches based on the pilot projects and past corporations.

The SMR Regulators Forum will continue the cooperation with NHSI and will focus on developing a regulatory cooperation toolkit that will include templates, guidelines, and other tools to support the practical implementation of NHSI processes. And we also want to create an SMR regulation toolkit that will support embarking countries to better be able to access and use regulatory reviews of SMR designs. We are also envisaging a project to consider how regulatory expectations on security aspect could be more harmonized. So again, I will be very interested in your views and thoughts about this initiative, and we'll be happy to expand with any questions later. So, this is all for me. Thank you very much, Patricia, and the floor is back to you now.

Patricia Paviet
Thank you very much, Paula, for this very comprehensive presentation. And we are going to go with our second presenter today. I have the pleasure to introduce Mr. Tarek Tabikh. He is the lead SMR Technical Advisor in the Directorate of Advanced Reactor Technologies at the Canadian Nuclear Safety Commission. He leads the CNSC’s SMR Readiness Program, aimed at optimizing regulatory readiness to license novel and advanced nuclear reactor technologies.

He's also involved in international collaboration and cooperation activities on SMRs, including the IAEA Nuclear Harmonization and

Standardization initiative that we just heard about. So, Tarek, again, thank you very much for being here with us today. And without any delay, I give you the floor. Thank you, Tarek.

Tarek Tabikh
Thank you very much, Patricia, for that wonderful introduction and good morning, good afternoon, and good evening to everybody on the call here today. Thank you for joining us from wherever we are. So, as Patricia mentioned, my name is Tarek Tabikh and I am honored to represent the CNSC, the Canadian Nuclear Safety Commission, on Canada's approach to small, modular, and advanced reactor licensing and readiness. So, throughout the presentation today, I'll be sharing a few kind of brief highlights of who we are as a CNSC before transitioning to a discussion on our approach to licensing SMRs and advanced reactors. And finally, I will discuss in detail our approach to readiness for these advanced reactor technologies.

So next slide, please. So, who are we as the CNSC? The CNSC is the nuclear regulator in Canada.

Next slide, please. Our mandate is to regulate the use of nuclear energy and materials to protect the health, safety, and security and the environment. It's also to implement Canada's international commitments on the peaceful use of nuclear energy and is to disseminate objective scientific, technical, and regulatory information to the public.

Next slide, please. We have an independent commission, and this is our decision-making body. They are transparent and science based. They are a quasi-judicial administrative tribunal, and they are also the agents of the Crown, which means that they have a duty to consult.

Our commission members are independent and are part time. So, there is seven commission members including the chair, which is our CEO and president. And we follow a very transparent and clear process where our commission hearings are public and webcast. And the decisions from the commission are reviewable by federal court if there is any dispute from the decision.

Next slide, please. So, the CNSC regulates all nuclear facilities and activities in Canada from the time the ore is removed from the earth to when it's processed, used in its end use, and finally when it's disposed of as waste. CNSC regulates the entire lifecycle of nuclear energy and materials in Canada.

So that's a quick overview of who we are, the CNSC.

Next slide, please. Now, in terms of our approach to licensing.

Next slide. Just like any other nuclear power plant, SMRs and advanced reactors are subject to class I nuclear facilities regulations and licensing decisions will still be made by the commission. The CNSC licensing process requires a license application which includes sufficient information to demonstrate that the reactor can be constructed, operated, and decommissioned safely. Licensees must provide evidence and justification for alternative designs or approaches. The submission will need to address all the 14 safety and control areas in the licensing process, and this is commensurate with a graded approach.

The CNSC has regulatory documents for all the CNSC safety-controlled areas, so the guidance is clear for potential applicants. These documents are expected to be used in conjunction with the license application guides, which we also make available for proponents to develop a project specific licensing basis. CNSC staff provide recommendations to the commission and the license will be issued if the commission accepts the application. So, as I mentioned, they are the decision-making body in our organization. And subsequently, if a license is issued, CNSC staff perform compliance activities against the licensing basis throughout the lifecycle of the facility.

Next slide please. So, we operate according to a performance-based regulation for nuclear facilities. So, this is in contrast to a prescriptive-based process which some regulators have. Here, the focus is on desired measurable outcomes rather than prescriptive processes, techniques, or procedures. And this has really been a great benefit when it comes to advanced reactors and novel technologies as we are already on the right foot and set up for success when it comes to reviewing SMRs. The rules are at a high level and rarely need to be changed, is still based on real world experience and is informed with OpEx or operational experience and allow one to achieve a performance objective via different means including ones that are new techniques that may have not been reviewed in the past, as long as it is well supported with evidence.

Next slide please. So, on that point while we do provide requirements and guidance on how to meet requirements, an applicant or licensee may put forward a case to demonstrate that the intent of the requirement is met by another means. And in the background, you see a REGDOC 252 which is our design of reactor facilities requirements and guidance. In there, there's a specific section that

talks to alternative requirements wherein a proponent could achieve any of the requirements through a different means if they support it adequately. And as the second bullet says, it must be demonstrated with supportable evidence. And the commission is all with the final authority as to whether or not the requirement has been met.

In effort to provide further guidance for advanced reactor and SMR proponents, the CNSC published REGDOC-115 which is supplementary information for SMR proponents, which also includes advanced reactors, and it provides guidance on information to be provided in support of an application to prepare, site, construct, or to operate. It takes into consideration different SMR technologies and considers application of a graded approach and alternative to your requirements.

Next slide, please. So, with that, I will transition on to our discussion to our approach to readiness.

And next slide. Here we are going to be setting the stage of the Canadian Advanced Reactor Landscape, so to put into context why we set about this SMR program. On the left-hand side, you'll see our current projects for advanced reactors and SMRs. These are projects for which we have licensed applications in hand. The first one on the list here is OPG's Darlington new nuclear project where they have submitted the license to construct for a GE-H BWRX-300 reactor. We are currently reviewing the license to construct the application, and there's a hearing for that application scheduled for October 2024.

And also in Ontario, Global First Power submitted the license to prepare site for a USNC micromodule reactor, which is based on a high temperature gas cooled reactor technology. We are currently undergoing the license prepared site review, and they propose to operate by 2028. In New Brunswick, NB Power submitted as of last year a license to prepare a site for an ARC-100 SMR reactor. That's a sodium fast cooled reactor. And they propose their operation by 2030.

