Effective Nuclear and Radiation Regulatory Systems: Preparing for the Future in a Rapidly Changing Environment

Summary of an International Conference
Abu Dhabi, United Arab Emirates, 13–16 February 2023

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EFFECTIVE NUCLEAR AND RADIATION REGULATORY SYSTEMS: PREPARING FOR THE FUTURE IN A RAPIDLY CHANGING ENVIRONMENT

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PROCEEDINGS SERIES

EFFECTIVE NUCLEAR AND RADIATION REGULATORY SYSTEMS: PREPARING FOR THE FUTURE IN A RAPIDLY CHANGING ENVIRONMENT

SUMMARY OF AN INTERNATIONAL CONFERENCE
ORGANIZED BY THE
INTERNATIONAL ATOMIC ENERGY AGENCY
AND HOSTED BY THE
GOVERNTMENT OF THE UNITED ARAB EMIRATES
AND HELD IN ABU DHABI, 13–16 FEBRUARY 2023

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FOREWORD

The International Conference on Effective Nuclear and Radiation Regulatory Systems: Preparing for the Future in a Rapidly Changing Environment took place in Abu Dhabi from 13 to 16 February 2023. The conference, hosted by the Government of the United Arab Emirates, was the sixth in a series on the topic of effective nuclear and radiation regulatory systems. The five preceding conferences were held in The Hague, the Kingdom of the Netherlands, in 2019; Vienna in 2016; Ottawa in 2013; Cape Town, South Africa, in 2009; and Moscow in 2006. Building on the conclusions and deliberations of these earlier meetings, the 2023 conference reviewed issues of importance to the global regulatory community, focusing on the importance of regulators in ensuring a high standard of performance while navigating a rapidly changing environment.

More than 600 registrants, including senior regulators from around the world, participated in what was the most widely attended conference on this subject to date. Approximately 360 attendees from 95 Member States and three international organizations participated in person; others followed the conference remotely. There were four keynote presentations, five technical sessions, five panel discussions, two side events, a special panel and four side presentations, while 68 invited papers were presented. Daily plenary sessions facilitated further discussions, as well as questions and answers.

The objective of the conference was to share experiences of improving the effectiveness of nuclear and radiation regulatory systems. The focus was on how to prepare for the future in a rapidly changing environment, including identifying strategies to ensure regulatory resilience, and on overcoming life cycle challenges of nuclear installations and of activities involving radiation sources. It also focused on strengthening international cooperation and information sharing to improve regulatory effectiveness, agility and consistency in regulatory approaches related to new technologies. The major themes of the conference covered methodologies to increase public and stakeholder trust and regulatory credibility, best practices to sustain a competent workforce and develop the next generation of regulatory professionals and leaders, and programmes and strategies for the safe and secure use of radioactive material.

This publication includes the opening addresses, a summary of the deliberations at sessions and panels, and the Conference President’s summary and conclusions.

The IAEA wishes to thank the contributors involved in the preparation of this publication. The IAEA officers responsible for this publication were S. Mallick, K. Asfaw and M.A. Añez of the Office of Safety and Security Coordination.

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1. OPENING SESSION

1.1. WELCOME ADDRESS

L. Evrard
Deputy Director General,
Department of Nuclear Safety and Security,
International Atomic Energy Agency,
Vienna

Dear Excellencies, ladies and gentlemen, dear colleagues,

It is my great pleasure to be here for the opening session of this major international conference on regulatory systems. On behalf of the IAEA, please let me start with a very warm welcome to all of you.

This IAEA conference is the sixth international conference on effective regulatory systems, which started 16 years ago. The participation today is impressive, commensurate with the interest the international community has shown on regulatory matters for nuclear safety, radiation safety and nuclear security.

In total, more than 600 participants have registered, from 95 Member States and three international organizations. This is a record number of participants ever for a regulatory conference. There are also 45 volunteers from the host organization who are supporting this event.

My deepest thanks go to all those who were and are committed to making this conference in Abu Dhabi a success, with the ultimate objective of enhancing safety and security worldwide, for the benefit of all of us.

Allow me to start by extending my sincere appreciation to the Government of the United Arab Emirates for hosting this important conference, to His Excellency Hamad Alkaabi, and to the Federal Authority for Nuclear Regulation for its dedicated support and involvement with the logistics and preparations for the conference.

I would also like to take this opportunity to express my deep gratitude to Mr Christopher Hanson, Chair of the United States Nuclear Regulatory Commission and to Mr Christer Viktorsson, Director General of the UAE Federal Authority for Nuclear Regulation, for agreeing to serve as President and Vice-President of this conference.

My thanks also go to all members of the Programme Committee for their active and key contributions to the preparation of this conference.

This week's conference is a flagship event for nuclear safety and security. This year, the topic selected by the Programme Committee is Preparing for the Future in a Rapidly Changing Environment. This topic is not completely new, of course, but it has taken on a very specific meaning over the last three years, which have been characterized by significant and unpredictable events for nuclear safety and security.

I remember the last regulatory conference, held in 2019 in the Netherlands, where we addressed a set of major issues related to the conference topic, which was at that time 'Working Together to Enhance Cooperation'.

The topics we covered during that conference related to regulating radiation and medical facilities, regulating nuclear installations, and leadership and management for safety and security. All these topics were very valid in 2019, and they are still very relevant today. However, when I remember that conference in 2019, I get the feeling that today we are living in a very different world. And yet, it was just three years ago. Of course, the environment we are working in is always evolving. But nowadays it seems to be more than that: time is speeding up and also some of the changes we are experiencing are disruptive.

Let me give you just a few examples of some of the major changes we have experienced in a very short period of time.

First, we are observing an increasing interest in new and innovative technologies, and in the deployment of safe and secure small modular reactors (SMRs) in particular. There will certainly be benefits for nuclear safety, but the deployment of SMRs also raises new issues, in particular regarding the licensing process and the nuclear security of such reactors. That is why the IAEA Director General has launched a new initiative on this important topic, the Nuclear Harmonization and Standardization Initiative (NHSI).

Second, the global pandemic has brought its share of change, including for regulatory activities. On another topic, in the light of recent extreme events, the severity of external hazards also needs to be reconsidered.

Last, we have been observing and experiencing in some contexts extremely difficult conditions for ensuring nuclear safety and security over the past year. This has meant we have had to adapt our way of assessing nuclear safety and security, and to some extent, to develop a new mindset for doing this. All this is evidence that there are some events that we cannot predict.

Within our mandate, as regulators and as the IAEA, we have to adapt our way of working to address these new challenges, while keeping the focus on maintaining nuclear safety and security. In particular, we can collectively develop our capacity to be more resilient, while facing unexpected or unprecedented situations, and we can do this by implementing appropriate measures. However, in spite of all these changes, there are some fundamental constants in nuclear safety and security, just as there are for physics.

Some of these fundamental constants are:

— Nuclear safety and security culture;
— Knowledge management;
— Stakeholder involvement and transparency;
— The need for diversity, be it geographical diversity, gender diversity, or diversity between people of different generations, because diversity and the openness and questioning attitude it implies are a true asset in maintaining nuclear safety and security at the highest levels;
— Building and sustaining a competent workforce, preparing the next generation of professionals and leaders for nuclear safety and security is also a key issue.

So, under these rapidly changing conditions, what do we need to ensure nuclear safety and security at the national level and at the global level?

The key words for me are resilience and capacity to adapt. I believe that resilience will come from holistic approaches and international cooperation. Increased resilience will help anticipate some challenges in the future, but we will still have to continue to learn how to address unexpected and unpredictable events, and for this, to develop our capacity to be flexible, and to develop new thinking and even a new mindset as needed.

The IAEA will continue to further strengthen international cooperation in support of regulatory effectiveness, agility and consistency in regulatory approaches to enhance nuclear safety and security worldwide.

This week's programme is very intense. It is aimed at capturing many of these aspects the IAEA is fully committed to supporting. The conference will involve a wide range of panellists who have been selected for their expertise, knowledge and experience, and who represent the diversity that we are committed to promoting.

The audience is also very wide and diverse, and I hope that this will enable very active and fruitful interactions. As you can see, all the ingredients are here to make this a great conference.

To conclude, I would like to refer to the conference poster. I like this poster very much because it is a combination of simple but key messages:

— Technology will be at the heart of our future;
— The human dimension will be omnipresent;
— Nuclear technology and people will have to be efficiently combined, and be in harmony with one another;
— Working together and building trust will be indispensable;
— Finally, on the poster there is also a nice light for an inspiring and positive approach to the future.

As we can see, many symbols in a single poster, very well designed.

Excellencies, ladies and gentlemen, dear colleagues,

We have been facing unprecedented challenges for the last three years. We are still experiencing very complicated times at the global level. This week provides us with a rare opportunity to collectively reflect on how to strengthen nuclear safety and security in such a rapidly changing environment. I hope that this week will be extremely productive, drawing on everyone's experience and expertise.

I would like to emphasize that technical issues should remain at the heart of our discussions this week for us to gain the greatest benefit from having gathered so many seasoned experts from a wide range of backgrounds and with diverse expertise.

Let me conclude by thanking once again, on behalf of the IAEA, all those who have been involved in making this conference happen in such excellent conditions.

Thank you very much to our host, the United Arab Emirates, to the President and the Vice-President and their teams who provided great support, thank you to all speakers, to all participants, and to the team from the IAEA Department of Nuclear Safety and Security and the other IAEA departments involved, with special thanks to Shahid Mallick, the Scientific Secretary of this conference.

I count on you to make this week's conference as fruitful as possible. I look forward to the outcomes of the discussions. I count on you to mobilize the best of our collective expertise, which is so rich and diverse, with the ultimate objective of enhancing nuclear safety, radiation safety and nuclear security throughout the world.

And this is what brings us together today. I wish you all a very successful Conference.

Thank you.

1.2. WELCOME ADDRESS

H.E. Ambassador H. Alkaabi
Permanent Representative of the United Arab Emirates
to the International Atomic Energy Agency,
Vienna

Mr. President, Excellencies, distinguished guests, ladies and gentlemen.

At the outset, I would like to welcome our distinguished guests to Abu Dhabi who are attending this week's International Conference on Effective Nuclear and Radiation Regulatory Systems, which is organized by the International Atomic Energy Agency and hosted by the United Arab Emirates Federal Authority for Nuclear Regulation (FANR).

The selection of the theme for this year's conference, 'Preparing for the future in a rapidly changing environment' is both timely and crucial in light of the changes that we have been witnessing in recent years to the global nuclear industry.

There has been a steady increase in the demand for nuclear energy, with about 60 reactors that are under construction today, and many counties are considering embarking on their own nuclear energy programmes to meet the increasing demand for energy in addition to meeting their clean energy goals.

Such changes to the industry comes with its set of challenges that Governments, regulators , operators and the international community need to address and be prepared for ensuring the safe and secure use of nuclear energy and the application of radiation, while maintaining the sustainability of the industry.

We, in the United Arab Emirates, are proud of the historic milestones made in the past decade to realize the UAE's Peaceful Nuclear Energy Programme since the UAE Government issued its nuclear policy in 2008. We have developed and implemented a robust regulatory infrastructure, which played a crucial role in supporting the programme's successful execution .

The UAE is the first country in the Arab region to build and operate a nuclear power plant, and the first start a new programme in the last three decades. Today, two units of the Barakah Nuclear Power Plant are commercially operational and delivering electricity around the clock; Unit 3 is under commissioning phase and soon will move into commercial operation . We expect Unit 4 to receive the operating licence later this year from the Federal Authority for Nuclear Regulation. This success was the result of the UAE Government vision, commitment and long term strategies in delivering a unique and responsible peaceful nuclear energy programme supporting the realization of the UAE's 2050 Energy Strategy.

The UAE has been taking concrete steps towards diversifying its energy mix, which have been evident in its 2050 Energy Strategy, and it is commitment to achieve its Net Zero Goal by the year 2050. Furthermore, the hosting of COP28 in the UAE later this year, and declaring 2023 to be the Year of Sustainability are some of the initiatives taken by the UAE Government to address climate change, which is one of the key topics in this conference that is directly linked to the role of the nuclear industry and its regulation.

Mr. President,

I would like to underscore that the development of the UAE's robust nuclear regulatory infrastructure was the result of our long and strong cooperation with our national and international partners, and in particular our close cooperation with the

IAEA. The IAEA's support, since the inception of the UAE's nuclear energy progamme, was instrumental and significant in developing the UAE nuclear regulations, policies and standards, hence positioning the UAE a role model for nuclear new comer countries.

In conclusion,

I would like to express my gratitude and thanks to the international experts, Member State representatives and speakers for their participation to enrich discussions in this conference and share best practices to prepare for the future for more effective nuclear and radiation regulatory systems.

It will without a doubt help strengthen the shared vision and the roadmap to achieve the safety and security of the peaceful uses of nuclear energy globally.

I am confident that we will achieve our goal. I wish you constructive discussions in the days ahead , and an enjoyable stay in Abu Dhabi.

Thank you.

1.3. WELCOME ADDRESS

C. Hanson
Conference President,
Chair of the United States Nuclear Regulatory Commission,
Washington, D.C., United States of America

Colleagues, distinguished guests, good morning! May I call the meeting to order. Thank you. Welcome to the IAEA International Conference on Effective Nuclear and Radiation Regulatory Systems.

Thank you to the IAEA team, Deputy Director General Evrard and Your Excellency Ambassador AlKaabi. I am Christopher Hanson, Chair of the United States Nuclear Regulatory Commission, NRC, and I am honoured to be the President of this conference. I want to extend my welcome to all of you and congratulate the Programme Committee and Conference Secretariat for their efforts.

And I would especially like to thank my good friend and colleague the Director General of the Federal Authority for Nuclear Regulation, Christer Viktorsson, for serving as Vice President of the conference. It is the combined effort of the Programme Committee, the Secretariat and the FANR which has resulted in the largest attendance ever for this conference. Six hundred registered.

This is the sixth in a series of conferences on effective regulatory systems, which began in 2006; the most recent in The Hague in 2019. These conferences emphasize our role as regulators in the safe and secure use of nuclear materials. After the conference, I hope we all return home with insights that will strengthen our individual organizations, which will in turn strengthen nuclear safety worldwide.

Later today, James Scott of the Australian Radiation Protection and Nuclear Safety Agency will provide an overview of activities and progress since the last conference. I strongly encourage everyone to share what has changed in your organizations since the previous conference. Together, we will learn from our collective wisdom and experience.

The theme for this week is ‘Preparing for the Future in a Rapidly Changing Environment’. These words were chosen intentionally to acknowledge the many dynamic environments impacting our regulatory role. First, that climate change is leading to increased interest in nuclear power — keeping existing plants open and building new ones. And second, that the regulatory environment is changing due to significant advancements in nuclear technologies — not just new reactor designs, but advances in the use of radiological materials, including medical technologies.

Finally, we gather today in unprecedented circumstances as the safety of nuclear power plants is threatened by war. These circumstances challenge the way we must think about the safety of nuclear facilities. I want to commend Director General Grossi for his leadership in upholding the ‘Seven Pillars of Nuclear and Safety and Security’.

The programme includes four keynote addresses this morning, five topical sessions followed by engaging panel discussions, and numerous poster sessions and side presentations.

This afternoon the side presentation is a young professionals competition. I encourage you to listen to the newest generation of nuclear regulators make their presentations and then cast your vote for your favourite.

Speakers will share their countries’ ongoing efforts on:

— Emerging challenges;
— Regulating modern medical and radioactive materials;
— Enhancing regulatory agility;
— Considering climate change effects on nuclear installation safety;
— Addressing the full nuclear lifecycle;
— Cooperating to promote a credible and resilient regulator; and
— Building capacity for safety and security.

I encourage you all to help make the conference a success by engaging, asking questions and sharing your views. At the end of each day, I will host a panel with the Chairs of that day's sessions to highlight the main topics, conclusions and potential recommendations. Each morning, DG Viktorsson (Christer) and I will spend 15 minutes summarizing the major points and looking forward to the day ahead. We will build the President's Report from the conference as we go.

We will hear from regulators with decades of experience and regulators who are only now standing up their programme. It's an exciting time to be involved in nuclear and radiological safety, and it's imperative we learn from each other and hold each other accountable to the safety and security mission we all share. To conclude, let me again thank the conference Programme Committee, the IAEA Secretariat staff, and FANR for all their efforts to bring us all together and to make this week a success. I wish you all an engaging and worthwhile conference, and I look forward to learning from you.

Thank you.

1.4. NUCLEAR AND RADIATION REGULATORY UPDATES SINCE THE LAST CONFERENCE

Mr J Scott of the Australian Radiation Protection and Nuclear Safety Agency provided a summary and overview of actions since the 2019 conference in The Hague, reporting in particular, the following:

— The IAEA published IAEA-TECDOC-1974 on Application of a Graded Approach in Regulating the Safety of Radiation Sources and IAEA-TECDOC-1980 on Application of a Graded Approach in Regulating Nuclear Installations, and provided training based on these reports.
— The IAEA published IAEA-TECDOC-1899 on Effective Management of Regulatory Experience for Safety.
— The International Conference on Safety and Security of Radioactive Sources (in June 2022) addressed the management of disused sources and those out of regulatory control and prevention of loss of regulatory control through preventive measures, including tracking, registering and cross-border cooperation.
— The IAEA published Technical Reports Series No. 1002 on Notification, Authorization, Inspection and Enforcement on Safety and Security of Radiation Sources.
— The IAEA published Considerations for the Development of a Protection Strategy for a Nuclear or Radiological Emergency in the Emergency Preparedness and Response series of reports.
— There were various IAEA initiatives for the development of regulatory infrastructure, including:

    - A new strategic plan in support of embarking countries was developed by the Regulatory Cooperation Forum.
    - An Advisory Mission on Regulatory Infrastructure for Radiation Safety and Nuclear Security (RISS) was organized.
    - Two Emergency and Preparedness Response Capacity Building Centres were established in Morocco and France; Capacity Building Centres were also established in Austria, Japan, Republic of Korea and the Russian Federation.

— The IAEA continued to enhance the efficiency and effectiveness of peer review and advisory services. Two technical meetings of the Peer Review and Advisory Services Committee were held, in 2020 and in 2022. Integrated Regulatory Review Service (IRRS) self-assessments have been improved and guidelines have been developed for IRRS-ARTEMIS back-to-back missions.
— The Nuclear Harmonization and Standardization Initiative (NHSI) was launched in March 2022 to bring together key stakeholders to harmonize regulatory and industrial approaches to the deployment of advanced reactors such as SMRs.
— The Rays of Hope programme was established to assist Member States in developing cancer care capacity, including radiation safety legislation, quality control, guidance and training, together with procurement of equipment for medical radiation applications.

— The IAEA response to COVID-9 included surveys of regulatory bodies to determine the impact of the pandemic on the regulation and safety of nuclear and radiation facilities.

1.5. KEYNOTE PANEL

PREPARING FOR THE FUTURE IN A RAPIDLY CHANGING ENVIRONMENT

The Keynote Panel comprised her Excellency Ms Mariam Almheiri, the UAE Minister of Climate Change and Environment, Ms Rumina Velshi, President and Chief Executive Officer of the Canadian Nuclear Safety Commission, Mr Olivier Gupta, Director General of the French Nuclear Safety Authority and Chairman of the Western European Nuclear Regulators' Association (WENRA), and Dr Khalid A. Aleissa, Chief Executive Officer of the Nuclear and Radiological Regulatory Commission of the Kingdom of Saudi Arabia.

The keynote speech by the UAE Minister of Climate Change and Environment, was delivered by video. She said that 2023 is to be the year of sustainability, as announced by the UAE President, His Highness Sheikh Hamad bin Zayed Al Nahyan, and in line with the country's hosting of the United Nations Framework Convention on Climate Change Conference of the Parties (COP 28) later this year.

The Minister stated that, as the host country of COP 28, the UAE has two roles to play: first, to welcome the 197 attending countries and bring them together to address the threat of climate change, gain consensus and define firm actions and next steps to accelerate progress towards a climate neutral world by mid-century; second, as a member of the Paris Agreement, to ensure that the UAE continues to make substantial efforts to realize its own commitments for combating climate change and reaching net zero by 2050.

Given that climate change threatens all of us and our planet, the Minister urged collective action to mitigate and adapt to the future effects of climate change. Among the many measures to address the climate crisis, the Minister affirmed that peaceful, clean nuclear energy is a significant pillar and that a paradigm shift was necessary to enable a just energy transition.

The Minister described the UAE's progress as the first Arab country to use nuclear energy for peaceful purposes, with the first three units of the 5600 MW Barakah Nuclear Power Plant already connected to the grid. Once fully operational, the Minister stated, the plant will provide up to 25% of the country's electricity needs, eliminating up to 22 million tonnes of carbon emissions every year, equivalent to removing 4.8 million cars from UAE roads — half the number of private vehicles registered in the country today.

In conclusion, while the COP 28 UAE Presidency will highlight decarbonization as a global imperative, the Minister stressed that enhancing the effectiveness of nuclear as well as radiation regulatory systems is essential to a global response to new and emerging environmental challenges to combat the climate crisis.

Ms Velshi, President and Chief Executive Officer of the Canadian Nuclear Safety Commission, noted that this series of conferences has always been, and continues to be, an important forum for advancing nuclear safety and regulatory excellence, and this year's timely theme, Preparing for the Future in a Rapidly Changing Environment, focused the conference on a time of change and challenge. She noted that nations are motivated to accelerate the fight against climate change and, at the same time, are increasingly concerned with achieving energy security. Nuclear is being seen, therefore, as a critical tool in achieving these goals.

In this changing environment, Ms Velshi considered the onus to be on the global nuclear community to work together to deploy a safe, reliable and effective nuclear fleet. To fulfil this responsibility, she emphasized the need for international standardization of designs and the pursuit of greater harmonization of regulations across borders. Ms Velshi, noting that forces at work today will shake the nuclear and wider energy industry for decades to come, asked: 'How shall regulators react'? She emphasized that regulators exist to protect people from risk. They must be ready for whatever technology comes next and keep pace with changing times across society.

The evolving nature of information sharing and communications demands that regulators globally, without any surrender of national sovereignty, be more transparent in their operations, more inclusive in their structure and more global in their vision. In this regard, Ms Velshi considered there was both an opportunity and an obligation to work together more closely and to share ideas, perspectives and experiences for the benefit of all.

In her remarks, Ms Velshi posed three questions for regulators to consider:

- What practical and immediate steps can we take to contribute to global efforts in developing harmonized approaches to regulatory regimes?
- How can we improve the implementation of the IAEA's safety standards to ensure a robust and safe global deployment of new technologies?
- What best practices can we share that will help advance the harmonization of regulations and standards?

Ms Velshi urged regulators to keep the focus on safety, but to avoid becoming an obstacle to progress or an impediment to the deployment of SMRs or new technologies. Noting that the COVID-19 pandemic was a generational challenge for scientists, policymakers and regulators, it exemplified how we can seize opportunities to collaborate internationally and adapt to new challenges. For SMRs, the focus had shifted from national to global, and regulators would need to adapt.

Concluding, Ms Velshi said that working together and sharing experiences more closely makes for more efficient and effective regulation. It reduces duplication of effort and it leads to better, quicker, more informed decisions, all without surrendering regulatory sovereignty or compromising safety.

Mr Gupta, the Director General of the French Nuclear Safety Authority and Chairman of WENRA, reaffirmed that the nuclear community has entered a new and challenging era in the post-Fukushima decade during which all stakeholders have been focusing on safety. European nuclear power plants (NPPs) undergoing stress tests are benefiting from substantial modifications to face potential loss of power. The benefits of such improvements have become more apparent with the war in Ukraine and with some NPPs facing loss of power.

Countries are seeking to be more energy independent in terms of nuclear fuel supply. In this context, Mr Gupta noted there may be safety consequences arising from undue pressure and burden on nuclear stakeholders, pressure from citizens and from governments on NPP licensees to put priority on electricity supply, and pressure on nuclear regulators to not delay the development of nuclear projects.