On the right-hand side, these are future potential projects where there's a communication of intent to deploy. So, in Darlington as well, they plan to expand the one BWR to up to four in the DNP site [ph]. In Ontario, Bruce Power has a Bruce C project where they plan to deploy large advanced reactors. It's a province of Saskatchewan. There are two projects on the go. There's SASKPOWER that aim to deploy the BWRX-300 as well, and Saskatchewan Research Council, which aim to deploy a commercial demonstration of a Westinghouse eVinci reactor, and that's a microreactor.

OPG recently announced that they plan to also deploy further advanced large reactors moving forward. So, suffice to say there's a lot of interest in Canada in deploying advanced reactors. And as a regulator, we need to ensure that we are ready for when the license application comes, and we are able to review and not be a bottleneck when it comes to these license applications. Our focus is always and will always be on safety.

You can see over here there's at least five different reactor technologies, and that sets up the stage for a lot of work and readiness required for the regulator.

So, next slide. So, this is the approach, the kind of four key approaches we took to readiness. The first one on the blue, on the left-hand side is leveraging our existing robust performance-based framework, which also includes risk-informed regulatory decision making. That really has set us up for success as we move forward on this endeavor. In the green box, you'll see our organizational change and priority. Here, we identified the importance of our readiness activities early on, and the organization made a change to focus and prioritize this as a topic. So, they created the directorate that I work in, which is the directorate of advanced reactor technologies to really collate and focus the efforts on these technologies, and licensing and preparedness for these technologies.

On the right-hand side, you'll see our pre-licensing process. This is a process that we have been providing for a number of years, is to review a design of advance of a reactor early on in the process to provide feedback to the vendors. This has also allowed us to gain an appreciation and understanding of where potential gaps to optimization for readiness may be and to close that gap early on.

We also provide an avenue for proponents to discuss your license application early on. And all of this has kind of set us up for the development of the SMR readiness program or project, which is in the bottom right-hand side. This is a comprehensive, robust, integrated approach to addressing identified regulatory gaps to ensure optimization for readiness. And this is what I'll be spending the rest of the presentation discussing.

Next slide. At a high level, the project has a five-year timeline where we plan to address over 60 objectives geared towards optimizing CNSC's SMR readiness. We received funding from the Government of Canada of $50.7 million over the course of the project. We also invested significantly in our staff and have hired over 40 project management scientists, engineers, to support the execution of the project.

Next slide. Our overall mission is twofold. The first is to optimize CNSC's readiness to license and regulate SMRs. If you could scroll the previous slide, please. Awesome. Thank you. And the second is to position the CNSC as an international leader in SMR regulation. This really aligns with our priorities of being a modern, trusted, global and agile regulator.

Next slide please. Perfect. So, in terms of our scope we developed it from numerous areas. I won't go into the detail of all the different aspects, but it really started from significant work at least a decade before we started this readiness project, getting ready for new nuclear in Canada. We talked to our experts to ensure we had the up-to-date information of where there are gaps based on their expertise. We supported a pan-Canadian action plan, and we had action that came out of that. We used our collaboration and cooperation with our international partners and through different forums such as the SMR Regulators Forum that Paula mentioned, to identify where there may be gaps in regulatory space. And we also – and this is kind of important, we did not do it in a silo. We held workshops with industry. We had discussions and communication with industry to understand from their perspective as the potential future proponent where do they see the gaps? And this really informed our scope.

Next slide. Thank you. So, with all that scope we identified four key pillars for SMR readiness, of which we need to address to optimize our readiness. The first one being regulatory predictability. And this is really targeting optimization of our regulatory framework for SMR licensing and providing guidance and clarity to SMR proponents such that they could provide a wholesome, complete application at the first submission.

The second pillar is capacity and capability. You saw in the previous slide how many different technologies are being considered in Canada, let alone the number of SMR and advanced reactor technologies that are worldwide. So, we want to ensure that our staff, we improve and expand on our existing competencies and capabilities in the technical areas.

The third pillar is policy insured responsibility. This is really understanding and accepting that there's opportunities for harmonization and optimization and streamlining within our domestic, within our borders. So, we want to work with our federal, provincial, territorial partners to find ways of streamlining our various areas of responsibilities.

And last on the list here is international collaboration. This really goes into strengthening our existing international collaboration activities and more strongly pursuing harmonization goals. Over the next few slides, I'll cover these pillars in more details and what's involved in each one of them.

Next slide please. So, under the regulatory predictability pillar, we have a total of 18 objectives or projects. And the outcomes that we want to see from this pillar is that our Reg Framework is up to date and addresses the requirements and expectations for novel technologies, making sure it is tech neutral and that we provide the clarity to proponents upfront. Some examples of projects in scope is guidance on transportable nuclear power plants or marine based power plants, how to apply the graded approach and more support on that, and clarity on what it means to have defensive depths in these advanced technologies.

On the right-hand side, in what I call the sticky notes, you'll see some of our recent successes. Just based on looking at time here, just a couple on each slide. We developed a process to manage long lead items to provide that clarity to proponents and we significantly advanced work on SMR focused license to construct compliance plan. As you'd imagine, our experience in Canada are CANDU. So, this is a big step forward in making it tech neutral.

Next slide. Under the capacity and capability pillar, this is by far our largest pillar. It has 28 objectives or projects. The outcomes is to ensure the CNSC is resourced and have the capacity and capability to respond to SMR related initiatives and it's to foster community of research for these advanced technologies and to ensure we have the right training in place to continuously improve our staff's expertise in these areas.

Some examples of scoped-in projects is analyzing and addressing the novel means of containment aspect. So, looking at it from a functional containment standpoint as opposed to a traditional concrete based structure containment. You saw a number of different technologies prior and they have different fuels that they use. So, looking into novel fuel qualifications and how we will approach this as a regulator.

Some of the recent accomplishments we've had is significant staffing actions completed. I mentioned over 40 staff that were hired to support SMR licensing and readiness activities, which is a major accomplishment. We've also invested over $3 million across 29 university SMR research projects through collaboration with our federal partner of NSERC, which is the Natural Sciences and

Engineering Research Council of Canada. So, this goes back not only to have access to independent research on these advanced technologies, but also to promote the expertise development within our borders of these technologies.

Next slide, please. Under the policy insured responsibilities pillar, we have eight objectives where outcomes at the end of the day, we want to see federal policies that are based on sound technical and regulatory advice and that we coordinate and support the development of federal, provincial, and territorial policy across Canada.

Some examples of projects in this pillar is our approach for environmental reviews for SMR fleets, policy for Canadian enrichment, so supporting the policymakers in enrichment policy decision making, and fostering and establishing partnerships with our domestic partners. So, some examples of successes recently, and I'll note these are all still in progress, but they have been advancing due to this project, is the identification of a licensing approach for SMR fleets. So, imagine 2030 of the same standardized reactor deployed across a province. How do we approach this? Is it one-off licensing as we have currently, or is there a different way we could approach it as more agile, and more risk informed?

So, this is something that we are advancing currently. And we have had also progress on impact assessment readiness with our federal partner of the Impact Assessment Agency of Canada, where we have a number of work groups looking to streamline areas where there's multiple regulators involved in a similar review. In this case, on the impact assessment there's ourselves, the Impact Assessment Agency of Canada. So, finding ways to make that process more efficient.

Next slide, please. And the last pillar, but not the least for sure, is the international collaboration pillar. Here we have ten objectives, where the outcomes is that CNSC contributes to international harmonization efforts for SMRs and to seek increased harmonization of regulations across international regulatory bodies to enable the sharing of technical expertise for more effective and efficient regulatory reviews.

As we are very aware, as kind of Paula also mentioned in her preceding presentation, SMR deployment is a global initiative and we see interest all over the world with a nuclear renaissance, as we term it in many countries globally. So, if you could find ways and work towards understanding the differences in the regulatory frameworks and going through the path of leveraging an existing framework or existing review from a regulator after we ensure it meets our

requirements, that is the way that we are looking to support. Some examples of our scoped-in project is NHSI, which we discuss in the SMR regulatory forum already, but also international collaboration and cooperation initiatives with bilateral or trilateral activities, such as with the US NRC, the UK ONR and Poland's PAA.

Some examples of successes to-date is our continued support and the CNSC is leading, chairing the IAEA's Regulatory Cooperation Forum with our current acting CEO and president being the chair of that forum. A big item is our five-party, which now will be called our six-party charter joint review with the US NRC and recently joined UK ONR. This is a very interesting arrangement where we have our regulators, and we have our proponents. So OPG in Canada and TVA in the United States who identify areas of potential benefit of joint reviews. The regulators accept and perform those joint reviews, leveraging one another's experience. And we have the designer GEH, which provides technical information.

And we also have our support for embarking nations such as Poland. As they develop the regulatory framework for licensing nuclear, we are able to support and share our experience as an experienced regulator to ensure safety is held as priority as the global community seeks deployment of SMRs and advanced reactors even in non-traditional nuclear states.

And I'll move on to the last slide. In closing, the CNSC is prepared for nuclear innovation and expansion in Canada without compromising the safety and security of the environment and the public. We will license SMRs and advanced reactors according to our existing licensing frameworks. As I mentioned, it was as class I facilities. And CNSC is ensuring readiness through an integrated approach to addressing the four pillars for readiness, which is regulatory predictability, capacity and capability, policy and shared responsibility and international collaboration.

Next slide. I thank you very much for your attention and I'll be happy to answer any questions at the end of the session. I'll be happy to go to any details on the different topics within the pillars. You also see our SMR readiness email at the bottom of the slide here. So, if you have questions later on, you could always shoot us an email and we'll be happy to support. Thank you so much and back to you Vladimir.

Vladimir Kriventsev
Thank you very much Tarek, thank you for the interesting presentation presenting the views of the Canadian regulator to these

advanced reactors and SMRs. And also, thank you for the keeping time almost exactly in timescale.

And now we will listen the presentation of another regulator from the neighboring country from the US. And this will be Dr. Greg Oberson who is Branch Chief of Advanced Reactor Technical Branch 1 at the US Nuclear Regulatory Commission in the Office of Nuclear Reactor Regulations. Dr. Oberson has been with NRC for about 17 years, the majority of which was in the Office of the Nuclear Regulatory Research. He was working on issues related to corrosion in power reactors and spent fuel management systems.

Greg has a bachelor's degree in Materials Science and Engineering from Johns Hopkins University and also master's degree and Ph.D. from University of Maryland, again, in Materials Science and Engineering. Thank you for joining us today, Greg. Please go ahead with your presentation.

Greg Oberson
Thank you. Welcome today, thank you on behalf of the NRC for giving your kind attention. I'm really happy to have the opportunity to speak with you about a lot of the exciting work that NRC is doing in advanced reactor area. And just by way of a bit of context, when I refer to advanced reactors, I am primarily going to be speaking about what we refer to as advanced non-light water reactors. Some of the other presentations that mentioned small modular reactors, light water reactors, for example, we do have an active licensing program for those as well, but I won't [Unclear] about those as a focus of my presentation today.

So, you can proceed to the next slide. Thank you. So, I do want to give you a landscape of the ongoing NRC licensing activities for advanced reactors. To date, NRC has issued one construction permit for a test reactor I referred to as Kairos Power Hermes 1 in Oak Ridge, Tennessee. The construction permit for that facility was issued several months ago. That's a trace of fueled salt cooled reactor.

Currently we have construction permit reviews ongoing for three facilities. Kairos Power Hermes 2.0. So, of an evolution of the Hermes 1 design. Abilene Christian University in Texas, we have a license review ongoing for a construction permit for what's called the Molten Salt Research Reactor. And very recently we received the construction permit application for the TerraPower Natrium Unit 1 in Kemmerer, Wyoming. We are currently performing what we call an acceptance review, determine if we will accept that construction permit for docketing.

We have ongoing pre-application activities with a number of vendors which you can see listed on the slide, X-energy, Terrestrial, Westinghouse, Oklo, among many others. And this is not even the full list, and I'll speak in a few slides about more specifically what I mean by pre-application activities. But consistent with what the other speakers have shared, we do have a growing work portfolio as this is very much in the US interest for the advanced reactor deployment.

If we could proceed to the next slide. So, NRC has flexible licensing pathways. The key message is that our current regulations are suitable appropriate for the licensing of advanced reactors. Would want to clear up any misconception or perception that we do not have an adequate regulatory framework because, as mentioned, we are already doing and have issued licenses for advanced reactors. NRC has what's referred to as the 10 CFR Part 50 process. That is a kind of a two staged licensing process. There's an initial issuance of a construction permit and subsequent to that an operating license. This is the means for which the large majority of the current operating fleet and the non-power reactor fleet was licensed. And the initial license applications which we have received such as those for Kairos Hermes and the TerraPower Natrium project at Kemmerer are under the ten CFR Part 50 framework.