WENRA has reflected on this new situation and issued three recommendations: one for governments; one for licensees; and one for regulators. The first recommendation is that energy policy decisions be taken in due time and remain stable in the long term. This is essential because an absence of predictability and a lack of stability are detrimental not only to the industry but also to nuclear safety. The second recommendation is that licensees continue to have prime responsibility for safety and

thus, be expected to demonstrate the safety of their operations and activities and submit these demonstrations in a time frame that enables rigorous regulatory review. The third recommendation is that regulators commit to work effectively and efficiently to make regulatory decisions in a timely manner. Also, the continued independence of regulatory decision making is essential so there is no undue interference in regulatory decisions.

Dr Aleissa, Chief Executive Officer of the Nuclear and Radiological Regulatory Commission of the Kingdom of Saudi Arabia, speaking especially as a member of a new regulator established three years ago, highlighted the importance of cooperation and collaboration, and learning from other regulators. He also recognized the importance of communication among regulators and had worked to establish positive working relationships with regional and international regulators. He emphasized the importance of establishing and upholding cross-border coordination and collaboration between State nuclear regulators in order to provide stronger transboundary control over matters like nuclear security and nuclear emergency preparedness and response, as well as State level nuclear control.

The IAEA, on the other hand, functions as an important global nuclear regulatory platform to promote harmonization, establish standards and guidelines and provide assistance in building capacity. However, the IAEA alone will not be enough to play the necessary roles for several reasons, among which are its limited financial resources and the rapidly expanding needs of its Member States. States, in particular their national nuclear regulators, can provide several diversified forms of support to the IAEA that contribute to a more effective nuclear control and safety regime around the world.

The general conclusions of the Keynote Panel were:

— Nuclear power must be in the energy mix to reach global climate change goals, decarbonization and electrification.
— There was growing concern of some Member States regarding their ability to achieve the short, medium and long term balance between electricity production and consumption.
— The global nuclear community was encouraged to support nuclear embarking countries and work together to deploy a safe and reliable nuclear fleet while ensuring that regulatory independence and effectiveness is preserved and continuously improved.
— Forward thinking is needed regarding the growing needs of the sector in the face of the rapid evolution of nuclear technologies. Regulators must develop a performance based, risk informed approach to regulatory readiness and effective communication and engagement.
— The continued independence of regulatory decision making is essential.
— Greater harmonization is needed to enable the development of new projects and regulation need not be an obstacle to innovative design if regulatory bodies become engaged early in new design development.

2. SESSION SUMMARIES

2.1. SESSION 1

LEADERSHIP THROUGH NEW AND EMERGING CHALLENGES

This technical session provided an opportunity for regulatory bodies to share their experiences on how to: ensure regulatory resilience; better understand strategies, needs and ways to adapt and respond to unexpected challenges; and share notable practices and lessons learned from regulatory experience.

The following points were noted during the session:

— During the COVID-19 pandemic, nuclear and radiation safety and security regulatory bodies demonstrated their capability to continue performing their duties to ensure an uninterrupted supply of electricity and radiopharmaceuticals.
— It was recognized that the IAEA global survey of regulatory bodies on the impact of the COVID-19 pandemic on regulatory activities for the safety of radiation sources showed that many regulatory bodies have developed plans to minimize the impacts of such unforeseen events to continue to ensure regulatory oversight for safe and secure operations. However, regulatory bodies in some Member States noted some reductions in regulatory activities and staffing levels and there could be an increased risk of radioactive sources becoming orphaned.
— The challenges from a rapidly changing environment highlighted the need for regulatory bodies to be prepared to 'expect the unexpected' and to develop programmes to keep ahead of emerging threats while at the same time sustaining the performance of their oversight activities.
— Climate change was highlighted as presenting a range of new challenges for regulatory bodies, including the hazards posed to operating NPPs by changing seawater levels and severe weather conditions. The drive for low carbon energy sources and concerns over energy security has led to national governments making rapid decisions on life extensions for existing NPPs and accelerating proposals for new nuclear build, including new technologies such as SMRs.
— The regulatory bodies in some Member States responded to these challenges by focusing attention on people and technology. The importance of maintaining an engaged and highly skilled workforce was emphasized. It was recognized that the ageing demographic in many regulatory bodies was a challenge to securing the appropriate competencies to ensure continuing organizational resilience. Capacity building activities should focus on developing the next generation of regulators.
— The use of diagnostic imaging procedures utilizing ionizing radiation such as radiotherapy technology and procedures is increasing in some Member States that have previously had only limited access to such applications. This has created a need for regulatory bodies to promote greater awareness of radiation protection and safety of associated radiation exposures to protect patients from risks related to radiation.
— The need to adapt to new working practices was stressed, such as hybrid working, and the greater use of available technology for digital transformation along with the recognition of the cybersecurity issues associated with remote working.

— Regulatory bodies need to use technology to work smarter, including using data analytics to highlight areas for regulatory attention and improvement in a risk informed environment. Experience was shared regarding the means of transformation to a modern risk informed regulator by relying on the unique interaction of people, technology and innovation to provide a systematic approach to regulatory decision making.
— Regulatory bodies need to be flexible but positive in their approaches to new and emerging technologies. The benefits from adopting a more risk informed approach to regulatory oversight and more objective oriented regulations, as against prescriptive oriented regulations in some Member States, was highlighted. The risk informed approach to regulation can bring agility and flexibility to regulatory oversight activities.
— Examples of regulatory body resilience as a result of regional cooperation were highlighted where the benefits of the regional availability and free movement of critical workers, access to medical testing along with access to specialist equipment were stressed. Regional body cooperation can alleviate issues associated with long term resilience of the workforce and supply chain issues. The need for increasing cooperation and coordination nationally, regionally and internationally was emphasized.
— International cooperation should be further strengthened to support the development of resilience and robustness of nuclear safety, radiation safety and security regulation through cooperation at the regional and international levels. International cooperation is needed to address global issues such as the effects of climate change, the energy crisis and other unexpected scenarios.
— The challenges from the introduction of new technologies involving innovative NPP designs were outlined, particularly the uncertainties over the use of passive safety systems. Such systems may enhance safety, but may also bring unexpected challenges such as from the demonstration of the performance of passive safety systems. The harmonization of safety requirements and licensing approaches for innovative designs was discussed along with the importance of using opportunities to share knowledge on the design and safety evaluation of new NPPs.
— The importance of bridging communications between the political and scientific communities to reduce any points of confusion and optimize public messaging. Greater transparency of regulatory activities through the use of social media has benefits, but can also introduce misinformation and reduce trust and confidence in the regulatory body. Effective communication, in particular using plain language when communicating the concepts of risk and safety, is key to building trust with all stakeholders.
— The challenges for regulatory bodies from military actions around nuclear facilities were highlighted. The impact of such actions on regulatory activities included the unavailability of staff, unstable communication channels, power blackouts, loss of water, heat supply, cancellation of scheduled inspections and diverting resources to emergency preparedness and communications activities. A nuclear or radiological accident during a conflict could have disastrous consequences for the people of neighbouring States, and beyond.
— The importance of the IAEA's seven indispensable pillars for ensuring nuclear safety and security in an armed conflict was emphasized.
— To adapt and respond to unexpected challenges. regulatory bodies need to be increasingly forward looking and develop strategies to prepare for the

unexpected. Regulatory bodies should develop crisis management plans and use lessons learned to continue developing resilience through cooperation with other regulatory bodies at the regional and international levels.

PANEL DISCUSSION 1

LEADERSHIP THROUGH NEW AND EMERGING CHALLENGES

The Panel discussed recent and future challenges and the need for strong leadership for the regulatory oversight of safety and security aligned across all regulatory bodies and other related agencies. Experience was shared in responding to a wide range of challenges, such as new and innovative technologies, communication with stakeholders and cyber security.

The following points were noted during the Panel Discussion:

- The importance of regulatory body robustness and resilience was stressed, along with the need to be forward looking while at the same time focusing on the necessary competence to make regulatory decisions. Regulatory bodies should be proactive, agile and responsive to stakeholder needs.
- Maintaining effective legislative and regulatory oversight of nuclear and radiation safety and security during periods of challenge can be achieved through effective contingency planning and optimizing the use of resources. The flexibility to adapt regulatory activities, such as inspection procedures and decision making processes, is key to an effective response to unexpected challenges.
- Two key aspects for regulatory bodies to ensure business continuity in a rapidly changing environment were people and infrastructure. It was recognized that both the workforce and the working environment are changing. The ageing demographic challenges regulatory bodies to secure the appropriate skills and competencies to ensure resilience with robust knowledge management and knowledge transfer processes. New ways of working have recently been introduced, such as working from home, accelerating the need for digital transformation, the use of cloud technology and web-based meetings.
- Recent global events have shown the need for regulatory bodies to be prepared to expect the unexpected and develop frameworks to respond to unforeseen challenges. Such challenges require a change in the way of thinking and the need to train personnel to deal with unexpected scenarios. The importance of recognizing and learning from previous challenges was emphasized and how these challenges were managed can be used to develop a response to future challenges.
- The importance of regulatory body cooperation and collaboration was emphasized. Regulatory bodies should not work in isolation and effective cooperation and collaboration should also extend to the industries being regulated. The means of securing collaboration and support is available through the IAEA and other multilateral bodies and a harmonized and collaborative approach between regulatory bodies must become the norm, not the exception.

— It was recognized that the public can now access a wide range of information on nuclear science and technology and is a benefit and a challenge. Regulatory body communication with all stakeholders, including the public, needs to be proactive and use language that is clear and easy to understand. It is important for regulatory bodies to communicate and inform public opinion and they must communicate to protect the public from risk, not from progress.
— Regulatory body leaders need to be proactive in discussions with stakeholders to provide the facts on emerging challenges, such as new and innovative technologies. The legal and regulatory frameworks will evolve over time to ensure they remain fit for purpose. Leadership needs to respond in a timely manner to enhance the efficiency and effectiveness of regulatory activities and to continue to develop and improve working models.
— Reflection is needed on reinforcing the international framework relating to nuclear facilities in situations of armed conflict. The IAEA's seven indispensable pillars for ensuring safety and security during an armed conflict were also highlighted, including the need to ensure that the nuclear facilities are protected with the ultimate aim of preventing a nuclear accident.
— In response to the challenge from climate change, regulatory strategies are needed to ensure the resilience of existing and new NPPs, along with the need for enhanced efforts to monitor the external environment to prepare for future challenges.
— New and innovative nuclear technologies bring new challenges such as how to regulate the use of artificial intelligence (AI) and its impact on nuclear safety and nuclear security. The need for more collaboration and information exchange on the positive and negative impact and implications of AI was emphasized. As an example, the need to demonstrate the capability to detect the presence of malicious software and protection against cyber-attacks and the implications of on-line remote inspections.
— It was noted that the number and types of cyber-, and their potential impact on nuclear security, have increased over time and are arising from numerous sources. There is a continual need to identify the nature of these threats and respond by adapting the business continuity plans. Having the appropriate regulatory competencies to identify and respond to these threats is a challenge. There is a need for regulatory bodies and the regulated industry to work closely together to better understand potential cyber-attacks and develop the appropriate responses to strengthen computer security. In this regard, it is important to separate information technology from operational technology.

2.2. SESSION 2

HARMONIZATION, INNOVATION AND NEW TECHNOLOGIES: APPROACHES TO ENHANCE REGULATORY AGILITY

This session addressed the regulatory strategies and programmes to respond to innovative and advanced technologies in nuclear and radiological applications, including consideration of: the 'graded approach' for SMRs, transportable reactors and fusion reactors; and radiological applications, such as medical and industrial technologies.

The importance of international cooperation and the potential for harmonization of safety requirements and licensing approaches were considered along with the application of a graded approach in regulatory activities. Activities to advance the mission of the regulatory bodies through targeted research activities, data analytics for risk assessment and decision making and the use of AI and other technologies were discussed.