We do also have 10 CFR Part 52 process. This is sort of a process that was put in place for the previous generation of large light water reactors such as your AP 1000s, EPRs, etcetera. This is sort of a single stage licensing process. There is a potentially early site permit, a combined license. We do design certifications for certain technologies. And again, this is a pathway that is available, and we have had some interest from potential vendors in exploring this pathway, although no applications currently in house following this approach.

And then as mentioned, we do see potential for optimizing and making more efficient some of the regulations that are currently codified in part 50 and part 52. And therefore, we have initiated what's called a 10 CFR Part 53 rulemaking process. This is a technology-inclusive, risk-informed licensing pathway. We have previously provided a draft of that rule to the commission, the NRC commissioners. They provided further direction to staff that staff are currently implementing. Intend to have this rule in place by mid-2025. And I'll speak to at some high level about some aspects of that regulatory framework at a later portion of the presentation.

Next slide please. So essential to the efficient licensing and deployment of advanced reactors is what we call pre-application

engagement. This is intended to streamline again and make more efficient the licensing process. There are a few goals outlined on this slide that's very similar to things I heard in the CNSC presentation. So, the intent of this would be to achieve regulatory clarity on matters prior to the submittal of an application, identify complex technical and policy issues that might have a potentially long time to resolve to get that process started. Of course, we want to improve our staff familiarity with the technology again, so that we are not just learning as we are doing application reviews. And we believe that the value of our external engagements is enhanced again through this process as well. So, in the typical US NRC model of pre-application engagement, it is common for vendors to submit what we call a regulatory engagement plan, which sets forth a schedule of engagements, a schedule of perhaps deliverables leading up to the submittal and application itself.

Aspects of that could include white papers or topical reports, which are sort of written technical documents for which the vendor may request any informal to formal feedback from staff. We are committed to transparency in our regulatory process, so there are typically public meetings that are included within the plan. And prior to, maybe immediately prior to the submittal of an application itself, perhaps in the three- to six-month time frame prior to the submittal of that application, the staff may be requested to do a readiness assessment, essentially a sort of pre-look at the application or a largely complete application to determine if there are any significant holes or deviations that the licensee or potential licensee would want to look at before submitting that application. And a real commitment to this application process itself that is likely to result in a potential reduction in the licensing timeline, which, again, I'll speak to a little bit later on.

Next slide please. So, this slide is just a sampling of some of the topics that we have found very useful to have pre-application engagement with a number of vendors. I'll just speak to a couple of these. Materials performance assessment. For instance, if novel materials are intended to be part of the design, fuel qualification, classification, safety classification components, emergency planning, physical security, PRA approaches, use of consensus codes and standards. Again, the degree to which we are able to have that early insight into vendors or potential licensees approach to this is likely again to make the regulatory licensing process go more efficiently. So, our feedback can range from just general observations, perhaps communicated verbally or in writing, and also up to and including formal evaluations that can essentially be incorporated by reference into a license application.

You can proceed to the next slide. So, licensing efficiencies. Again, as my counterpart from the CNSC mentioned, the role of NRC is to enable the deployment of the advanced reactive technologies in a manner which is safe and secure. We do not intend again to be a bottleneck or a stopping point in the deployment of these reactors, and therefore we are doing a lot of work to address our licensing efficiencies. A couple of those are reflected on this slide. We put into place what we refer to as core review teams. These are sort of multidisciplinary groupings of staff that are intended to follow an application from the pre-application stage all the way through the licensing process to the issuance of the operating license or the COL [ph]. We believe the continuity of the staff is, the ingrained knowledge is really essential. So, we're going to try to keep that in mind. Our engagements with Department of Energy, Industry, International counterparts, again, to the degree which we can learn from one another, leverage the work that one another are doing, is going to be critical.

Data and analytics, looking at the parts of our workflow, where are we having challenges. Are they for certain technical issues, are they process issues, and what can we use from the data that we have to make those perhaps process improvements? We believe that consensus coincidence standards are essential to sort of standardizing the reviews. So, we involve ourselves with the consensus bodies such as ASME, ACI, ANS, and so forth, modeling and simulation, that is to say, developing our own capabilities within house to do pretty advanced modeling and simulation of their reactors, such that we have sort of independent computational capabilities. I won't speak about it too much other than right here, but we do have an environmental review process which is sort of complementary to the safety evaluation process, which I am largely speaking to. And we are taking a number of steps to streamline our environmental review process in line with the nation's sort of environmental laws.

Next slide, please. So, this slide outlines representative licensing schedules. And I would say that these are largely sort of legislative or legally directed timelines. So, you can see here, depending on the sort of application, whether it's a construction permit, an operating license, a topical report, I don't have listed here, but a combined license, you generally would see something from, in the three to four year timeframe, from the time an applicant application is submitted until it would be fully licensed and ready to operate. It should be noted that we believe that the schedules could be shorter or longer, again, depending on certain aspects, the complexity of the review and so forth. As mentioned earlier, the intent is that pre-application engagement, effective pre-application engagement, could

substantially or meaningfully reduce some of these timelines. I mean I speak to that with respect to the Kairos Hermes review here shortly.

Next slide, please. So, I did want to highlight some major accomplishments of our advanced reactor program. We have a number of MoU's, Memorandum of Understanding we put in place between NRC and the Department of Energy to cooperate on various aspects of advanced reactor demonstration and deployment, recognizing common interests in these areas and our respective capabilities. As was mentioned earlier, we've really focused on international engagement collaboration with counterparts in Canada, UK, and around the world.

We developed the computer models for different reactor designs. As I mentioned, we have issued a large number of guidance documents that address aspects of our regulatory policy, address aspects, for instance, of what should be included in a reactor in a licensing application, and how staff should review those. We focus highly on public engagement and transparency, so hardly a week goes by that we don't have a couple of public meetings on any number of topics involving advanced reactors.

I believe tomorrow we have our quarterly what we call the advanced reactor stakeholder meeting. We get great participation in that. Many of you on the line here maybe have participated in that as well, but we have some that are just even individual meetings with specific vendors.