The following points were noted during the session:

— Achieving net-zero carbon emissions will depend on, among other things, a significant increase in the worldwide construction of new NPPs. This will include existing designs and a wide range of new and innovative NPP designs, including SMRs, advanced modular reactors and high temperature gas reactors.
— It was recognized that the introduction of new and innovative reactor designs and associated new technologies will pose a challenge to many regulatory bodies. In particular, challenges such as verifying the safety functions and safety margins for new designs and proving the reliability of new or novel components associated with these designs.
— In some Member States the legal and regulatory framework has been further strengthened to respond to the introduction of these innovative NPP designs. It was emphasized that communication between the regulatory bodies and the designers and operators at an early stage in development is essential for the effective and efficient licensing of these new designs.
— The benefits of a two step licensing process, with an initial construction permit followed by an operating permit to help, can support the introduction of new NPPs designs.
— Learning from the experience of other regulatory bodies was also highlighted as an important means of preparing for the licensing of new and innovative NPP designs. The benefits of learning lessons from a wider source, such as the aviation and petrochemical industries, was also stressed.
— The deployment of new reactor designs will not become a reality without a streamlined approach to regulatory reviews to allow a worldwide fleet of standardized reactor designs and to increase confidence in the industry's ability to deliver.
— Harmonization of the approach to NPP licensing was discussed, including the most effective means of globally reviewing regulatory approaches, methods and outcomes and gaining the acceptance of other regulators.
— The Nuclear Harmonization and Standardization Initiative (NHSI) was considered to be a timely initiative promoting harmonization of approaches to innovation and new technologies while enhancing regulatory agility. The aim of

the NHSI is to enhance harmonization of regulatory activities and standardize industrial approaches to encourage deployment of new nuclear designs. NHSI supports the further collaboration among regulatory bodies to avoid duplication of effort and develop potential common regulatory positions.

— The IAEA is also assisting Member States by preparing publications and developing and revising safety standards and security guidance aimed at supporting the regulation of new NPP designs and adapting regulatory approaches to different designs.
— Examples were presented of a range of innovative NPPs designs and enhanced regulatory frameworks for dealing with these designs. Regulator and nuclear industry coordination to contribute to timely development of safety requirements and technical standards was highlighted as good practice.
— Continuously changing climate data presents challenges to the validity and reliability of current model predictions for future outcomes. Global collaboration is needed to update climate change models frequently to capture new data, share scientific results and promote greater resiliency against factors such as drought.
— Regulatory bodies must make full use of information technology for greater connectivity and use artificial intelligence and other technologies, risk insights and research and development to effectively fulfil the functions of the regulatory body.

PANEL DISCUSSION 2

HARMONIZATION, INNOVATION AND NEW TECHNOLOGIES: APPROACHES TO ENHANCE REGULATORY AGILITY

This panel discussed the challenge of meeting the large increase in nuclear and radiation technologies and the way these projects must be delivered by governments, regulatory bodies and industry. The importance of international regulatory cooperation was discussed to gather best practices and lessons learned.

The Panel noted the following points:

— The important characteristics that influence regulatory body agility were considered to be the organizational structure, the trust of its stakeholders and the ability to promptly obtain resources and funding to respond to new challenges and new technologies.
— While regulatory independence is a fundamental requirement, regulatory bodies must not work in isolation. The agility to respond to new technologies requires early engagement with the industry to be informed on the deployment new technologies and to share regulatory questions and concerns. Such early engagements are essential to foresee future challenges.
— The importance of government commitment to cooperation between the regulatory body and technical and scientific support organizations (TSOs) at the international level was stressed to develop the capacity to meet technological challenges. Government commitment to the international safety standards and security guidance was also considered to be essential.
— A change in NPP technology for mature regulatory bodies can pose challenges, particularly when a first of a kind technology is proposed as

against deploying an existing reference NPP design. Different requirements and skill sets may be needed to licence the first of a kind NPP and external support may be required and knowledge transfer from any external support is essential. Programme delays will occur if the regulatory body is not fully prepared to meet the challenge of new technologies.

— The legislative and regulatory framework must be ready to licence new technology. A reference plant approach and the use of codes and standards from the vendor country were discussed. In addition, the role of TSOs was considered vital, particularly during the early stages of licensing activities.
— Examples of regulatory body agility were provided in response to the COVID-19 pandemic where regulatory bodies needed adjust oversight activities without losing focus on safety. The risk informed approach to regulation allowed inspection activities to be adapted to identify those that could be done remotely and prioritizing those that needed a physical presence.
— Examples of regulatory body agility to deal with technological developments in medical applications of radiation technology were provided. For instance, the operating licence of an NPP was amended to allow the production of the medical radioisotope ^{99}Mo. The licensing of new radiotherapy techniques (positron emission tomography–computed tomography (PET-CT)) using international standards of the International Electrotechnical Commission and International Organization for Standardization .
— Harmonization of regulatory requirements was considered to be a long term goal, but international cooperation and collaboration provides a bridge toward achieving this goal. Collaboration does not mean giving up national approaches and decision making but benefits from the experience of others and avoids reinventing the wheel. Differences in regulatory approaches should not be an impediment to harmonization.
— While safety is the responsibility of the operator, the industry also needs to collaborate to develop common standards, which in turn would help the harmonization of licence applications.
— The IAEA International Generic Ageing Lessons Learned (IGALL) programme was noted as a good example of harmonization, where there was agreement on requirements for the long term operations of NPPs. The lessons learned from IGALL were not considered to be directly transferrable to the licensing of new designs of NPPs, such as SMRs. IGALL focuses on key technical issues of concern where a common understanding can be achieved and is based on many years of operating experience. The licensing of the new design of NPPs will be based on limited or no operating experience.
— The panel addressed new digital systems and use of AI by licensees and the regulatory body. Traditional mechanical and hard-wired regulatory systems are well understood, but digital systems are complex and require the relevant knowledge, skills and experience in their application to be in place. While regulatory bodies have used opportunities provided by digitization, caution was urged in the adoption of AI to ensure the benefits risks outweigh the risks, especially for security of data. It was recognized that AI has limitations and must not replace expert judgement in regulatory decision making.

2.3. SESSION 3

FULL LIFE CYCLE CHALLENGES AND STRATEGIES

This technical session addressed the challenges and strategies related to the full life cycle of nuclear and radiation facilities, including the establishment of a new programme, managing the ageing of nuclear and radiation facilities, decommissioning, and radioactive waste storage and disposal.

A nuclear power programme is a long term commitment that needs long term technical and financial considerations. Establishing effective nuclear and radiological regulatory oversight requires national, regional and international collaborative efforts to strengthen nuclear and radiation safety and security. It is essential to provide support to regulatory bodies from those Member States embarking on a new nuclear power programme or new radiation facilities from the very beginning.

The following points were noted during the session:

— The life cycle of nuclear and radiation facilities is complex, and all elements are equally important to achieving safety and societal acceptance. Regulatory bodies need to ensure that the highest technical standards are achieved throughout the life cycle and communicate these standards to the public in an understandable manner.
— Radioactive waste management remains a major obstacle to decommissioning in many Member States. Interim storage is needed until a disposal route is in place. Sufficient financial resources must be provided for the decommissioning of facilities, recognizing that costs are always more than anticipated. Financial resources can be an issue if there is limited accrual during operation of facilities. There is a need to develop a national strategy and regulatory requirements for the management of radioactive waste, including the necessary infrastructure for long term storage and disposal.
— The licensing or authorization process for long term waste storage and disposal facilities, such as a geological disposal facility, is complex and challenging, requiring clear prerequisites. These prerequisites include: legal clarity; transparency of regulatory oversight; regulatory competence; and trust. One particular difficulty is defining and demonstrating the requirements for passive safety over very long timescales.
— There is a need for regulatory body agility to enable the transition from a theoretical understanding of a geological disposal facility to practical oversight and to respond to advances in knowledge and technology and other potential developments that were not necessarily part of the original authorized design.
— The need for regulatory body agility to adapt and develop national regulatory frameworks and infrastructure for new or expanding nuclear and radiation facilities or from programme decisions that switch rapidly from phasing out to life extension. Decommissioning of cyclotrons and other radiation facilities is a new experience for many Member States and requires specific competences in the regulatory body.
— The unique challenges associated with radioactive sources was highlighted with their applications in medicine, agriculture, industry and education. The mobility and portability of these sources poses a particular security challenge. The levels of regulatory infrastructure for oversight of radioactive sources vary with the

absence of available storage and disposal options in some Member States.

— The management, control and recovery of orphan sources remains an issue. Regulatory bodies should assess the financial viability of radioactive source users as part of the authorization process to ensure that the licensee has the resources to properly meet the cost of eventual storage, transfer, or final disposal of sources to avoid orphan sources.
— The regulatory oversight of the supply chain was considered by many Member States to be a growing challenge with the need to prevent the use of counterfeit or fraudulent items. Adequate resources need to be applied to verification of the supply chain. The benefits from learning from the experience of other Member States was highlighted and the importance of cooperation between regulatory bodies on supply chain issues was emphasized.
— In addition to the regulatory oversight of existing technologies, regulatory bodies need to have the competence and agility to respond to new and emerging technologies associated with nuclear and radiation applications. Regulatory frameworks and infrastructure may need to be adapted for new or expanding the use of nuclear and radiation facilities, or for ageing management of these facilities.

PANEL DISCUSSION 3

FULL LIFE CYCLE CHALLENGES AND STRATEGIES

This Panel discussed challenges associated with the supply chain and the potential for counterfeit, fraudulent, and suspect items. Also discussed was decommissioning and waste management of power and research reactors, including interim and long term storage challenges and strategies for managing spent fuel. The use of financial assurance instruments for life cycle confidence, and strategies for radiological and environmental impact and control during the full life cycle were some of the other issues discussed.

The Panel session highlighted the following points:

— Examples of decommissioning of radiation facilities, such as a cyclotron dealing with activated metal and activated concrete and the opportunities for the reuse of these materials. Public consultation was undertaken on the plans for decommissioning and management of the waste involving separation and reuse under controlled conditions. This public consultation also set the stage for consultations on NPP decommissioning.
— Examples were presented where supply chain difficulties resulted in construction delays and also the shutdown of an NPP. The panel discussed the options available to regulatory bodies for regulatory oversight of the supply chain.
— Some regulatory bodies are currently authorizing equipment manufacturers for specific classes of safety equipment. These authorizations allow inspections to be performed on supply chain management systems, quality systems and manufacturing processes.
— While oversight of the supply chain has resource implications for the regulatory body, the value of applying the graded approach was emphasized.

— In general, the operator or the licensee is responsible for ensuring the quality of the supply chain; qualified contractors may be used for verification. Some licensees are using long term contracts for the supply of key safety related equipment.
— The panel discussed the policies and strategies to ensure that there are adequate financial arrangements in place for decommissioning. In many Member States there is a legal requirement for the producers of radioactive waste and nuclear and radiation facility operators to contribute funds for decommissioning and waste management.
— It was noted that the final disposal of waste can take place over decades and funding may be challenged if the original operators are no longer available.
— Some Member States require the operators to provide a regular review of their plans for decommissioning, along with a statement on their financial arrangements for decommissioning, waste management and waste disposal.
— The panel noted that the life cycle of nuclear and radiation facilities covers a very broad area, and the regulatory bodies need to be fully prepared to meet the challenges, from construction to operation, then to decommissioning and waste management, and to final disposal of waste.

2.4. SESSION 4

TRUSTED REGULATOR: COOPERATIVE TECHNIQUES TO PROMOTE CREDIBILITY AND RESILIENCE

This technical session addressed the importance of building trust, improving communication effectiveness and enhancing stakeholder and public involvement in the regulation of nuclear and radiation safety and security activities. The session highlighted key issues associated with developing and maintaining trust and provided examples of practices employed by Member States to achieve this trust.

Engaging with a wide range of stakeholders is an essential part of the regulatory oversight of any nuclear and radiation undertakings. The involvement of stakeholders in regulatory decision making can enhance awareness and understanding and provide confidence that nuclear science and technology applications are used safely and securely.

Building or maintaining trust requires the regulatory body to have the competence to carry out a particular task and to adhere to a set of principles or commonly accepted ethical standards such as honesty and fairness.