As mentioned, we review some technical reports from potential applicants in the pre-application space in which to provide findings or feedback to them. We've reviewed more than 100 of those. We have been beating our generic schedule as was referenced on the prior slide, and we think we can continue to do even better. And again, as referenced the schedule, we completed the Kairos Hermes 1 construction permit 50% faster than the generic goal as was referenced on the prior slide. So, in this case that was about 18 months or so, 1-1/2 year, for Hermes 2, the second iteration of the Hermes design. We're going to go – we believe we can go even faster than that, recognizing that there's a lot of issues that we've already addressed in the Hermes 1 licensing space. We are primarily focused on deltas, changes that would manifest themselves in Hermes 2. So, we do believe that sort of second of a kind, or nth of a kind licensing is going to help us to achieve even more efficiency in our licensing process.

You can go to the next slide, please. So, as was mentioned, our current regulations, such as those codified and 10 CFR Part 50 and

52, are appropriate, usable and adequate for all aspects of advanced reactor licensing. But nevertheless, we do believe that there are efficiencies to be gained by even more bringing the regulations into conformance with aspects of advanced reactor design. So, I already mentioned 10 CFR Part 53, but we have rule-making or regulatory development, regulatory guidance activities going on in a number of spaces. You can imagine physical security and environmental emergency preparedness, for example, recognizing perhaps a different safety paradigm for the advanced reactors at a different deployment concept. We would want to look at those, ensure that they are appropriate. Our regulations are appropriate for purpose.

Likewise siting, as is referenced on this slide. It is fine references construction oversight. That's sort of our construction inspection process, which I'll mention. And some of the guidance, some folks may be familiar with our regulatory guidance related to content of application and really the review process. That's what's referred to as TICAP and ARCAP on the second to last bullet. And the microreactors I'll also speak to very briefly in an upcoming slide.

So, you can proceed to the next slide, please. So, advanced reactor construction and oversight program. I just wanted to mention this as one example of a sort of what we believe is a process efficiency that we can put in place to make the sort of right size of our regulations for the reactor technologies. We do have a construction oversight program that we put in place, you can imagine, for the large light water reactors, for instance the AP 1000 that recently came online in the US. But we do envision that advanced reactor construction could be substantially different in kind or in concept. There can be more factory fabrication. There could be modules or aspects of it that are sort of fabricated in different places and then converge in an operating unit. So, we want to primarily – the point here would be we want to be risk informed and scalable in terms of what our construction oversight is going to look like. And we want to have some iterative process that rolls into lessons learned as we work through the process to devise further enhancements to this program. And we have been doing a lot of engagement with the vendor community on what the implementation of a construction oversight program would look like.

You can proceed to the next slide, please. So, this, as was mentioned, microreactors, which are sort of very small units, such as eVinci, Westinghouse eVinci is one example of those, but there are a number of others. This is of much interest in the US and of much interest to the agency itself. So, this slide references the concept essentially of building a unit, a reactor unit, and potentially even fueling it in a factory, and then from the factory deploying it to a location for

operation. And then after the reactor operates for a certain amount of time, something would happen to it, perhaps it would go back to the factory, be refueled on site, etcetera. There are different models.

We are seeking commission policy direction, because again these really involve regulatory interpretations of what latitudes we have or what is permitted under our legal authorities to sort of make approvals of this sort of operational concept. So, this would involve what for instance would be allowed if we were to issue a vendor a manufacturing license and a license for possess special nuclear material. It has very been very clearly explained to the agency that there are certain companies for which their business model depends on the capacity to build and deploy among an order of tens to hundreds of these units per year. So, we're talking about serialized or nth of a kind deployment concepts. So, one example of a policy matter would be what are our obligations for public participation in a safety environmental review process, given those number of reactors potentially being built and deployed throughout the nation?

Next slide, please. So, we do have a very expansive research program to ensure our readiness for current and future technologies. I've just listed some of the matters which we have under research in various degrees. Materials and fabrication techniques, advanced construction technologies, remote and autonomous plant operation, online monitoring prognostics which you may have heard referred to as digital twin technologies, continuing to enhance our computational modeling and simulation capabilities, ensuring that we have the appropriate risk assessment tools. And we certainly do keep sight of the fuel cycle back end and waste management obligations under law for a consideration of those as part of our regulatory process.

Next slide, please. All right, so this is my final slide. I do want to communicate again, the NRC sees no fundamental regulatory obstacles, at least in the US regulations, to advance reactor licensing and deployment. Our goal is to accomplish an efficient and predictable licensing process focused on risk significant issues. We do believe that pre-application engagement is effective and is likely to be the most important pathway towards an efficient, licensed process. We appreciate and highly value our collaborations with our regulatory counterparts and continue to try to seek even more value of those. And as just previously mentioned, our ongoing research program ensures our readiness when to address near-term and long-term challenges. And that brings a conclusion to my presentation. So, I'll be happy to turn back over to the moderators. Thanks.

Vladimir Kriventsev

Thank you. Thank you, Greg, for the great presentation. Patricia. Patricia. We don't hear you.

Patricia Paviet
I see that. So, thank you very much, Greg, for this excellent presentation on all the activities that the US NRC is taking. I myself took a picture of one of your slides with the ongoing activities, the licensing activities. I mean, this is amazing. The ongoing construction permit review, ongoing preapplication activities. You and your team and the NRC are extremely busy and the same for the Canadian partners. It's unbelievable. Great for the nuclear energy sector. So, I think, Berta, you're going to show the last slide. I give you the floor, Berta, before we start the Q&A session.

Berta Oates
Thank you, Patricia. And thanks to our wonderful speakers. Before we move to the Q&A portion of our panel discussion, we do just want to give you a quick look of the upcoming webinars that we have scheduled. In June, Directed Energy Deposition Process of Corrosion Resistant Coating for Lead Bismuth Eutectic Environment. In July, On-line Monitoring Development in Support of The Nuclear Fuel Cycle. And in August, a presentation on the International Molten Salt Research in Support of MSR Development will be another panel session that we look forward to.

Patricia Paviet
Yeah. Thank you very much, Berta. So, I am inviting our three panelists. We have received several questions, and Vladimir and I, we will alternate the questions. So, I am going to start with the first one that we have for Paula.

So, Paula, and maybe, Berta, you will put that in the chat for Paula to be able to read the question as well. Paula, with regards to the IAEA publications related to citing and external hazards, will the scope of work cover off the consideration of changing hazards between deployment sites and facility or reactor transport to and from a service facility, whether by land or marine activity? Is it covering both purely transport, domestic transport, and across international boundaries? So, the question is pretty long. Can you see the question, Paula, in the chat?

Paula Calle-Vives
No, but I can answer. I can answer. Thank you so much, Patricia. A great question. Unfortunately, the answer is very simple. No, we are not covering these issues in this siting publication. The siting publication is more general approach to consider SMRs and other reactors generally. But I want to say that the IAEA is also doing some

work on transportable. At the moment it's focusing on design aspects, not necessarily including external hazards. But this is nothing we identified as some kind of gap that we need to address with the time. So, we are aware that this is something that needs to be considered but at this stage, we are not yet considering. But there will be plans to do it in the future. So, I guess my answer is very easy.

Patricia Paviet
Okay, yeah, that was fine. The question, looked, oh, my God. But the answer was pretty easy. So, thank you so much, Paula.

Vladimir Kriventsev
I have a question which is not asked by the audience, but personally, my personal question to Greg and to Tariq. Just could you just give us numbers? How many, let's say, innovative or Gen IV reactors already licensed in your countries? How many in the process and how many SMRS? Because SMRs, okay, it's not all SMRs are Gen IV, but anyway, it's innovative reactors, what we call in the IAEA. How many? Just in numbers, how many already, how many in the process? And that's it. Approximate numbers.

Tarek Tabikh
I could jump in just quickly. I think I have a shorter response than Greg. So, we currently have zero SMRs are advanced. So, we call SMRs, we group them light water, non-light water, group them together under the umbrella SMR and advanced reactors. Zero licensed. We have three undergoing license reviews: one license to construct, and two license to prepare site. However, there's also interest to deploy. So, we are expecting license applications from four other license applications at least. And there was one in one of the slides. So, zero, three on hand…

Vladimir Kriventsev
And all are water reactors, right?

Tarek Tabikh
No, so the one with the license to construct a boiling water technology, the two others that we are reviewing for license to prepare site, one is a high temperature gas cooled reactor, and one is sodium fast cold reactor. And then we are also expecting to receive eVinci license application potentially in the future. So that's a heat pipe technology microreactor. And we are also expecting large advanced reactors, so Gen III+ Bruce Power and OPG in the future. So at least a mix of light and...

Vladimir Kriventsev
Great. And now Greg, please.

Greg Oberson
Yeah. So, for the advanced reactors, and again, referring to the non-light water reactor technologies, we've issued one construction permit, that is for the Kairos Hermes test reactor in Oak Ridge, Tennessee. We have three construction permit applications ongoing for this Hermes 2.0 for the Abilene Christian University Molten Salt Research Reactor. And then one construction application for a power reactor, a TerraPower Natrium in Kemmerer, Wyoming. That is the only power reactor application in-house. And as I mentioned, that has only been submitted for review. We haven't yet made a decision whether to accept that application. That is a stage of our licensing. I would anticipate within the next three years that we would probably receive at least five to six more construction permit applications or combined license applications. I won't name the vendors nor their schedules. Some of those are proprietary to those. But you saw a list of those and just the names of those in a slide that I shared with you. And then we do have, as mentioned, a couple of small modular, light water reactor reviews ongoing. For instance, the NuScale in particular I can reference.

Patricia Paviet
Thank you so much. Thank you so much, Greg. Next question to Paula. Paula, can you comment on the harmonization with the International Maritime Organization concerning maritime use of SMR?

Paula Calle-Vives
Thank you. Thank you very much for that question. They are very interesting questions. Again, I cannot really comment on this other to say that the IAEA, again, is considering the topic of transportable and floating NPP. And we are now acknowledging that what we currently have is not applicable, it's not fit for purpose. And we are in an internal discussion as well. We are working with IMO and identifying potential way forwards. We also need to work with our committee on the safety standards that are dealing with the transportation regulations and so on. So, we are for now just exploring different avenues and doing some technical work. But we are not really – still, there is not a decision or sufficient clarity on the way forward. So not much more I can say about that other to say that the IAEA is going to be working on this in the near future.

Patricia Paviet
Thank you, Paula.

Vladimir Kriventsev
Okay, thank you. We have another question from the audience. It's actually two questions, both to Tariq about where can we see these

60 plus readiness objectives, which is CNSC's proposal? There are two questions. Because is any document we can read about the 60 plus objectives?

Tarek Tabikh
Yes, thanks for the question because I meant to mention that in my presentation. We are currently finalizing our external page on SMR readiness, so it will be available on CNSCs SMR page. We already have a lot of information there. So, if you Google CNSC SMR, you'll find a lot of information on our pre-licensing process and our approach to SMR and advanced structure readiness. There'll be a specific page with all the objectives, all objectives or projects, 60 plus, 62 of them specifically right now that you could find there their scope and we plan to share their outcomes as well.

I would also take this opportunity to promote or bring a light to our current licensing reviews. So, the most advanced one is a Darlington new nuclear project. We have a site dedicated with information on the license that was submitted, our staff's review and timelines for the reviews and timelines for the hearing, and all applicable information in our open government portal. So, I could share it in the chat or if you google CNSC DNNP, you'll find that information as well if you're interested.

Patricia Paviet
Thank you very much, Tarek. Next question again, Paula. Can environmental regulators join with experience in regulations of reactors? And the person asking is from the UK.

Vladimir Kriventsev
The question is, I just clarified, the question is if they can be member of the SMR Regulatory Forum, this environmental agency of the UK?

Paula Calle-Vives
Well, the approach to become a member of the SMR forum is to approach the secretariat and then put a case that the organization will have the resources and the expertise associated with the topics under discussion by the SMR forum. And then the decision is taken by the SMR from a steering committee. So, this SMR forum is an independent forum. We just provide secretariat. So, the decision will depend on whether the topics that are currently under consideration will require this type of expertise. At the moment, the SMR forum is not looking into the environmental assessment topics. Maybe something for the future. And I will recommend to get in touch with us, get also in touch with the Office for Nuclear Regulation that is currently representing the UK, and discuss that possibility. I

mean, so far, the forum is really focusing on the topics that I mentioned in my presentation.

Thanks a lot.

Patricia Paviet
Paula, so if the person who asked the question doesn't know exactly where to go, can she send you an email? I think we have the three emails of the presenters as well as Vladimir and I. Can she do that?