The following points were noted during the session:

- Trust is one of the key attributes of an effective regulatory body and can be achieved by demonstrating independence, competence, impartiality, credibility, and transparency. Trust is built over time and is hard to win; it requires effort to maintain but is easily lost.
- Proactive engagement with stakeholders is essential to build trust and confidence. Engagement needs to be open, sincere and honest and tailored to take account of different cultural and demographic stakeholder needs along with using the most effective channels of communication.
- It was emphasized that stakeholder involvement in the regulatory decision making process is an effective way to ensure such decisions are understood, accepted and trusted. Regulatory bodies should avoid using jargon and use technical information in a form that is clearly understandable to its stakeholders.
- New modes of communication, such as social media and the speed of this communication, poses a significant challenge for regulatory bodies. It is essential that regulatory bodies develop and implement appropriate policies and strategies for dealing with social media.
- Regulatory bodies need to balance the societal demand for instantaneous information with need for accuracy and integrity in their communication. Issues arising from ill-considered communications, particularly from social media, were highlighted as was the need to mitigate the consequences of errant communications. However, the visibility of the nuclear industry in media presents an opportunity for the regulatory body to positively engage with the public.
- Benchmarking of regulatory body activities, such as through the IAEA's Integrated Regulatory Review Service (IRRS), was considered to be an essential mechanism for promoting stakeholder and public confidence. Regulatory bodies were urged to make the results of these reviews publicly available.
- A robust communications strategy for nuclear and radiological emergencies should be developed to ensure there is transparent, timely, objective, factual,

relevant, accurate, clear and credible information which is disseminated regularly and efficiently. The need to deliver easily understandable information and communicate via traditional, electronic and social media was considered to be essential.

— The session called on international organizations, governments and national regulatory bodies to encourage bilateral agreements with neighbouring countries for the exchange of information in emergency situations and the conduct of joint, cross-border emergency exercises.
— There should be mutual understanding of the roles of the regulatory bodies and operating organizations. While regulator–operator views will differ, there will be a healthy tension and there is the need for mutual respect to remove barriers and focus on common agreed outcomes.
— The importance of international cooperation through multilateral and bilateral activities was highlighted with the objective of working together to maintain high standards of safety and security that ensures protection of individuals, society and the environment.

PANEL DISCUSSION 4

TRUSTED REGULATOR: COOPERATIVE TECHNIQUES TO PROMOTE CREDIBILITY AND RESILIENCE

This Panel highlighted key issues associated with developing and maintaining trust and discussed examples of the practices employed by Member States to achieve this trust. It was recognized that different stakeholders may have specific information requirements and expectations, which may need to be addressed in different ways.

The Panel noted that enhancing collaboration both within and between Member States in nuclear and radiation safety and security is key to strong, harmonized, and sustainable regulation.

The Panel concluded that:

— Stakeholder trust is a key component of an effective regulatory body and there is a need for a firm commitment to openness and transparency to develop trust. It can take many years for a regulatory body to build stakeholder trust, but it can only take one mistake to lose that trust.
— Developing and maintaining stakeholder trust needs to become an integral building block of a comprehensive and successful regulatory body stakeholder communications programme.
— The characteristics of a trusted regulator and the processes for building and maintaining stakeholder and public trust include stakeholder engagement during both the regulatory steady state and during emergency situations.
— In order to develop stakeholder trust, the regulatory body should be accessible and visible to stakeholders and also seen to be responsive to their concerns. Accurate and honest communication is necessary using plain and understandable language. Overly technical language and the use of acronyms should be avoided.
— Regulatory bodies must recognize that social media is now an important means of communication. Communication by anyone anywhere can become communication everywhere, often within a very short period of time. The demand for knowledge, and for this knowledge to be instantaneous, poses a challenge for regulatory bodies.

— Regulatory bodies need to understand the needs of their different stakeholders and recognize that social media does not reach everyone. To this end the more traditional means of communication have an important role to play.
— Social media is good medium for broadcasting information, but regulatory bodies must monitor public network and take steps to ensure that 'fake news' is challenged. Some Member States respond by publishing accurate information and include contact details to allow for follow-up requests so that information can be verified.
— Regulatory bodies need to have competent communicators; it is not enough to just have the scientific and engineering expertise.
— In some Member States, the primary means of regulatory body communication with the public is through social media. There is a need for regulatory bodies to look for opportunities to use social media and recognize that it is here to stay.
— The regulatory bodies should use routine communications to build trust that creates credible communications channels that could be used during an emergency.
— A prerequisite for maintaining trust during an emergency is timely, accurate and complete public information on abnormal events, incidents and accidents at nuclear or radiation facilities.
— Regulatory bodies should develop emergency communication plans that clearly define the roles and responsibilities of the national stakeholders involved in communications. The requirements for both domestic and international communications should also be addressed, as well as the requirements for different types of information for the general public and for technical experts.
— Information must be shared and effective coordination undertaken with neighbouring countries, international and regional organizations when communicating public protective actions. Sharing information is key to at least having an understanding of views even if priorities differ.
— Trust is gained and strengthened with the dissemination of accurate and timely information that is constantly updated. Language should be clear, short, and supported by visual material.
— Maintaining effective and agile emergency preparedness and response (EPR) communication programmes utilizing new technologies will require timely coordination with off-site competent authorities and responders. Regulatory bodies need to be prepared to react quickly and accurately; the greatest danger is not communicating.
— Enhanced international and regional cooperation is core to creating effective partnerships; effectiveness and credibility can be enhanced through self-assessment and peer reviews.

2.5. SESSION 5

CAPACITY BUILDING FOR THE FUTURE: HOLISTIC APPROACHES FOR NUCLEAR AND RADIATION SAFETY AND SECURITY

This technical session focused on sustainable capacity building strategies and programmes in nuclear and radiation safety and security. The discussions emphasized the importance of systematic, harmonized and globalized approaches to human resources and education and training in nuclear sciences and technology. The session also addressed the challenges regulatory bodies face in a rapidly changing environment, including financial constraints, an ageing workforce, and the need for new competencies in areas such as cybersecurity and digitalization. The importance of leadership for safety and safety culture were highlighted as essential components in driving capacity building, along with greater diversity and inclusion.

The following points were noted during the session:

— The importance of establishing a national strategy for capacity building to produce the necessary competences in a sustainable and timely manner was emphasized. National strategies should be aligned with future needs by optimizing existing resources to complement the available external regional and international assistance. National governments play a key role in integrating education and training programmes into an overall strategy for building and maintaining capacity. This should involve all relevant stakeholders and cover the medium and long term capacity building needs and requirements.

— A holistic approach to capacity building for regulatory bodies requires strategic planning to ensure long term competence management and intergenerational knowledge transfer across nuclear and radiation safety and nuclear security. The approach should cover all regulatory body functions, such as authorization, inspection and enforcement, and involve all relevant stakeholders. Adopting a holistic approach to capacity building means integrating efforts to maintain all the key pillars of capacity building of education and training, human resource development and knowledge management to ensure regulatory bodies are prepared for future challenges.

— It was recognized that human resources are a tangible and vital organizational asset and emphasized the important role of nuclear knowledge management for knowledge transfer and human resource development. The knowledge management system should be integrated into the regulatory body management system. It was recognized that knowledge and experience can be localized and may need to be transferred from one industrial sector to another and from one generation to the next. For example, the need to ensure long term competence in nuclear safety in light of the phase out of nuclear energy and a focus on other areas such as decommissioning and a deep geological repository.

— The ageing demographic in many regulatory bodies poses a challenge to knowledge retention. In some Member States, it was anticipated that 30% of qualified regulatory body staff will have retired by 2026. Consequently, intergenerational knowledge transfer will be needed along with the consequent recruitment of new personnel. This will require a more effective means of

attracting the next generation to pursue careers in the regulation of nuclear and radiation safety and security.

— A needs-oriented approach is needed to identify national elements for the creation and development of competences of regulatory body staff dealing with medical and industrial nuclear and radiation applications.
— The role of human resources and capacity building programmes at the national and organizational level for achieving safe, secure and sustainable nuclear power programmes was emphasized. Leadership programmes are important to strengthen leadership culture and to foster leadership competencies. The importance of continuing to strengthen competences in nuclear and radiation safety culture and nuclear security culture was emphasized.
— The importance of Member States sharing knowledge and experience for mutual benefit in developing their capacity building strategies through active cooperation in a fast-changing world.
— It was noted that further promotion of other regional and global networks is needed to enhance capacity building and safety infrastructure through sharing of knowledge, experience and lessons learned. It was emphasized that the IAEA has an important role in coordinating the efforts of Member State regulatory bodies to enhance capacity building for the sustainable development of regulatory frameworks by enhancing regional and international cooperation.
— The need to develop more effective and efficient training methods and identifying new or different styles of learning were highlighted. Examples included a combination of the traditional methods of lectures, group exercises and field exercises, along with the use of virtual reality systems. Examples were presented of the use of virtual reality systems to learn the characteristics of a facility and its physical elements by examining a three-dimensional view of facilities and operations and allow learning skills for insider threats. A useful development would be for more e-learning platforms and state of the art means of training for physical protection and cyber security using virtual reality.
— Changes in work patterns pose new challenges, such as increased mobility, working from home, hybrid working, advanced ways of regulatory supervision, modernization of working conditions and increasing digitalization.

PANEL DISCUSSION 5

CAPACITY BUILDING FOR THE FUTURE: HOLISTIC APPROACHES FOR NUCLEAR AND RADIATION SAFETY AND SECURITY

This panel discussed sustainable capacity building strategies and programmes including education and training, knowledge management, human resource development, and knowledge networks. It focused on the exchange of best practices for preparing the next generation of regulatory professionals, leaders and decision makers.

Since 2011 there has been a global downturn in the nuclear industry which has in turn resulted in difficulty in maintaining nuclear and radiation capability in many regulatory bodies. Coupled with an ageing demographic, this poses problems for maintaining a suitably qualified and experienced workforce to service future needs. There is a need for a systematic approach to workforce planning, competency development, succession management, education and training and knowledge

management. This panel discussion provided an insight into how organizations are addressing these issues with a holistic approach.

The following points were noted:

— Important components of a holistic approach to regulatory capacity building for the future include: strategic planning; human resource management; education and training; knowledge management; knowledge networks; organizational culture; and change management. The holistic approach requires the involvement of national governments, regulatory bodies, operating organizations, technical support organizations and academia.
— Effective programmes should be in place to build capacity for a nuclear regulatory regime and regulatory bodies should be able to attract and retain sufficient human resources in the short, medium and long term. These include: competence needs assessment; knowledge management; organizational development; managerial competencies; leadership development programmes; management for safety; safety culture self-assessment and response.
— The rapidly changing environment in many Member States and uncertainties in the political decision making process can significantly impact the strategic planning for developing and maintaining the necessary regulatory body competencies. Organizational readiness and agility are important for regulatory bodies to respond to changing market forces, national policies, natural hazards, new and evolving threats, and other external factors. Regulatory bodies should seek early engagement with designers and industry to understand planned technology adoption and deployment to inform future resource needs and priorities.
— The development of a capacity building strategy needs to consider the full life cycle of the industry being regulated for the design and operational stages as well as for ageing management of facilities, and decommissioning and disposal of waste. There is a need to adopt comprehensive strategic planning and workload forecasting methods for the planning and prioritization of regulatory activities and initiatives.
— The importance of knowledge networks to support knowledge management was underlined. Member States need to tailor their capacity building programmes to meet the needs of the national infrastructure and reflect resources that are available.
— The means to leverage collective global and regional technical expertise to achieve timely and consistent regulatory decisions was emphasized as a means of maintaining safety and security regulatory frameworks for radioactive source management and disposal including.
— Examples of regional cooperation were discussed, such as the Ibero-American Forum of Radiological and Nuclear Regulatory Agencies (FORO), and Competencies of the Staff of Regulatory Bodies in Medical and Industrial Radiological Applications (CreAR). Capacity building support for nuclear security, safeguards and non-proliferation in Asia is available through the Integrated Support Centre for Nuclear Non-proliferation and Nuclear Security (ISCN) of the Japan Atomic Energy Agency (JAEA). The IAEA Global Nuclear Safety and Security Network (GNSSN) was highlighted as a means of facilitating cooperation and sharing lessons learned and serving as a hub for international coordination of capacity building.