Paula Calle-Vives
Yeah, of course.

Patricia Paviet
Okay, very nice. Thank you so much, Paula.

Vladimir Kriventsev
Okay, thank you, Paula, again. And I noticed that I have to leave now, immediately. Before I leave, I can answer the question, is Russia and China amongst the regulators currently? If not, why? I can say Paula knows better, of course, but I know that both countries actively participate in the different activities, preparing documents, and also, they are members of this SMR regulatory forum. And that's confirmed, right, Paula? Is it correct?

Paula Calle-Vives
Yeah, yeah, that's correct.

Vladimir Kriventsev
And then, before I leave, I'd like to thank every organizer, everybody, Berta, Patricia and all our panelists, Paula, Tarek and Greg, for attending. And sorry I have to go now, but I wish we meet again and wishing successful completion this webinar.

Patricia Paviet
Thank you so much, Vladimir. Thank you so much. You see, everyone is very active in the nuclear energy sector. There's no doubt about that. So, I'm going to continue. We still have a few questions. Let me see. Paula, what is the planning for having documents on transport floating reactor? Is the nuclear propulsion included?

Paula Calle-Vives
Okay, so, so far, we are just working on floating. There is going to be a document on the design and safety aspects of floating nuclear power plants, and that is not including nuclear propulsion. We are

also planning some – this is very, very tentative, we may develop some work on microreactors, regulatory aspects as well.

As I said, I think the IAEA currently needs to be a bit more holistic in the way we consider this and there needs to be some strategy or some plan on how we are going to address these issues in the future, because it's very complicated topic and there are some aspects that we are not considering yet. So that's something we need to take a little bit of time to do because we need to talk to the right stakeholders, our member states, and that will be coming in the next year maybe, or it needs a bit of time. So, these are the two pieces of work that are under development. There may be further work that needs to be done in the future because these two pieces of work does not really resolve the whole issue.

Patricia Paviet
Thank you, Paula. To both Tarek and Greg, what are the main disagreements between regulators and if there's any disagreement?

Greg Oberson
I would say – well, I guess I would say I don't believe that I would not characterize anything as a disagreement. I would say that there are different regulations that apply to different countries in compliance with their national law and policy, and there's some matters that require, in that sense, different approaches. But I would say I would explain those as perhaps different approaches more so than disagreements. There's none that have come to my mind.

Tarek Tabikh
Yeah. I would echo what Greg mentioned. I don't think there's any disagreements, just different approaches. And we have had a lot of success thus far working with our counterparts in the US through our MOC with the US NRC, analyzing different topics together and identifying similarities and differences in our approaches. We have recently published, I guess, the first part of our comparison of our approaches to structure systems and component safety classification. And that's on the US NRC's website, where we identify there's strong similarities in how we approach safety classification. And this kind of sets up the groundwork for future collaboration as we progress to that ultimate goal.

There are also some differences in approaches, but that is to be expected. And one thing I would also note is the US NRC has done a lot of work in terms of applying TICAP and ARCAP, as Greg mentioned, so risk informed, performance based, technology inclusive approach. So, part of that report, compared to the LMP or the Licensing

Modernization Project as well, and where we find as well, similarities to our traditional Canadian approach.

Patricia Paviet
Very good. Paula, is Switzerland actively participating in NHSI activities?

Paula Calle-Vives
Yeah. So, we have Switzerland recently joining one of our working groups of NHSI. They came to the meeting we had in April together with the SMR regulators forum. And in that meeting, basically the discussion was about finalization of the phase 1 work and also areas for future work. So, for that, Switzerland joined at the right time, and they were very active in the discussion. Okay, so thanks a lot for the question.

Patricia Paviet
Thank you very much. Greg, if 10 CFR part 53 is issued, what is the change to the licensee? As an example, is it accident analysis, safety classification and so on and so forth?

Greg Oberson
I would say that the regulation is intended to reflect. I wouldn't say it's a change per se, I believe it's just more intended to provide a regulate…

The primary benefit is that it would reduce the number of exemptions that an applicant would need to take from the current regulations in part 50 and part 52 because of matters that are not relevant to their design. You can use, for example, control room staffing. There could be other examples of transient analysis or accident analysis methods. So, it sort of obviates some of the complications that come with that. I don't believe what fundamentally changed the safety basis or the safety case that they would need to make, and certainly no manner sort of either increases nor decreases the standard of the analysis would be required for an application. So, as it concerns turns to what particular dimensions of that would have an implication for a particular vendor's design or application, that would really be very much vendor or design specific.

Patricia Paviet
Thank you very much Greg. Tarek, what are the differences in regulation approach for existing reactors and SMRs in terms of performance based and risk informed approach?

Tarek Tabikh

Thank you for that great question. So, when regulating SMRs advanced reactors, we are taking the same approach which we've always been as a performance-based, risk-informed regulator. With SMRs, there is a potential for proponents to demonstrate other aspects that was not there in traditional power plants, for example, inherent safety aspects. So, when applying a gridded approach and risk informed approach, we need to understand from the proponent the level of confidence and demonstration of these novel aspects and safety features. It is, I would say, a little bit of a double-edged sword. If the claim has very low confidence due to the lack of R&D work to justify and substantiate the claims being made, then the risk-informed process requires further analysis and scrutiny of the claims being made. However, if there is sufficient demonstration to validate and verify those claims, then the regulator could take a less in depth review due to the high confidence of the results.

And we understand that it would be beneficial to proponents and to licensees if it was clearly laid out. It's already in our existing documentation, but as part of our program where we have a couple objectives, one on risk informed decision making, and one on defense-in-depth demonstration, to provide that clarity and kind of case examples to proponents to better understand our expectations. So, I know we are currently working on this, and we plan to publish something specifically on defense-in-depth shortly and moving forward in the next few months on the gridded approach as well. So, we will have that further clarity at that time to potential proponents.

Patricia Paviet
Thank you so much Tarek. A question for Paula. Can the IAEA develop technology inclusive safety standards at a high level that are applicable to water-cooled and not water-cooled reactors.

Paula Calle-Vives
Yeah, thanks a lot. That's a great question. And it's something that now that we are doing the revision of the IAEA safety standards to address the gaps, we are thinking about that. So, I think generally the IAEA would like to have technology-inclusive safety standards and this to be done as much as possible. On the other hand, it is important to also ensure that we are not losing granularity, and we are not removing information that can be of use for the water cool technologies. And the same for some of the non-water-cooled technologies, it may be useful to bring some additional examples of information. So, we need to find the right approach to do that. The design safety standards have not yet been planned for revision to include non-water-cooled technologies at this moment, but this is something that we know is coming. And currently, the section that

is in charge of doing that work is considering how to do this and when to do this and what are the alternatives to do this.

Just as an example, this is not of relevance to this specific question, but for example, some of the work we did now on updating the SSG towards the safety guide on licensing, at the end this is a general safety guide that should be applicable to any technology. But we took the decision to have an appendix on SMRs, so we will not include too much information on the main body of the text that is only applicable to one type of technology. So, even if the safety guide will be applicable to everything, we added an appendix for some specific type of technology. So, it's going to be an approach taken case by case, and it's a decision of the experts involved on how to provide the right amount of information.

Patricia Paviet
Okay, very good. So, I have I guess probably one of the last questions from Kenya to all the panelists. I want to hear what the panelists have to say about some sort of standardized international regulatory process that will make SMR and microreactor financially accessible to countries like Kenya.

Paula Calle-Vives
I am going to start, and then I'm sure that Greg and then Tarek can give their perspective. So, I think there is an acknowledgement internationally that these technologies need to be deployed globally and that the regulatory cooperation is more and more important. There are also issues with resources from regulatory bodies. And of course, we are also realizing embarking countries are very interested in these technologies. And it's not so easy to assess them, to consider them. So, the other consideration is that the harmonization really among countries is not really possible and actually may be meaningless because we need to understand how these requirements are applied to a design to be able to get to the same goal. So, in NHSI, in order to try to help all these things, we just created this multinational joint review process that would allow regulators to review something jointly. I mean, this is not an international process. It's not an international design certification process. It's a very, very early on review that will be carried out jointly and the response by the regulatory bodies involved with the responsibility of the different regulatory bodies. So, there is no like entity or an international process to do this. But this kind of approach will allow that kind of a standardization that could also help embarking countries to better leverage feedback or inputs from other countries. The problem is that I think Tarek and Greg can represent the point of view of national regulators where the country needs to review the design against the national expectations. You know, the process exists, the

responsibilities with the country, and we cannot shortcut this with an international process, but we can try to streamline the reviews, we can try to work together much more to try to share resources and knowledge. So that would be our first step to achieving something like the participant was asking.

Patricia Paviet
Yeah, thank you, Paula. Greg or Tarek, something to add?

Greg Oberson
Yeah, yeah. I guess I would say that the NRC, I believe the United States as a policy matter generally supports standardization and harmonization. But as a policy matter, I believe just sort of echoing what was previously said, there is a belief that certain decisions are appropriately made by the autonomy of the individual government, and that's a principle that will continue to underpin the NRC's engagement within the international community.

Patricia Paviet
Sure.

Tarek Tabikh
And I'll just supplement what my colleagues said, so fully agree with what they mentioned. National sovereignty is a really important point when it comes to this. We need to walk before we could run. We have SMR and advanced reactor license applications with us today, and I know in many countries they are expecting licensed applications soon. And just in realistic timelines to develop something. This could be a future aspiration certainly, but for the time being we're focusing on using what works well. For example, our existing robust framework, our collaboration with our counterparts, supporting embarking nations, and as we support some of the initiatives that the IAEA is championing as well, which kind of goes to that future aspiration.

For the quest for Mr. Agar [ph] from Kenya. I would also say that it's important for each national regulator to be an intelligent customer, to be able to accept and ensure the safety for their citizens and their environment, their public, as part of that acceptance of an international review. And I would also encourage participation in leveraging the tools that are being developed by some of these international activities, like the joint review process developed by working group 2 and NHSI, or the leveraging of information that developed by working group three. These are all tools that one could leverage to streamline the lesson review in their home nations.

Patricia Paviet

Thank you very much, Tarek, Paula and Greg. Paula, I think it's for you. Is there cooperation with the International Maritime Organization?

Paula Calle-Vives
There's been some discussions on the difference in the work that they are doing, in the work that we are doing. We have involved them in our work, and we have a constant dialogue with them. But again, as I said, we need to decide what is the next step in the work.

Patricia Paviet
Okay, very good. Greg, what is the most time-consuming issue in the actual licensing process for non-water cooled reactors?

Greg Oberson
I believe that it is – I don't know that we've done enough of them to say that there is one specific issue that I could speak to, for instance, core design or something like that. I believe if I were to take a guess, the most complicated matters will be related to actual siting, seismic design, seismic analysis. I believe with some insight that that's likely to be the most complicated issue for some of these designs.

Patricia Paviet
Thank you. Greg. Maybe the last question. I think we covered all of them. We are almost done two hours. Thank you so much for hanging them with us. Paula. The last question. What is the plan to revise SSR 2/1 to be applicable to SMRs?

Paula Calle-Vives
Okay, so that's one of the safety standards, the requirements that is very, very important for the design. So far, the safety standard is not in the medium-term plan for revision because it was issue – the last revision was not so long time ago. But now as I said, the section that is in charge of the safety standard is considering how, when the safety standard will be revised. They are doing now the plans for 2026-2027 and they are considering this topic. So, there is no plan yet, but it's going to be a plan in the near future to revise this safety standard. And this is one of the very important ones to revise for sure for SMRs and non-water-cooled technologies.

Patricia Paviet
Thank you so much. Paula, I think we covered all the questions. Three minutes and it will be 2 hours that we are all together. It was my pleasure really to have you, Tarek, Greg, Paula with us, and also to Vladimir, who left a little bit earlier. Thank you so much for a very, very good Q&A session. You know, Berta and I, we are doing that for almost eight years now, and we have realized that the Q&A

session is as important as the presentations. All the webinars are recorded and archived at www.gen-4.org.

So, if you want to really again listen carefully, take some notes, do not hesitate to look again at this webinar. Diffuse the information. Thank you again, Paula, Tarek, and Greg. I think, with that, I am going to give everyone the time, and I wish you a good day, a good evening, a good night. Thank you again. And we see you on the 5th of June for our next webinar. Thank you very much, everyone. Bye-bye.

Berta Oates
Bye-bye.

Tarek Tabikh
Thank you, Patricia, Berta, everybody. Bye-bye.

Paula Calle-Vives
Thank you.

Patricia Paviet
Bye-bye for now.

END