— The importance of managing the interface between safety and security and maintaining strong safety and security cultures was highlighted.
— The need to develop and empower the next generation of regulatory body leaders by defining the necessary traits and taking concrete actions to train and empower them so that they can drive regulatory missions forward was noted. Also highlighted was the integration of young professionals into regulatory bodies by providing structured learning and support programmes for career advancement, and ensuring that diverse viewpoints and backgrounds are incorporated in decision making processes.
— The need to implement knowledge management activities to cater for the loss of knowledge from retirements from an ageing workforce and also to explore new approaches to recruitment and to improve the gender balance. There is a need to develop strategies to engage the younger generation to make nuclear and radiation regulation an exciting and attractive career pathway.
— Preparing for the recruitment and incorporation of a Generation Z workforce and developing future leadership development and succession planning programmes focusing on inclusion and diversity. The need to improve the onboarding processes for new recruits and make greater use of technology such as e-learning platforms and video lectures. Remote communication tools are now widely accepted and provide an important advantage for creating regional distance learning programmes.

2.6. SPECIAL PANEL

REGULATING A MODERN ERA OF MEDICAL AND RADIOACTIVE MATERIAL FACILITIES AND APPLICATIONS: THE JOURNEY CONTINUES

This Special Panel provided the opportunity to consider progress made since the 2019 Regulatory Conference and to discuss current priorities and initiatives. The panel exchanged experience gained on the role of international instruments in strengthening national legislative and regulatory frameworks, including the Code of Conduct on the Safety and Security of Radioactive Sources and the Supplementary Guidance on the Import and Export of Radioactive Sources. Other issues discussed included the initiatives to support the sustainable introduction or expansion of radiotherapy for cancer treatment and measures for the prevention, detection and response to nuclear and other radioactive material outside of regulatory control.

Considering the breadth of the issues faced by Member States in the regulatory oversight of radioactive sources, this panel comprised two parts. The first part focused on the importance of international collaboration between Member States on the regulatory oversight of radioactive source safety and security. The second part examined the challenges for national regulatory frameworks for the safety and the security of radioactive sources.

The first part of the Special Panel noted the following points:

— The value to be gained from international collaboration between regulatory bodies in their efforts to regulate the use radioactive sources was emphasized. Regulatory bodies have gained significant benefit from multilateral engagements such as this forum and the participants were encouraged to continue to support IAEA initiatives related to the safe and secure use of radioactive sources.
— A legislative and regulatory framework for authorization, inspection and enforcement of requirements for the safe and secure use of radioactive sources is essential for every Member State. The regulatory frameworks in Member States can be continuously improved through the sharing of the collective experience and resources of regulatory bodies globally.
— The infrastructure for regulating the medical applications of radiation technology in some Member States can be complex, with many different organizations involved. These organizations can include regulatory bodies, national and regional health authorities, product safety authorities, professional societies and academia. Coordination of the activities of the regulatory body and other authorities is crucial to facilitate access to safe and secure radiotherapy.
— The management and control of the radioactive sources currently in circulation is an area where sharing of lessons learned is essential. The IAEA initiatives to advance the collective expertise in Member States, such as the Regulatory Infrastructure Development Project (RDIP), has helped to strengthen regulatory infrastructure for radiation safety and the security of radioactive material.
— The benefits to Member States of a political commitment to reflect the Code of Conduct on the Safety and Security of Radioactive Sources and its supplementary guidance in national legislation was emphasized. In addition, the

importance of robust practical implementation of the Code of Conduct was stressed.

- At a global level around 30 million new cancer cases arise every year, resulting in around 16 million deaths. This has led to an increase in the demand for access to radiotherapy applications and the regulatory oversight of these applications poses a significant challenge for many Member States. The IAEA Safety in Radiation Oncology (SAFRON) initiative aims to improve the safety of radiotherapy applications by sharing safety related events worldwide.
- The application of medical radiation technologies may pose unique risks to workers, patients and the environment. The role of the regulatory bodies was emphasized as being important in promoting safety culture in this area. It takes time to build a strong safety culture, which can be achieved through education and training, continuous professional development, raising awareness, and good communication within and between relevant organizations. Comprehensive and sustained training programmes on radiation safety for all medical staff is a key element.
- Strategic partnerships between Member States can reduce or remove barriers to the acquisition of radiotherapy technologies. Initiatives such as the IAEA's Rays of Hope are a welcome development to advance access to diagnostic and therapeutic treatments to fight cancer in Member States that currently lack such capacity, while at the same time creating sustainable regulatory oversight programmes.
- Keeping pace with rapid developments in the field of emerging innovative radiation technologies is a challenge for some regulatory bodies. Advances in technology are taking place faster than new regulations can be introduced. Regulatory bodies must become more agile to deal with this challenge. The sharing of knowledge, regulatory experience and successful strategies for controlling the safety of emerging technologies was emphasized as a priority for the global regulatory community.

The second part of the Special Panel addressed current challenges for national regulatory frameworks for nuclear and radiation safety and the security of radioactive sources. For all facilities and activities using radiation sources, the regulatory framework consists of the relevant legislation, regulations and guidance and a leadership and management programme for safety. This framework is led by the regulatory body, which must have appropriate competence and resources.

There are very large numbers of radioactive sources in use globally in health care, academia, food irradiation to improve crop yields in agriculture, and for security purposes at ports of entry.

The second part of the Special Panel noted the following points:

- Developing and sustaining a safety infrastructure is a complex and lengthy process, particularly for Member States with limited resources, no nuclear power industry, or a small number of radiation facilities and activities. The framework must be capable of ensuring the safety and security of radioactive sources across a broad range of applications in various life cycle stages.
- All national frameworks for safety must ensure the safety and security of radioactive sources across a broad range of applications in various life cycle stages.
- To use limited resources more efficiently and effectively, regulatory bodies should apply a risk informed or graded approach to ensure safety and security

throughout the life cycle of sources, from ‘cradle to grave’ in use, in transit, storage and to final disposal. This approach can provide the flexibility to respond to rapidly changing situations.

— Measures for routinely accounting for radioactive sources and preventing their loss should be reinforced through national legislation and through international cooperation in accordance with international best practice. The respective responsibilities of source manufacturers, users and regulators was also highlighted.
— Regulatory bodies were urged to leverage, through the IAEA, regional expertise to provide training and technical assistance to build regulatory competence and confidence. Regulatory bodies should use the lessons learned from events associated with radioactive source control to improve knowledge management and implement strong source management programmes.
— Measures for routinely accounting for radioactive sources and preventing their loss should be reinforced through legislation and regulations and, in particular, through international cooperation in accordance with international best practice. Radioactive material reported lost, stolen, or are outside of regulatory control present a safety concern.
— The significant impact of instruments, such as the Code of Conduct on the Safety and Security of Radioactive Sources, was emphasized along with the Supplementary Guidance on the Import and Export of Radioactive Sources and the Guidance on the Management of the Disused Radioactive Sources. These instruments have been very successful in encouraging harmonized approaches to the characterization and regulatory control of sources, particularly in cross-border circumstances.
— There is a need to reinforce national regulatory frameworks regarding the control of disused radioactive sources, including centralized storage facilities and global reporting. Recent incidents of sources discovered in scrap metal, particularly in transit across borders, calls for further strengthening of international regulatory cooperation and coordination.
— The implementation of import/export control provisions remain challenging in some Member States, notably the need for prompt communication between exporting and importing States before transfer of sources takes place.

2.7. SUMMARY OF THE SIDE EVENTS

2.7.1. SIDE EVENT 1: YOUTH PANEL — YOUNG PROFESSIONALS COMPETITION

A side event for young professionals, defined for this event as up to 35 years of age, was held during the conference to bring innovative ideas on various topics, including: climate change; regulatory strategies and programmes; decommissioning and radioactive waste management; capacity building; digitalization and innovative technologies; and regulatory communication and outreach. The IAEA received 56 synopses from 18 Member States; from these submissions, 14 professionals were shortlisted to submit extended papers to further describe their ideas. Ultimately, the evaluation committee selected five submissions for oral presentations during the panel and four submissions for posters. The event aimed to encourage new and fresh perspectives on important topics within the nuclear industry.

During the conference, young professionals from five IAEA Member States presented innovative ideas within regulatory frameworks for safety. A panel of experts from the IAEA, ARPANSA, USNRC and FANR asked questions and judged the presentations. Conference attendees voted through the IAEA conference app. The votes were weighted as 60% from the floor, 20% by the judging panel and 20% assigned earlier to the competing essays. The UAE team was declared the winner for their design of a 'Nuclear Ferris Wheel Application' to modernize information sharing on nuclear safety and radiation protection; the team from the United States of America finished in second place and the team from the United Kingdom was in third place. The awards were presented by IAEA Deputy Director General Ms L. Evrard and Conference Vice President Mr C. Viktorsson; Ms Evrard invited the winners to share their projects at the 67th IAEA General Conference in Vienna in September 2023.

2.7.2. SIDE EVENT 2: REGULATORY CONSIDERATION OF CLIMATE CHANGE CHALLENGES TO NUCLEAR INSTALLATION SAFETY

This side event discussed the increasing threat of climate change to nuclear installation safety. The Panel suggested using climate models to project climate impacts and incorporating climate projections into risk and vulnerability assessments.

The starting point for assessment of risk induced by climate change should be the lessons learned from recent events, and an IAEA monitoring system with systematic event analysis and real-time alerting would provide an opportunity for international cooperation. The Panel considered the need for nuclear fleets to develop climate adaptation plans as well as contingency plans supported by innovative safety assessment tools.

Nuclear technologies, including those supporting medicine, agriculture, clean water and environmental monitoring and protection, can help countries mitigate climate change and meet the United Nations Sustainable Development Goals.

At the side event, the following points were noted:

— Many incidents that have been reported to the IAEA/OECD NEA International Reporting System for Operating Experience (IRS) appear to be related to climate

change scenarios, and some damage recorded at nuclear sites in recent years may be direct manifestations of climate change.

— The increase in frequency of climate change related events was noted, and the mean values and uncertainties associated with them posed difficulties in translating hazard into risk. The effect of extreme climate events to structural loads of containment structures due to wind, snow and temperature was described.
— Some events recorded at nuclear facilities in recent years may be direct manifestations of climate change, extreme temperatures, heavy precipitation, sea level rise, river flow rate and high wind speed. However, many such events previously screened out during safety assessment of nuclear installations at the design phase were considered to be unlikely events, such as sandstorms, droughts, wildfires, salt sprays and rotational winds at high latitudes. Other events were excluded from assessments, such as permafrost melting. In addition, the potential for climate change to impact on other aspects affecting safety, such as site vehicle access, emergency evacuation routes and off-site electricity supply grid malfunctions, was considered.
— Hazard assessments should use climate models to consider climate impacts at the regional and local levels. Incorporating climate projections into risk and vulnerability assessments for nuclear installations enables a response that is science driven.
— Historical information on natural external hazards could be integrated into climate model projections to determine the risk to future infrastructure developments under varying climate change scenarios.
— Periodic safety reviews of nuclear installations are a valuable tool for assessing those natural external hazards that may be influenced by climate change. These reviews may identify lessons learned from recent events and should also take account of ‘near-misses’ in addition to the actual events recorded. The lessons learned should be used as preparation to respond to such events in future and to be able to mitigate their consequences.
— There is a need to develop climate adaptation plans for nuclear installations with the focus on improving both robustness and resilience to the effects of climate change. These plans should be supported by hazard design reviews, safety assessment and safety margin evaluation of climate change influenced beyond design basis events.
— One Member State noted a new initiative to incorporate climate change into regulatory environmental protection review reports.
— Specific examples were provided of the effects of long periods of rainfall, combined with instances of local, intense precipitation. Extremely strong wind speeds resulted in NPPs automatically shutting down and the salt spray associated with these strong winds damaging on-site power transmission equipment.
— Research and development activities related to climate change were discussed, including projects related to the assessment of NPP safety under extreme natural hazards and combined natural hazards. For example, heavy rain, storm surges and strong winds were being assessed to develop approaches for accident preparedness and management against extreme and or combined external natural hazards.

3. CLOSING SESSION

3.1. SUMMARY AND CONCLUSIONS FROM THE PRESIDENT AND VICE-PRESIDENT

C. Hanson
Conference President,
Chair of the United States Nuclear Regulatory Commission,
Washington, D.C., United States of America

C. Viktorsson,

Conference Vice-President,
Director General of the Federal Authority for Nuclear Regulation,
Abu Dhabi, United Arab Emirates

The Conference President and Vice-President presented the summary and conclusions of the conference. A 'Call for Action' was issued as an outcome of the conference.

GENERAL OBSERVATIONS OF THE CONFERENCE

The theme of this week in Abu Dhabi, 'Preparing for the Future in a Rapidly Changing Environment', generated dynamic, lively discussions on important topics through four keynote presentations, five topical sessions and five panel discussions.

A youth side event highlighted the critical role of the younger generation of professionals and the innovative ideas they bring to the profession, while another side event on climate change addressed regulatory approaches to the impact of climate change on the resilience of existing and new NPPs.

A special panel on regulating modern era medical and materials facilities and applications proved of interest to the broad spectrum of participating global regulators. Finally, the Conference highlighted security, emphasizing the importance of regulatory measures for prevention, detection and response to nuclear and other radioactive material outside regulatory control.

The conference focused on emerging challenges such as: the safety and security of advanced reactors and new technologies; the full life cycle challenges of nuclear and non-nuclear applications; ensuring regulatory agility and resilience and being prepared for the unexpected; information sharing; transparency and international cooperation in the event of nuclear or radiological emergencies; and capacity building.

The conference stressed the need to use regulatory experience gained from successfully managing the COVID-19 pandemic to improve preparedness for other unprecedented and immediate threats, such as civil unrest or armed conflict in the vicinity of nuclear facilities.

The pandemic has caused Member States to adopt new ways of working to maintain the safe, secure and reliable operation of nuclear and radiation facilities and activities. Additionally, the unprecedented situation in Ukraine, in which an armed conflict threatens the nuclear safety and security of an NPP and the safety of its operating staff, has led regulators to assess how this affects their planning and legislative frameworks and to confront the operational limits on their capability to regulate safety and security. All these issues were at the forefront of discussion at this

conference, which had been convened at the beginning of the post-Fukushima decade, with the current situation highlighting that the effectiveness of a common, sometimes global, response to crises lies in sustaining our commitment to international cooperation.

At a more technical level, the current energy crisis gave cause for discussion about the ongoing capacity of States to achieve a balance between electricity production and consumption. This raised issues such as: increased enthusiasm for embarking on nuclear power programmes; extended plant operating lifetimes; and reviews of planned closure dates for operating NPPs, together with a trend towards turnkey facilities such as SMRs. At the same time, concern was expressed about undue pressure on nuclear stakeholders, including the regulators, who must keep safety at the forefront.

In all the above respects, the President and Vice-President concluded that significant political decisions may need to be made, but noted that this conference has demonstrated that opportunities exist to: reinforce international cooperation; develop joint approaches to regulatory functions and activities; cooperate on safety assessments; and enhance global harmonization while employing global best regulatory practices, particularly with regard to early engagement of regulatory bodies in the design and development of new technologies.

ISSUES TO BE CONSIDERED BY THE REGULATORY BODY

Regulators globally must expect the unexpected and develop regulatory strategies to keep ahead of emerging threats in a rapidly changing environment, such as cyber-security and the potential risks associated with unmanned aerial vehicles, economic uncertainty, armed conflict, or civil unrest. New and evolving threats reinforce the need to review regulatory frameworks and activities to ensure resilience and continuing oversight of safety and security in similar circumstances.

Regulators should consider the strategies and resources needed to respond to new regulated technologies in an era of rapid development in nuclear reactors and extended operating life of existing plant and waste management facilities. In addition, techniques for effective assessment and regulation of new technologies must be developed and maintained in a period of rapid development, both in the field of nuclear power and the medical and industrial environments. In this regard, forward planning and workload forecasting are of great importance to regulatory bodies to ensure that the appropriate resources and capabilities are maintained for future needs.

On the topic of climate change, new regulatory strategies are needed to ensure the resilience of existing and new nuclear installations and radiation facilities, together with enhanced efforts to monitor the external environment to prepare for future energy, industrial, and health care demands arising from climate change.

Regulators should make use of risk insights and research and development, together with information technology for greater connectivity and consider the potential benefits of AI and other technologies to fulfil the functions of the regulatory body.

Acquiring and sustaining competences for managing this digital transformation and increasing the use of AI and cyber-security should be planned and resourced to ensure the regulatory capacity to deliver timely, effective and appropriate regulatory responses in an environment of rapid electronic communications, media disinformation and digitization.

The conference addressed the challenge of stakeholder involvement in nuclear and radiation applications and the necessity for regulators to build good relationships

based on trust and transparency. This aspect of good regulatory practice must continue to be enhanced in the current environment and focus regulators globally on international cooperation and harmonization of regulatory activities in the face of fast-changing technologies, and social and political circumstances. In this respect, regulatory programme effectiveness and credibility can be enhanced through self-assessment and peer reviews.

Maintaining a safety and security culture is fundamental. Leadership in this respect is essential both for regulators and regulated facilities and activities. In addition, safety and security culture should be instilled in the new generation of professionals through capacity building programmes.

ISSUES TO BE CONSIDERED BY GOVERNMENTS

The energy crisis challenges the ongoing capacity of nations to achieve a balance between electricity production and consumption. In response, governments may consider new nuclear power programmes or reviews of planned closures. At the same time, there is growing demand globally for medical and industrial radiological applications. However, significantly enhanced resources will be needed to maintain regulatory effectiveness, particularly where new and innovative technologies such as SMRs are being considered.

In this environment, ensuring the continued independence of regulatory decision making is essential, especially after revision of nuclear plant closure dates and the increasing trend towards new and expanding projects in nuclear and radiation applications.

In the light of recent global crises, governments should consider enhancing their promotion and resourcing of national programmes for capacity building to ensure the ongoing capacity of national regulators to secure the safety and security of nuclear facilities, materials and radioactive sources.

Governments should give priority to the coordination of activities of all national bodies with interfacing and overlapping regulatory responsibilities, including for emergency preparedness and response.

ISSUES TO BE CONSIDERED BY INTERNATIONAL ORGANIZATIONS

International organizations should consider the following:

- The need to strengthen international cooperation, knowledge transfer, mutual learning and efficient networking in particular, through regional networks.
- Increased and coordinated international cooperation to develop resilience of the nuclear and radiological sector through cooperation of regulators and industry at regional and global level.
- Support for regulatory strategies for managing the unexpected, and increasing regulatory agility, adaptability and resilience.
- Support for leadership for nuclear and radiation safety and security together with safety and security culture, especially when training the new generation of professionals.
- Support for diversity and gender balance in the regulatory workforce and the need to fully prepare and empower a new generation of leadership.
- The need to maintain effective and agile emergency preparedness and response programmes, with modernization options such as: regulatory utilization of

emerging technologies; timely coordination with off-site competent authorities and responders; effective coordination with neighbouring countries, international and regional organizations and jurisdictions; and communication with the public.

— How international peer review and advisory services can contribute to trust and transparency in addressing regulatory challenges.

CONCLUSIONS FOR THE CONFERENCE AS A WHOLE

Since the previous conference in The Hague in 2019, regulatory frameworks and infrastructure have continued to improve, but in the same period, regulators globally have been faced with unprecedented challenges including the COVID-19 pandemic, climate change and the energy crisis, compounded in some regions by armed conflict, which has added risks to some nuclear and radiological facilities and activities to an extent never before experienced.

There is a realization that stability is a tenuous concept and regulators (and operators by requirement) must be ready for the unexpected. Agility and flexibility are keywords of this conference and apply also to the regulatory capacity to maintain oversight and control of rapidly developing new technologies as they are deployed across the spectrum of regulated nuclear and radiation practices, facilities and activities.

This conference has shown that global coordination and cooperation are the key to so many of the challenges facing regulators today. This conference has urged the global nuclear community to engage in international cooperation efforts to accelerate regulatory progress through harmonization and to gather best practices to be applied to a coordinated approach to the safety of nuclear and radiation facilities and activities and security.

3.2. CALL FOR ACTION

Leadership: Invest in people skills and capabilities, develop the next generation, be brave and intentional:

- Define the traits needed for regulatory leaders and take concrete actions to train and empower them so they can drive our regulatory missions forward in changing environments.
- Integrate young professionals into regulatory bodies, provide structured learning and support programmes for career advancement, and ensure that diverse viewpoints and backgrounds are incorporated in decision making.
- Make regulatory decisions in an effective and efficient manner. Uphold a strong safety and security focus while striving to not impede progress.

Organizational readiness and agility: Use proactive planning frameworks and adaptive management techniques to assess the environment, plan for the future and address the unexpected:

- Adopt comprehensive strategic planning and workload forecasting methods for the planning and prioritization of regulatory activities and initiatives; revisit assumptions on a routine periodicity (e.g. yearly) to assess the need for changes. Seek early engagement with designers and industry to understand planned technology adoption and deployment as a means to inform regulatory priorities.
- To be prepared to address new challenges, evolving threats and unprecedented stressors on safe operation of facilities, establish a risk informed strategy that fosters continued safety and security — leverage international partners as needed for support and benchmarking, and share feedback from experiences to elevate global safety and security.
- Start with the end in mind. Incorporate security by design for small modular reactors and advanced reactor designs. Consider facility life cycle at the design and authorization stages and have clear responsibilities and frameworks for ageing management and waste disposal. Develop and enhance international and domestic regulatory frameworks for source management and disposal to include safety standards, security practices and liability guidelines.

Trust: Demonstrate competence, openness, and impartiality:

- Prioritize actions that engender trust between the regulator, the regulated community and members of the public.
- Meaningful communication and engagement with the public on policy and oversight activities should be tailored to specific communities through appropriate media and direct engagement.
- Demonstrate reliability and credibility by re-evaluating safety and security legislation, regulations and regulatory approaches to ensure they remain effective and valid to ensure that guidance is easily understood. If gaps exist, create a plan to close them, leveraging expertise and model frameworks from regulators, technical support organizations, or other relevant resources.

Collaboration and capacity building: Accelerate progress by engaging in joint reviews (harmonization), region focused capacity building and sharing of best practices:

- Transition to a global mindset. Invest in harmonization of regulatory approaches and incentivize standardization of small reactor designs as a means to maintain

a high level of safety and security, leverage collective technical expertise and achieve timely and consistent authorization decisions.
- Leverage regional cooperation for training, technical assistance and knowledge transfer among Member States to build regulatory competence and stakeholder confidence in the licensing and oversight of peaceful uses of nuclear and radioactive material.

Recommendations for moving forward:

- Create a method to track progress between now and the next conference.
- Encourage bilateral and multilateral exchanges on design and technical/regulatory matters and make the fruits of these exchanges well known to the public. Bilateral and multilateral technical exchanges, using the regional networks, Global Nuclear Safety and Security Networks, as well as national efforts are and should be augmented. For instance, by the activities of a variety of international enterprises that facilitate nuclear and radiation safety — intergovernmental organizations, multinational networks among operators, multinational networks among regulators, the international nuclear industry, multinational networks among scientists, and other stakeholders (public, news media, NGOs) that are engaged in nuclear safety. All these efforts should be harnessed to enhance the achievement of safe and security goals.
- Accelerate opportunities for youth to engage with experienced regulatory communities (e.g. have the winner of the youth competition present progress from the youth competition at the next IAEA General Conference, and include a young professional on the next planning committee).
- Challenge ourselves to be stewards of these recommendations.

3.3. CLOSING REMARKS

H.E. Ambassador H. Alkaabi

Permanent Representative of the United Arab Emirates
to the International Atomic Energy Agency,
Vienna

Mr. President, Excellencies, distinguished guests, ladies and gentlemen.

At the outset, I would like to express my sincere thanks for the success achieved this week during the IAEA International Conference on Effective Nuclear and Radiation Regulatory Systems: Preparing for the Future in a Rapidly Changing Environment. We are thankful for the contributions of all participants and the support of the IAEA and the Programme Committee to ensure that all discussions, topics and needs are taken into consideration.

Around 580 participants from 95 IAEA Member States had effectively deliberated the current status and future needs of the nuclear and radiation regulatory systems. I am delighted to see the enriched discussions to identify challenges and hammer out solutions to draw the roadmap to strengthen cooperation among nuclear and radiation regulatory bodies around the world to prepare for the future.

The conference focused on emerging challenges such as the safety and security of new technologies, full life cycle challenges of nuclear and non-nuclear applications as well as regulatory agility and being prepared for the unexpected circumstances that might occur and affect the nuclear sector at large. Collaboration and resilience are key perquisites for regulatory bodies to be ready for the future and ensure the sustainability of the nuclear sector.

The United Arab Emirates is ready to address such challenges and strengthen cooperation with our stakeholders to address them in a prompt and timely fashion. There is an imperative need to be ready: from regulations and robust oversight to having inspection progammes and building the cadre of persons who are able to regulate the sector and ensure its sustainability.

The UAE is ready to provide full support to the international nuclear community to be able to achieve its goals.

Thank you once again for your valuable contributions and looking forward to seeing you in the next edition of the IAEA International Conference on Regulatory Systems.

Thank you.

3.4. CLOSING REMARKS

Ms Anna Hajduk Bradford

Director,
Division of Nuclear Installation Safety,
Department of Nuclear Safety and Security,
International Atomic Energy Agency,
Vienna

On behalf of the IAEA, I thank the participants for their contribution to the conference and the President for an excellent summary which will constitute an excellent guide for all our future activities in strengthening regulatory effectiveness.

This has been one of the biggest conferences of nuclear and radiation regulators in the world, with more than 620 registered participants from 95 IAEA Member States and three international organizations. There were over 38 presentations throughout the week, along with 68 posters. This is a clear reflection of the strong interest in exchanging information and experience, and the willingness to learn from one another to continue to improve regulatory systems worldwide.

The wide and diverse variety of topics demonstrates the broad range of issues and challenges faced by the regulatory community worldwide, and this conference has helped develop ways to address them.

One of the key attractions of this conference for young professionals was the Youth Panel Competition, which received 56 synopses from 18 Member States. The competition winner was the UAE Team, which will be invited to the IAEA's 67th General Conference in September 2023 to present project ideas.

Regulators need to be adaptable and be prepared. Leadership for safety and security is needed more than ever, aligned across all regulators, agencies and other related organizations, including capacity building and training. The IAEA Secretariat stands ready to provide assistance to address the issues and challenges that have been discussed during the conference.

The key insights and recommendations from this conference will provide a valuable contribution to shaping our future activities.

The IAEA is sincerely grateful to the Government of the United Arab Emirates, in particular H.E. Ambassador Alkaabi for his personal interest and active support for this event, and I thank the UAE Federal Authority for Nuclear Regulation (FANR) for hosting this very successful conference, the excellent facilities provided, and the generous and gracious hospitality.

I declare the conference closed.

ANNEX I.
CONFERENCE STATISTICAL DATA

Organized by	IAEA Department of Nuclear Safety and Security (NS)	
Location	Abu Dhabi, United Arab Emirates	
Hosted by	Government of the United Arab Emirates, Federal Authority for Nuclear Regulation (FANR)	
Total No. of participants	**624 including invited persons**	
From Member States	604 from 95 Member States	
From Organizations	6 from 3 Invited Organizations	
IAEA Staff Members	14	
Virtual Attendance	628 App Users	
Total no. of invited persons	88	
No. of statements or presentations and others	Sessions and Panel Discussions	13 (incl. opening and closing)
	Side Events	2
	Speakers	87
	Posters	68
Secretariat of the Conference (IAEA)	S. Mallick, Scientific Secretary M. Moracho, Scientific Support M. Añez, Scientific Support S. Kunjeer, Scientific Support T. Danaher, Coordination Support A. Dixit, Communication Support A. Strohal, Communication Support J. Bamu, Finance Support H. Su, Administrative Support M. Lasheen, Intern	
Conference website	https://www.iaea.org/events/regcon2023	

ANNEX II.
LIST OF PRESENTATIONS

The presentations listed below are available on the Conference App of the conference[1]*. The Panel Discussions, Special Panel and side event on Regulatory Consideration of Climate Change Challenges to Nuclear Installation Safety were panel discussions and therefore no presentations were made.*

Session	Presenter	Member State/Organization	Title of the presentation
1	R. Pacheco	IAEA	Impact of COVID-19 pandemic on the regulatory activities for the safety of radiation sources
1	O. Korikov	Ukraine	The military aggression against Ukraine: Nuclear and radiological risks and threats, regulatory challenges and lessons learned
1	F. Mansoor	Pakistan	Expect the unexpected
1	A. Veil	United States of America	Addressing emerging challenges and becoming a modern regulator
1	J. Panek	European Commission	Resilience and preparedness in the European nuclear sector in face of unprecedented challenges Safety regulations for aged reactors
2	A. Bradford	IAEA	IAEA's activities to promote agility
2	S. Bilbao y León	World Nuclear Association	Delivering nuclear at scale and speed needs harmonization
2	A. Ferapontov	Russian Federation	Specifics in safety regulation of innovative designs in the Russian Federation
2	L. Hu	China	Tackle the challenges of safety review on the innovative technologies
3	S. Alamoudi	Saudi Arabia	Achieving regulatory effectiveness through national and regional collaborative cooperation and partnership

[1] https://iaea.event.do/#/e/5997

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3	D. Lukauskas	Lithuania	Decommissioning and waste management of Ignalina NPP
3	L. Valentino	Argentina	Regulatory verification of supply chain for facilities: A growing challenge
3	H. Looney	IAEA	Cradle to grave nuclear security: challenges and opportunities
4	M. Foy	United Kingdom	Establishing trust as a regulator
4	Y. Hah	Republic of Korea	Stakeholder involvement: Building a trusted relationship between a regulator and its stakeholders
4	F.A. Ollite	Mauritius	The regulator: Building trust through an effective communication of its regulatory processes
4	E. Ampomah-Amoako	Ghana	International and regional cooperation efforts of the Nuclear Regulatory Authority, Ghana
4	O. Lugovskaya	Belarus	Trusted regulator: Experience of the Republic of Belarus
5	R. Hammad	Pakistan	Holistic approach to regulatory capacity building for the future at PNRA
5	M. Ermacora	Argentina	Devising a programme for competence acquisition and development among radiological and nuclear regulators
5	N. Inoue	Japan	Capacity building support activities for nuclear security by ISCN/JAEA
5	S. Soliman	Egypt	ENRRA practice in building the capacity and managing the knowledge
5	M. Kenzelmann	Switzerland	ENSI's approach to capacity building

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Youth Panel	M. Hussain, M. Umer M. Furqan	Pakistan	Climate-smart regulations to enhance safety of nuclear installations
Youth Panel	A. Al Qubaisi K. Alawadhi F. Almheiri F. Al Hammadi	United Arab Emirates	Nuclear Ferris Wheel
Youth Panel	S. Garza Z. St Hillaire	United States of America	A proposed learning platform to encourage nuclear employment
Youth Panel	J. Gorman	United Kingdom	Nuclear Regulator Apprenticeship Network
Coffee Break Session	C. O´Connor	Ireland	Development and Implementation of a Risk-Based, Outcomes Focussed Regulatory Strategy
Coffee Break Session	P. Patil	India	Safety/Security Interface and Maintaining Safety and Security Culture in Nuclear and Radiation Facilities
Coffee Break Session	M. Sneve	Norway	Interfacing National, Bilateral and Regional Activities with International Programmes: Promoting Credibility and Resilience in Regulatory Processes
Coffee Break Session	T. Zhunussova	Norway	Stakeholders' involvement in Capacity Building in Central Asia's Nuclear and Radiation Safety and Security Regulatory Framework

ANNEX III.
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001	N. Al-Tameemi	Iraq	Evaluation of the effectiveness of the regulatory framework for radiation safety and security in Iraq
012	C. Salata	Brazil	Development of a methodology based on graded approach for preparing an inspection programme in the Brazilian nuclear authority
022	D. Bokov	Russian Federation	Revision of physical protection requirements to take into account experience of decommission and construction activities at existing nuclear facility
024	D. Lobach	Belarus	Adaptability of technologies for regulation and analysis of nuclear and radiation safety in Belarus
025	B. Dias Rodrigues	Brazil	Brazil's experience regarding the exceptional authorization to perform outdoor therapy with activities over 1850 MBq during the Covid-19 pandemic
032	Z. Tahiri	Morocco	Maintaining an effective regulatory oversight during the Covid-19 pandemic: Morocco's experience and lessons learned
040	K. Pakdee	Thailand	Business continuity plan for nuclear and radiation safety regulation training during the Covid-19 pandemic
045	V. Piplani	India	Guidance for application of graded approach in regulation of facilities and activities

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082	A. Haseeb	Pakistan	Adaptive strategy for effective regulatory oversight of nuclear installations and radiation facilities during the Covid-19 pandemic
089	C. Guembou Shouop	Cameroon	Cameroon YGN response strategies to unexpected challenges and lessons learned
102	B. Kaboro	Kenya	Use of criteria-based assessment tool to assess the implementation of the amendment to the Convention on Physical Protection of Nuclear Material in Kenya
103	M. Azfar Ramli	Brunei Darussalam	Impact of Covid-19 pandemic to the regulatory activities on radiation protection and security of radioactive material in Brunei Darussalam: Adaptability and resilience
129	T. Riekert	Germany	The regulatory challenges of licensing innovation in the nuclear industry and how these may be resolved
133	L. Martiri	Argentina	Implementation of a graded hybrid inspection and personnel licensing plan by the Argentine regulatory body during the Covid-19 pandemic and beyond
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186	J. Villafañe Z. Abulawi	Argentina Jordan	The impact of climate change on the effectiveness of regulatory bodies and possible solutions
187	V. Mañana G. Nyalunga P. Mashamaite L. Nogxina G. van der Merwe	South Africa	Effective and adaptive applications of communication and outreach tools to improve regulatory relations with stakeholders
188	A. Lee A. Valiaveedu D. Burgess	United States of America	Regulatory effectiveness in an increased use of digitalization and innovative technologies

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039	P. Ampornrat	Thailand	Cooperative techniques on construction licensing of an MNSR research reactor in Thailand
044	A. Mowitz	Sweden	Experiences and continued work — new regulatory code for nuclear safety and nuclear security in Sweden

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058	C. Gamulani	Malawi	Malawi's experience in stakeholders and public engagement in implementation of radiation safety and security
067	C. Guembou Shouop A. Simo	Cameroon	Effectiveness of radiation regulatory body: Case study of Cameroon
068	J. Scott	Australia	Regulatory oversight of the OPAL research reactor in-service inspection (ISI) programme
071	S. Sudprasert	Thailand	Living inspection programme for ageing research reactors
073	N. Hossain	Bangladesh	Regulatory aspects of establishing cyclotron facilities in Bangladesh
078	K. Mubiru	Uganda	Multi-objective life cycle budget allocation for nuclear supply chain management
084	M. Kostor	Malaysia	Enhancing regulatory compliance through "Licensing Clinic"
086	D. Ojha	India	Development and implementation of regulations for emergency preparedness and response programme
088	T. Teng	Malaysia	Regulatory framework and infrastructure for naturally occurring radioactive materials (NORM) milling facility
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093	S. Kassimi	France	ASN's supervision of decommissioning challenges and progress in France

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009	C. Tuğrul Zeyrek	Türkiye	The importance and implementation of education and training activities in new scope of regulatory framework and infrastructure for nuclear and radiation facilities in Türkiye

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033	Z. Tahiri	Morocco	New technologies in radiation therapy: Ensuring patient safety
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154	M. Ab. Rahim	Malaysia	Development of assets life cycle management (LCM) programme in sustaining regulatory functions in Malaysia
156	M. Al Mheiri	United Arab Emirates	Regulatory effectiveness and lessons learned for first refuelling outage of Barakah NPP Unit-1, United Arab Emirates
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184	H. Janžekovič	Slovenia	Building trust through inspection programme

The conference contributions listed above can be found on the Conference App[2].

[2] https://iaea.event.do/#/e/5997

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